JYU DISSERTATIONS 239

Tore Hoel

# Privacy for Learning Analytics in the Age of Big Data

## Exploring Conditions for Design of Privacy Solutions

UNIVERSITY OF JYVÄSKYLÄ
FACULTY OF INFORMATION TECHNOLOGY

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Esitetään Jyväskylän yliopiston informaatioteknologian tiedekunnan suostumuksella
julkisesti tarkastettavaksi kesäkuun 12. päivänä 2020 kello 12.

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on June 12, 2020 at 12 o'clock noon.

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# ABSTRACT

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Introduction of learning analytics to education opened up the can of worms related to privacy issues that come with big data. Privacy issues are increasingly 'wicked problems' that call for a rethinking of the key artefacts involved. Global information systems make privacy a challenge that go to the center of solution design and information science research. In this dissertation research we exemplify the long and winding process from capturing questions of concern, to constructing conceptual artefacts to begin discussing the concerns, to proposing the first constructs that could lead to technical solutions—all within the context of technology enhanced learning and education.

Learning analytics is a new discipline based on an increasing access to data, which will be extended by introduction of more and more sensors that are part of smart classrooms and intelligent campus projects. There is a gap between people's online sharing of personal data and their concern about privacy. However, online practices are volatile, which make action design research and design science research an appropriate approach to explore conditions for design of privacy solutions. The research has been carried out taking part in two practice communities, the learning analytics knowledge community, and the learning technologies standards community.

The contributions of this PhD research are both theoretical and practical. Privacy is defined in the context of big data; the theory of contextual integrity is extended to include the concept of 'context trigger', and design proposals explore the role of privacy policies in regulating data sharing. Risks and benefits of data sharing is explored to develop a learning analytics design space model. In addition, other constructs to facilitate discourse on data sharing in context are developed.

Keywords: privacy, privacy engineering, contextual integrity, personal data, learning analytics, big data

# TIIVISTELMÄ (ABSTRACT IN FINNISH)

Hoel, Tore
Oppimisen analytiikan yksityisyys Big data –aikakaudella – Yksityisyyden suunnitteluratkaisuja etsimässä
Jyväskylä: University of Jyväskylä, 2020, 61 p. (+ included articles)
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Oppimisen analytiikan käyttöönotto koulutuksessa avasi runsaasti kysymyksiä yksityisyydestä Big data -analyysiä hyödynnettäessä. Tietosuojakysymykset ovat yhä ′pahempia ongelmia′ ja uudenlaista ajattelua tarvitaan niiden selvittämiseksi. Globaalit tietojärjestelmät tekevät yksityisyydestä haasteellista ja tästä syystä on tärkeää keskittyä ratkaisujen suunnitteluun ja tietojärjestelmätieteen tutkimukseen alalla. Tässä väitöskirjatutkimuksessa havainnollistetaan aihealueen keskeisimmät kysymykset, konseptualisoidaan keskeiset käsitteet, joita tarvitaan keskusteluun yksityisyyden huolenaiheista. Lisäksi tässä väitöskirjassa ehdotetaan ensimmäisiä askelia yksityisyyden teknisiin ratkaisuihin teknologiavälitteisen opetuksen ja koulutuksen saralla.

Oppimisen analytiikka on uusi tieteenala, joka perustuu ulottuvillamme olevaan kasvavaan tiedon määrään. Tulevaisuudessa älykkäiden luokkahuoneiden ja –kampusten kasvava sensorimäärä tulee lisäämään oppimisen analytiikan hyödyntämistä. Ihmisten henkilökohtaisten tiedonjakamistottumusten ja heidän yksityisyyttä koskevien huoliensa välillä vallitsee kuilu. Ihmisten verkkokäyttäytyminen on ailahtelevaa, mistä syystä toimintatutkimus ja suunnittelutiede soveltuvat hyvin yksityisyyden ratkaisujen suunnittelemiseen. Tämä tutkimus on toteutettu toimintatutkimuksena osallistumalla kahteen toimintayhteisöön: oppimisanalytiikan yhteisöön ja oppimisteknologioiden standardisointiyhteisöön.

Tämän väitöskirjatutkimuksen vaikutukset ovat sekä teoreettisia että käytännöllisiä. Yksityisyys on määritelty Big datan kontekstissa; asiayhteyden eheysteoriaa on laajennettu ‘asiayhteyden laukaisijan’ käsitteellä ja suunnitteluehdotuksissa tutkitaan yksityisyyden käytänteiden roolia tiedon jakamisen sääntelyssä. Tiedonjakamisen riskejä ja hyötyjä tutkimalla on kehitetty oppimisen analytiikan suunnittelutilamalli. Lisäksi väitöskirjassa on kehitetty muita käsitteitä helpottamaan tiedonjakamiseen liittyvää tieteellistä keskustelua.

Asiasanat: yksityisyys, yksityisyyden suunnittelu, asiayhteyden eheys, henkilökohtainen tieto, oppimisen analytiikka, Big data

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Aspiring for a PhD as a conclusion of a rather unruly career is not the best of ideas. Through my life many people have obviously tried to point me in the right direction—and failed. I am sorry for not having listened to you; and I have forgotten your names. Some people have tried to block my path. I have also forgotten your names. So, I am left with a few persons that I know have had direct impact on this PhD project. All the rest know that I am grateful for every single argument we have had advancing our confusion and knowledge of issues at the edge of whatever field we were dealing with at the moment.

I have been working for one and the same academic institution for exactly 25 years. Director General Åsulv Frøysnes of Oslo University College recruited me as director of communications when world wide web and e-mail were a novelty for most academics. After five years, when learning technologies were more exciting than college sweaters with the right logo type, Frøysnes let me reinvent myself as a freewheeling learning technologist, standards expert, and pedagogue.

Two worlds opened up to me, both providing a fertile ground for research into practice. In the world of standardisation I met a lot of people smarter and more disciplined than me. Here I met my supervisor, Professor Dr. Jan Pawlowski, who also joined me in the world of European projects. My last EU project pioneered learning analytics and let me work together with Professor Weiqin Chen. She has been an unfailing source of inspiration and encouragement. Without her subtle insistence on the necessity of having to live with academic frustrations and red tape I had gladly ended the PhD process at any stage.

Along the winding path towards a PhD I have met good will from many other people who believed in me—at least for some time. I will mention only one, Professor Sten Ludvigsen, who let me hang around his research group at University of Oslo long enough to realise that research and academic writing is very different from the journalistic approach I brought to the table.

Oslo 1.4.2020
Tore Hoel

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| II | Hoel, T. & Chen, W. | 1, 2, 3, 4, 5, 6 | Privacy and data protection in learning analytics should be motivated by an educational maxim—towards a proposal |
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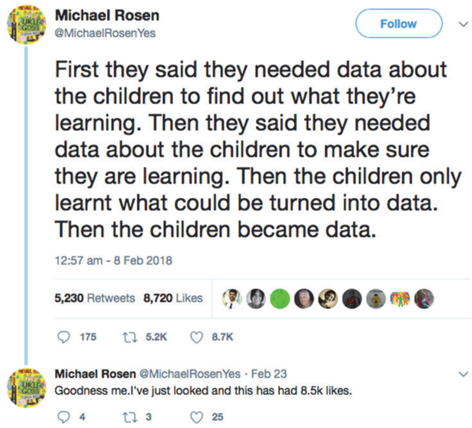
*) Contributor roles according to CRediT Taxonomy (casrai.org/credit) used above: 1) Conceptualization; 2) Investigation; 3) Methodology; 4) Validation; 5) Visualization; 6) Writing - original draft.




# 1 INTRODUCTION

In May 2018, GDPR, the first privacy framework adapted to the Internet era, came into effect in most of Europe. This year may well be the turning point for how online users look upon privacy. However, it is a high-risk effort to draw conclusions about an area of research that is so in flux, where there are new developments every time one opens the computer.

Privacy has always been an important topic in information science; however, extensive review of four decades of studies up till 2011 showed that "the overall research stream has been suboptimized because of its disjointed nature", according to Smith, Dinev, and Xu (2011, p. 1008). Reviewing 320 articles on privacy these authors found that very few studies had considered privacy at small group level. They concluded, "a single individual likely belongs to more than one group, so (s)he may adhere to different norms regarding privacy as (s)he travels between groups. How an individual navigates such different normative expectations would also be a fruitful domain for additional research" (ibid, p. 1007). In the same year, Belanger and Crossler found, in another review of 340 articles on information privacy, that few papers present design and action research on information privacy. "As design science becomes an increasingly important area of research, IS researchers should consider the development of more (and easier to use) privacy protection tools for individuals, groups, organizations, and society" (Belanger & Crossler, 2011, p. 1035).

This thesis narrows the scope of discourse to education and what happens with our conception of and solutions for privacy when terms like 'learning analytics' (LA) and 'artificial intelligence in education' start to appear in institutions' strategy documents. 2011 was the year when the first international conference on learning analytics and knowledge (LAK) was organised (www.solarresearch.org). From the very beginning this new research community had to develop the new knowledge field on a backdrop of controversies about privacy and data management. There were incidents of collapse of trust in ethical management of data, the most notorious in education being the shutdown of the inBloom project in 2014 (Horn, 2014; Kharif, 2014; K.N.C., 2014). In 2016, the European LACE project raised the question if privacy would be a showstopper for LA (Griffiths et al., 2016). Despite the concerns, looking back at the last ten years of research on LA and the use of educational data we would claim that we have seen few groundbreaking proposals for privacy solutions from this community.

Another practice community for this author, the learning technologies standards community, only recently published its first contribution to privacy in education, a technical specification on privacy and data protection policies (ISO, 2019). Based on participatory research in the LAK community and the standards community, the information science research reported in this thesis is a modest contribution to explore conditions for the design of privacy solutions for learning, education and training. The initial research questions have been how we do understand privacy in this domain, and what principles should guide privacy engineering in an educational context.

This thesis is structured as follows: The next section gives theoretical foundation and context for this thesis, identifies research gaps and concludes with the research questions addressed in this work. Section 3 elaborates research method and approach, which is based on action design research cycles interacting with the research community, the two communities of development and practice mentioned above, and end users. Section 4 gives an overview of the included articles. Section 5 summarises the theoretical and practical contributions of this thesis research and discusses limitations and further work. The 10 original papers this PhD research builds on are included at the end of this thesis.

# 2 BACKGROUND – THEORETICAL FOUNDATION AND RESEARCH CONTEXT

The key components of the dissertation is described in Figure 1, which gives a conceptual overview of the issues addressed in research. The model describes how issues related to privacy and data protection for LA are embedded in a bigger picture that only can be constructed through a multidimensional approach. The section gives an overview of previous research that has underpinned the approach chosen for this dissertation and concludes by explaining the implications and relevance of the topic in the domain of education where the empirical investigations of this PhD research were conducted.

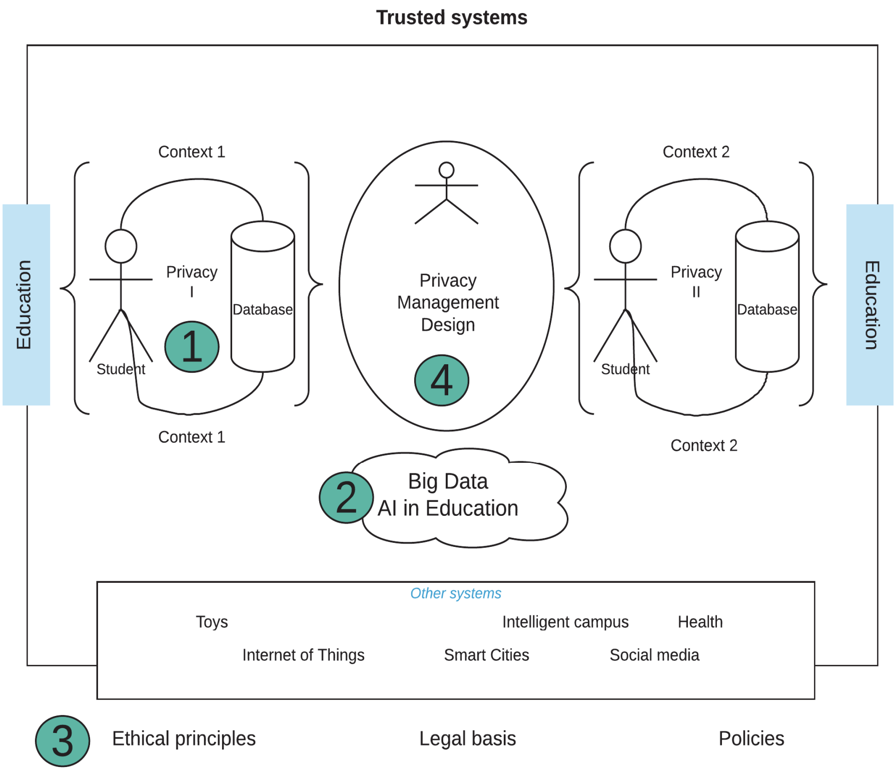



FIGURE 1. Overview of issues addressed in this research

Figure 1 outlines some of the deciding factors that define privacy, and ultimately trust, in the educational domain. At the core of the model is design for privacy management. The term privacy management describes the process of enabling the data subject, who is the source of the data streams, to achieve a level of control of personally identifiable information so that appropriate trust in the socio-technical system is established. The focus of this dissertation is how to contribute to design of processes and solutions that contributes to building trust in practices of data sharing. Trusted systems rest on ethical principles, law, and privacy policy frameworks.

The following subsections explain more in detail the issues raised in this dissertation, see the four aspects outlined in Figure 1.

## 2.1 A contextual Perspective on Privacy (Aspect I)

In Information science, privacy has always been a topic of interest (Dinev, Xu, Smith, & Hart, 2013), even though published research has had a normative and individualistic bias (Smith, Dinev, & Xu, 2011). From a LAK community point of view, privacy has mainly been viewed as a concern. This can be observed studying the papers published in the main proceedings of LAK conferences in 2016, 2017, and 2018 (www.solaresearch.org/conference-proceedings). In 2016 privacy was mentioned in 3 papers; in 2017 in 14 papers; and in 2018 in 16 papers. With one exception, Drachsler and Greller (2016), privacy is not defined in these papers; privacy is used in combination with other words, like data privacy; student privacy; ethics and privacy; security and privacy; privacy, data management, and consent; and privacy concerns.

It is well known that privacy as a concept "is in disarray [and n]obody can articulate what it means" (Solove 2006, p. 477), and "the picture that emerges is fragmented with concepts, definitions, and relationships that are inconsistent and neither fully developed nor empirically validated (Smith, Dinev, & Xu, 2011, p. 992). No wonder then that the LAK community tend to discuss privacy interwoven with other issues, like ethics and data protection (Ferguson, Hoel, Scheffel and Drachsler, 2016). Untangling these issues, Drachsler and Greller (2016), in the exception paper from LAK16 mentioned above, build an understanding of ethics as a moral code of norms external to a person, whereas privacy is seen as "an intrinsic part of a person's identity and integrity" (p. 2). They see privacy as first and foremost bound by context, "it forms the boundary of one's person or identity against other entities" (p. 2). Data protection, Drachsler and Greller see not as mere legal requirement, but as something that embeds privacy "deeply into Learning Analytics tools and increase[s] the trust of data subjects in these systems" (p. 7). It is not clear how much the distinctions between extrinsic versus intrinsic divers explain the role of ethics and privacy in a discourse on LA, and whether deep embedment would describe data protection. In the guest editorial on ethics and privacy in LA in Journal of Learning Analytics (JLA, vol 3, no 1, 2016) this author contributed to framing a discourse in which ethics comes with an imperative to act (a call to action rather than a restriction on action); data protection comes with legal requirements; and privacy comes with an understanding how the individual observes boundaries around personal and private data as social agreements that depend on who the owner is and in what social setting the data are created and shared.

In the inaugural volume of JLA (2014), Heath describes privacy as an ill-defined concept and offers an overview of contemporary privacy theory contributions. She observes in the early theories of privacy "[d]ebate regarding privacy has swung between arguments for and against a particular approach with the limitation theory and control theory dominating" (p. 3). Heath (2014) points to Nissenbaum's theory of *contextual integrity* (CI) (Nissenbaum, 2004) as the modern privacy theory that could provide a useful bridge to the real world of LA. According to Lester, Klein, Rangwala, and Johri (2017), this is the privacy theory espoused by learning analytics scholars. However, as Drachsler and Greller demonstrates in their influential paper on privacy and LA (Drachsler & Greller, 2016), also this theory needs to be understood in the right context. Drachsler and Greller claim

> Contextual Integrity is very much at odds with the Big Data business model that actually aims to collect and integrate as many data sources as possible and gain new insights from those data through overarching mining and analyses. It uses data that has been collected under different pretexts and circumstances. This repurposing of data is totally against the concept of Contextual Integrity… (Drachsler & Greller, 2016, p. 4).

In our opinion, this is a misunderstanding of the CI theory. First, the problem with the business model above it not that it is against the concept of CI, but that it is illegal (at least in a European GDPR setting). Second, CI is not per se at odds with Big Data; it depends on a concrete analysis of the particular data flow to see if the transmission principles are appropriate or not.

In the context of this thesis, the above brief summary of the conceptualisation of privacy within the LA research and practice community highlights the need for a more thorough understanding of the concept of privacy in LA in relation to ethics, data protection and the current development of data sharing. This is a research gap that has been addressed in this dissertation research.

**Privacy as contextual integrity in learning analytics**

Article IV (Hoel & Chen, 2016a) in this thesis describes the contextual integrity approach to privacy. According to Nissenbaum (2010) "a right to privacy is neither a right to secrecy nor a right to control but a right to appropriate flow of personal information" (p. 127). The context-relative informational norms that are governing activities related to privacy are characterised by four parameters: 1) contexts, 2) actors, 3) attributes, and 4) transmission x'principles. Nissenbaum's definition of contexts is "structured social settings characterized by canonical activities, roles, relationships, power structures, norms (or rules), and internal values (goals, ends, purposes)" (2010, p. 132).

To understand the concept of contextual integrity, let us explore how the Big Data example given by Drachsler and Greller (2016) above stands the test of contextual integrity, i.e., is the flow of personal information described in this case *appropriate* from the perspective of the data subject (the identifiable person whom the personal data refers to). Table 1 outlines a scenario where social media data and institutionally controlled data (from university systems) are analysed for a specific purpose and within a specific context. The default setting of this scenario is that integrity of the student within this context is not jeopardised in any way, even if Big Data is collected, merged and analysed.

Of course, also in this scenario contextual integrity may be violated, e.g., by extending the group of recipients of information, adding new information attributes to the analysis, or diverting from the agreed or expected transaction principles. But the scenario (Table 1) illustrates the point that it is the context and its inherent rules that decides if the integrity of the data subject is maintained satisfactory from this actor's perspective. An apriori judgement that a certain flow of personal information is violating privacy is not possible from a contextual integrity perspective. One has to do a case by case evaluation of the information flow in question.

TABLE 1 Contextual integrity in a scenario of collecting data from many sources

| Scenario: Use of Big Data from social media and university systems to support formative assessment in a social science course | | | |
|---|---|---|---|
| *Context* | *Actors* | *Attributes* | *Transmission Principles* |
| Data collected from social media (Twitter), the LMS, the Student Record System, and the Library system are integrated in a learning analytics session set up to support learner achievement in a social science course. | Sender of the information is the custodians of the social media tool (via giving access to API) and the custodians of tools under control by the university; Recipient of information is the science course teacher; and Information subject is the individual student. | Tweets data, filtered on hashtags relevant to the course; clickstream data from the LMS (e.g., forum entries, data submitted, assessment mark, days overdue, learning outcome achievement) | Data flow terms and conditions: Student has consented to the use of Twitter data for analysis in this particular course. Student has full insight in what data the university systems register. Tacit understanding within teaching-learning relationship that the analysis of the data will be used for formative assessment for the duration of the course only. |

## 2.2 Big Data and AI in Education (Aspect II)

The idea of LA is tightly coupled with the phenomenon of Big Data; in one sense LA is Big Data coming to education. The most common definition of LA, published in a call for papers to the first LAK conference in 2011, describes LA as "the measurement, collection, analysis and reporting of data about learners and their contexts, for purposes of understanding and optimising learning and the environments in which it occurs" (Siemens & Gasevic, 2012). Data is part and parcel of LA; the challenge, however, is to understand what is coming *together with* the data analytics practices when embedded into the educational sector. This *data context* is the topic of this subsection, and the purpose is to give the context for the privacy challenges that are to be handled through design of privacy solutions. As Lowry, Dinev and Willison (2017) find in their proposal for a bold research agenda for security and privacy research, big data (as well as online platforms and the internet of things) "carry innate information security and privacy risks and vulnerabilities that can be addressed only by researching each link of the systems chain, that is, technologies–policies– processes–people–society–economy–legislature" (p. 546).

In the following we will only touch upon some of those linkages, just to give background and help identifying research gaps and questions in this thesis research.

Firstly, LA is always introduced in a *political context*. In Norway, the national research centre on learning analytics (www.slate.uib.no) was established as a result of a government white paper on MOOCs (Hoel & Chen, 2017a). LA was first introduced in a national policy document in Norway in 2014. In their strategy for digitalisation of primary and secondary education the Ministry of Education (2017) used the term learning analytics four times, each time in conjunction with the concept of adaptivity: "Learning resources based on learning analytics contribute to an education adapted to the students' needs and preconditions" (p.12); teachers should have "knowledge about pros and cons about use of learning analytics and adaptive learning resources" (p.13); "new technologies and use of big data open up possibilities for adaptive learning researches and learning analytics" (p.19); and "ICT may give better assessment practice, and possibilities to use learning analytics and adaptive learning" (p.22, authors' translations). Whereas in China, LA is framed in a Big Data context (as in the preferred term 'educational big data'). This framing invokes national strategies, planning, resources and projects that eventually will trickle down the layers of government to be felt by the individual school and teacher. President Xi Jingping, in his report to the 19th Party Congress in October 2017, promoted the "profound convergence of the Internet, big data, artificial intelligence and the real economy" (Creemer, 2017).

It is obvious that the framing of privacy will be very different in a society that sees LA as an opportunity to fulfil the rights of the individual in terms of providing education that is adapted to his or her needs and abilities, versus a society that sees LA as an opportunity to drive economic growth and make sure that the worthy and high-achieving citizens are selected to lead the endeavour. We are not saying that this a fair characterisation of neither Norway nor China; we are just making the point that understanding the political context is essential for privacy design and represents a field where more research is needed.

Secondly, the fact that data drives LA brings a risk of LA contributing to the *datafication of education*. One may claim—at least rhetorically—that the most espoused definition of LA given by SoLAR (Siemens & Gasevic, 2012) has already taken a stand regarding the role of the learner in analytics. It says the LA is about data about the learners, not with the learners, suggesting a objectification of the learners. The consequences of datafication of education have been a concern also before LA came to attention (Breiter and Hepp, 2016; Hartong, 2017; Williamson, 2018a, 2018b, 2017a, 2017b, 2016, 2015; Selwyn, 2015, 2014). From a privacy perspective this concern is about how the available data and the emphasis on learner aspects that leave data traces represent the true learner. Are the data describing the real learner or just a skewed view of the learner provided by the limited set of data available.

Thirdly, LA may be *part of a 'perfect storm'* that involves trending technologies known as artificial intelligence (AI), all with a voracious appetite for data and a promise to provide personalised precision learning. Even if LA research and LA practices are within the educational sector privacy for LA will be strongly influenced by what happenings in society at large. In countries like Norway schools and universities separate clearly between data produced and managed by institutional systems, and data the users generate outside of education using sports apps, social media, and interacting with the myriads of systems leaving data traces. This may change by pressures that build outside of education and potentially without too much pushback from the data subjects, the students, themselves.

Development within AI has just begun to make an impression in public discourse, mainly in other sectors than education (transportation: self-driving cars; health: advanced diagnostics and precision medicine; environment: smart cities, etc.). However, AI will come to education; in the view of Anthony Seldon, Vice-Chancellor of The University of Buckingham, sooner than later. In 2017 he published a book titled *The Fourth Educational Revolution: How Artificial Intelligence is Changing the Face of Learning*, predicting that machines "will replace teachers within 10 years" (Tes Reporter, 2017). Human teachers will remain on hand to set up equipment, help children when necessary and maintain discipline, he said at British Science Festival to the Tes Reporter. However, the essential job of instilling knowledge into young minds will wholly be done by artificially intelligent computers (Tes Reporter, 2017).

While historian and Vice-Chancellor Seldon just predicts, the private non-profit US National University (which runs concentrated online courses) implements through a Precision Education Platform for Personalized Learning. It has established a 'Precision Institute' dedicated to precision education through 'adaptive, machine learning instruction' and 'individualized course navigation' using ‘real-time data generated from multiple sources of assessment tools.’ The platform gather data from students in order to analyse relationships between ‘student characteristics and learning outcomes’ (Williamson, 2018b).

These examples envision gathering and access to data on a scale that we have not seen in education yet, but which is not unrealistic from a number of reasons. Firstly, people give freely away personal information if they see some personal benefit. The success of the *tech giants* (Alphabet (Google’s parent company), Amazon, Apple, Facebook, Microsoft, IBM, Samsung, Alibaba and Tencent) are based on users gifting their data, covering most of their online activities. Their business model is built on aggregation of data and provision of cloud services (House of Lords, 2018, par. 122). Secondly, these tech giants are already deeply involved in education. Furthermore, AI technologies are not better than the datasets used to train the algorithms used. There is a concern that “many of the datasets currently being used to train AI systems are poorly representative of the wider population, and AI systems which learn from this data may well make unfair decisions which reflect the wider prejudices of societies past and present” (House of Lords, 2018, par. 119). This concern combined with promises of innovative learning technologies not yet heard of, would potentially create a great pressure to make available educational datasets for development of new AI tools.

In summary, the concerns highlighted in great detail in the House of Lords’ Select Committee on Artificial Intelligence (2018) also relate to education. Strengthening access to, and control of, data is a must to be able to design new solutions. At the same time there is a need to create intelligible AI (and LA), promoting both technical transparency and explainability.

## 2.3 Ethics, Law, and Policies (Aspect III)

When institutions start to apply LA at scale, they are no longer safeguarded (understood loosely) by decisions taken under the guidance of research ethics committees. They are moving from research ethics to operational ethics, and are struggling to see what that means, consulting ethical concepts and frameworks, drafting institutional codes of practice (Sclater, 2016, 2015) and meeting the organisational discourse on the benefits and challenges of introducing LA. Lester, Klein, Rangwala, and Johri (2017) found that ethics and privacy were en emergent and often ill-defined component of LA. “As with other technological advances, although learning analytics developers and researchers acknowledge the importance of considering ethics and privacy during the development and implementation of learning analytics tools, associated policies, procedures, and best practices related to ethics and privacy often lag behind tool development” (Lester et al., 2017, p. 77). From this perspective, it is interesting to observe the efforts of establishing *ethical design* principles now taking place in standards organisations and international fora, prompted by the interest in and progress of

AI or ′autonomous and intelligent systems′ (A/IS, the preferred term of IEEE) (House of Lords, 2018; IEEE, 2017; British Standards Institute, 2016).

IEEE, the world's largest technical professional organisation, has established a global initiative on ethics of A/IS and plan to release their final version of Ethically Aligned Design in 2019. As the field of LA has many similarities with A/IS, e.g., access and use of heterogeneous datasets and use of algorithms, the LA research community should pay close attention to the broader discourse on ethical design. IEEE concludes that ethical design, development and implementation of A/IS should be guided by the principles of human rights, well-being, accountability, transparency, and awareness of misuse (IEEE, 2017). These five principles summarise moral, economical, technical and legal reasoning that should have global support (or at least great effort is made to anchor the principles in Western, Eastern and African schools of thought). The IEEE guideline document outlines how these principles can be transformed into recommendations that can be turned into design actions, e.g., "[t]he systems should generate audit trails recording the facts and law supporting decisions and they should be amenable to third-party verification" (IEEE, 2017, p. 7).

The International Security Trust and Privacy Alliance published in 2007 a study of twelve privacy instruments to facilitate cross-instrument mapping of the principles identified, i.e., Accountability, Notice, Consent, Collection Limitation, Use Limitation, Disclosure, Access and Correction, Security/Safeguards, Data Quality, Enforcement, and Openness (ISTPA, 2007). The study concluded that "[l]egislation and the language of instruments start to look more alike in progression over time. (…) Legislation tends to be expressed as disconnected requirements (e.g., practices), with no cohesive or overall "system design" focused on the life cycle of personal information. (…) Comparison of the many imprecise concepts contained in privacy practices/principles depends on language interpretation. However, if the legislative instruments are 'abstracted' to a high level (within the restricted scope of this Analysis) clear commonality in requirements emerges" (p. 68).

Among the legal frameworks, the EU's General Data Protection Regulation (GDPR) is the latest and the only one that is designed to meet the requirements of the digital age. The GDPR provides measures to remedy the misuse of personal data (http://ec.europa.eu/justice/data-protection/individuals/misuse-personal-data/index_en.htm); it makes it mandatory to design with privacy in mind (the principle of Privacy by Design) and do privacy impact assessments; it gives European citizens specific rights to redress where AI or autonomous systems has been used, it gives the users right to data portability; and mandates providers to seek informed, explicit and unambiguous consent to collect and process data. However, these rights and regulations are given for use of data in general; the different sectors of society have a job to do in order to make sense of the regulations in their particular domain. For LA, Hoel and Chen (2016c) have researched what the GDPR requirements will imply for LA design and practicers.

## 2.4 Design for Privacy Management of LA – the Question of Trust (Aspect IV)

Privacy management is defined by OASIS (2016) as the collection of policies, processes and methods used to protect and manage personal information. Good management builds trust, which is essential to the smooth running of today's networked, interoperable and complex systems that work across legal, regulatory and policy environments.

Business managers may fine-tune their privacy assurance mechanisms to influence trust and moderate privacy concerns by publishing a clear and adequate privacy policy statement, manage company reputation, and improve the design appeal of their websites based on research on how these factors influence individuals with high- *vs* low-privacy concern (Bansal, Zahedi, & Gefen, 2015). However, our interest is in the design challenges that hopefully will lead to a more substantial improvement of privacy management *per se*. These challenges are addressed by both the practice community and the research community. OASIS has developed a privacy management reference model and methodology (OASIS, 2016), which is designed to build trust by allowing management of privacy by instantiating the relationship between privacy policies and personal information. The standard provides high level concepts, producing Privacy Management Analysis by mapping Policy to Privacy Controls to Services and Functions, which in turn are implemented by Mechanisms, both technical and procedural. The OASIS model and method is claimed to be applicable for all contexts and for different levels of granularity.

The global information system research community makes important contributions to privacy theory, e.g., how people value personal information, observing that a majority of users become reactant if they are consciously deprived of control over their personal data with the result that they many may drop out of the market (Spiekermann & Korunovska, 2017). However, as Lowry, Dinev and Willison (2017) determine, "organisational security and privacy issues are increasingly 'wicked problems' that call for a rethinking of the key artefacts involved" (p. 548). In their attempt to set the issues related to security and privacy research straight Lowry, Dinev and Willison (2017, p. 549-550) provide a non-exhaustive list of IS artefacts that are pivotal to security and privacy research: ethics artefact, information artefact, legal artefact, organisational artefact, person artefact, process artefact, protection artefact, social artefact, technology artefact, threat artefact, vulnerability artefact,

The focus of our PhD research is to ask which constructs are useful in order to build trust and solve privacy challenges within an educational context.

## 2.5 Research Objectives

The public debate about privacy often take a dystopian direction. The more dystopian the more need there is for privacy designs. The first research question relates to understanding the privacy context for educational stakeholders. A grasp of the context will contribute to establishing a necessary backdrop for developing requirements for privacy designs:

> *RQ1: What are the characteristics of the discourse on privacy in education, and how is this discourse influenced by the general discourse on Big Data?*

Privacy is more than the Cambridge Dictionary definitions of "someone's right to keep their personal matter and relationship secret", and "the state of being alone". The concept of Privacy by Design ties the data subject's perception of their personal boundaries and experiences related to exposure of personal information to how systems are set up to protect these boundaries and guarantee an acceptable experience. There are many definitions of privacy; in this thesis we need an understanding of privacy as a phenomenon in the educational context:

> *RQ2: What is privacy and Privacy by Design (PbD) – in the context of education?*

When the nature of the privacy challenges and urgency of supporting privacy in LA is made sense of the design work of solutions may start. However, there is a need for conceptual artefacts to help the design. The next research question is therefore:

> *RQ3: What are the conceptual artefacts and LA process description that will help the design of privacy solutions for LA?*

In describing a process or a tool for carrying out a process there are often implied solutions. The emphasis in this dissertation is the research question above. However, the last research question will point to some solutions that may contribute to build trust in LA through support of privacy:

> *RQ4: Where should designers of LA technologies look to develop their solutions while at the same time maintaining students' trust and privacy?*

# 3 RESEARCH APPROACH AND METHODS

This section explains the approach for the research included in this dissertation and what methods we have chosen to answer the research questions. The research is positioned in the information systems field, an applied science field drawing upon perspectives and results from other fields like computer science, political sciences, economy, and even humanities and philosophy (Peffers, Tuunanen, Rothenberger, & Chatterjee, 2008). The questions we explore originate from ill-defined, real-life situations where technology innovations meet educational practices resulting in stakeholders asking for solutions to their problems. The results sought after are not necessarily technical solutions expected to work immediately, but more conceptual tools and perspectives that would enable (or even empower) different actors to take part in finding future solutions. The appropriate approach for these research challenges is found within Design Science Research (DSR) (Gregor & Hevner, 2013) and Action Design Research (ADR) (Sein, Henfridsson, Purao, Rossi, & Lindgren, 2011), to be explained more in detail below.

This section will justify the chosen research approach and describe how design and action research may contribute to answering our research questions. The section will also address the selected approach for data collection and analysis, and describe how this research can contribute to the body of knowledge within information systems.

## 3.1 Design Science Research — contributing to knowledge and solutions

The ultimate aim of research is to contribute to the development of knowledge. But one may ask *what knowledge* is created by this research on a multifaceted phenomenon as privacy within a emergent field of technologies for teaching and learning? It is clearly not generalisable knowledge based on exploration of a stabilised field of research. This PhD research is situated in an explorative field of multi-vocal discourse where different stakeholders struggle to make sense of how personal information is managed in the use of educational big data. Our goal is to design conceptual constructs and models, and for this we have chosen DSR as an approach. Gregor and Hevner require that the specific approach adopted should be explained, "with reference to existing authorities" (Gregor & Hevner, 2013, p. 350), pointing to Hevner, March, Park, and Ram (2004), Nunamaker Jr, Chen, and Purdin (1990), Peffers et al. (2008), and Sein et al. (2011).

Most of these *authorities* of DSR have published their methodological guidance in the last decade or so, which makes this research approach new and open to challenge. What makes DSR more than just a process for doing development through a number of design cycles is described by Hevner et al. (2004) in their framework for information systems research. Before going through design cycles, one needs to go through a *relevance* process of demonstrating the business needs of the research and justify that the research is applied in the appropriate environment. Then there is the *rigour* process, where one makes sure that the research builds on sound methodological and theoretical foundations, and that the results add to the knowledge base.

The field of LA is quite immature, both in terms of conceptual understanding and access to applications. This puts boundaries to what kind of rigour to be sought. Gregor and Hevner (2013, p. 345) describe DSR activities as positioned in one of four quadrants in the cross-section of application domain maturity and solution maturity (Figure 2).

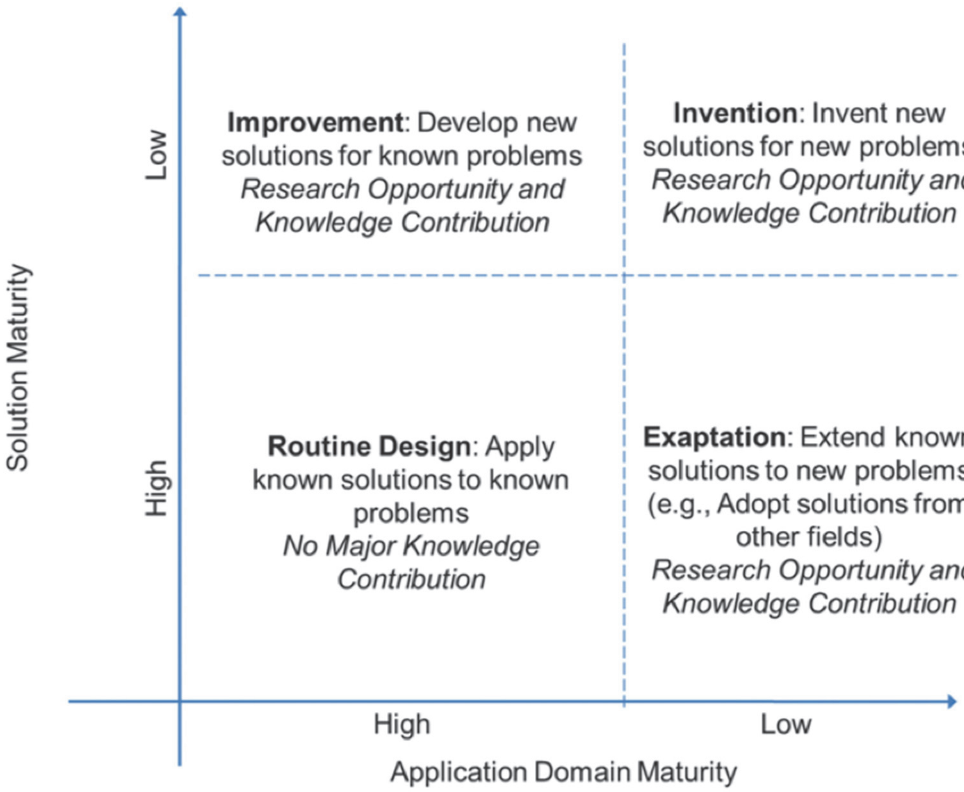



FIGURE 2. Design Science Research Knowledge Contribution Framework (Gregor & Hevner, 2013)

Within the field of LA, the solution maturity is low, which positions the available design activities as invention of new solutions for new problems, contributing to exploration research opportunities, and—if carried out rigorously—to knowledge contribution.

In deciding upon approach, the researcher also has to reflect the practice community he or she is part of, as this grounding often gives an indication of what access to data the researcher has. The research included in this dissertation is carried out in the context of two research communities, the ICT for Learning, Education and Training (ITLET) standards community and the academic LA research community. (The former community has mainly been organised around the ISO SC36 committee; and the latter community has been formed by the EU project LACE and the Society for Learning Analytics Research (SoLAR) Learning Analytics and Knowledge conferences.) While DSR contributes to both descriptive and prescriptive knowledge creation (Gregor & Hevner, 2013, p. 344), the main objective of standardisation will always be to harness prescriptive knowledge. Action Design Research, a near-standing field to DSR, is defined by Sein, Henfridsson, Purao, Rossi, and Lindgren (2011, p 40) as "a research method for generating prescriptive design knowledge through building and evaluating ensemble IT artifacts in an organizational setting".

## 3.2 Action Design Research — in search of prescriptive knowledge

Sein et al. (2011) offer mild critique of DSR, e.g., "the method articulated by Peffers et al. (2008) does not recognize that artifacts emerge in interaction with organizational elements" (p. 38); and claim the DSR "value technological rigor at the cost of organizational relevance" (p. 37). What ADR brings to design science is the "softening [of] the sharp distinction between development and use assumed in dominant DR thinking" (p. 38). The organisational context shapes the design as well as the artefact; research and organisational practice are entangled, therefore, artefacts are "ensembles emerging from design, use, and ongoing refinement in context" (p. 38 - 39). This contextual and organisational approach to design research fits well with the prolonged and not too linear enactment of our practice-inspired research (Figure 3).

However, by realising that research is both planned design and open to context—in short, dealing with messy and emergent, real-life problems—there is no less need to acknowledge the necessity for research rigour and due process. Mullarkey and Hevner (2019) proposed an elaborated ADR process model providing a flexible inquiry into the initiation, conduct, reflection, and presentation of rigorous and relevant ADR projects. This is an extension to the model presented by Sein et al. (2011), which describes four stages and seven principles of he ADR method. In this thesis research we use the simpler latter model, which describes the start of research process with Problem Formulation and ends with Formalisation Learning. In-between, there are Building, Intervention, and Evaluation (BIE); and Reflection and Learning. The main work, however, is done at the BIE stage, between the first three stages there are constant interaction as Reflection and Learning happen all the time; and the understanding of the problem at hand is updated during shaping of the artefact.

Not surprisingly, Problem Formulation in ADR is a dialectical process of a bottom-up principle (Practice-Inspired Research) and a top-down principle (Theory-Ingrained Artifact). The intent, say Sein et al. (2011), should not be to solve a problem *per se*, but to "generate knowledge that can be applied to a class of problems that the specific problem exemplifies" (p. 40). The problem of privacy in LA is a good case in point. There are hundreds of solutions that could maintain integrity for a particular context, but as we have seen in the previous chapter, contexts change, and with that the privacy challenge.

The principle of Theory-Ingrained Artefact goes beyond the obvious requirements that the previous research and theories should inform the problem definition. With a reference to Actor-Network Theory, Sein et al. (2011, p. 41) suggest that "like technology designers who inscribe in the artifact theoretical traces that reflect the sociopolitical context of the design situation (Hanseth & Monteiro, 1997), the action design researchers actively inscribe theoretical elements in the ensemble artifact". In this dissertation research, the choice of contextual integrity (Nissenbaum, 2004) as the lens through which privacy is viewed is an demonstration of this principle.

Sein et al. (2011) identified two end points for the BIE stage of ADR, IT-dominant BIE and organisation-dominant BIE. It is a continuum, and one can easily imagine that an organisational innovation at some stage would be turned into an IT product. For our privacy related research, we are, at least in the early stage of this PhD research, at the organisational-dominant end of the continuum. The BIE stage draws on three principles: reciprocal shaping (both the IT artefact domain and the organisational domain exert influence on building); mutually influential roles (between action researchers, practitioners and end-users); and authentic and concurrent evaluation (where shaping and reshaping is interwoven with ongoing evaluation) (Sein et al., 2011).

For the Reflection and Learning stage and the Formalisation of Learning stage there are only one principle each, the guided emergence principle (ongoing shaping by organisational use, perspectives, and participants), and the generalised outcomes principle (moving from specific-and-unique to the generic-and-abstract) (Sein et al., 2011).

## 3.3 Qualitative methods approach for evaluation

Research rigour will to a large extent depend on the quality of the evaluation in the BIE stage of DSR (Hevner et al., 2004; Sein et al., 2011). Up to recently, there has been little or no guidance provided in how to choose among different paradigms or methods to achieve a DSR project's evaluation goals. Venable, Pries-Heje, and Baskerville (2016) has developed a framework and a process to guide design science researchers in developing a strategy for evaluating the artefacts they develop within a DSR project. “In DSR, evaluation regards not only the utility aspect of the artefact in the environment, but also the quality of the knowledge contributed by the construction of the artefact” (Venable, Pries-Heje, & Baskerville, 2016, p. 87). To achieve both purposes the new framework establishes two dimensions (formative/summative vs. artificial/naturalistic) to help researchers position and plan evaluation episodes during design. The evaluation strategy process is guided by a process of four steps: explicating the goals, choosing a strategy or strategies for the evaluation, determining the properties to evaluate, and designing the individual evaluation episode(s). “It is possible to mix artificial and naturalistic evaluation as well as non-empirical, positivist, interpretive, and critical evaluation methods, supporting a pluralist view of science, where each has its strengths in contributing to a robust evaluation depending on the circumstance” (ibid, p. 87).

In this dissertation research we mainly use qualitative research methods due to the nature of our object of study, and due to the fact that our research is carried out in the early stages of design. Mullarkey and Hevner (2019) have recently elaborated the ADR process model identifying four stages (diagnosis, design, implementation, and evolution). Validating and reflecting on the design proposals in this process will naturally move through the use of different methods, the qualitative methods being more prevalent in the earlier stages of the process. As Hevner et al. (2004) summarise, “[t]he further evaluation of a new artifact in a given organizational context affords the opportunity to apply empirical and qualitative methods” (p. 77). For the later design cycles that are envisioned in future research, however, a mixed method approach with also application of quantitative methods would be used, e.g., to solicit feedback from end-users.

Qualitative research usually addresses unstructured and semi-structured approaches for exploring new concepts and issues (Creswell, 2004). This dissertation research is focussed on designing conceptual tools and constructs, and therefore, construct validity is of importance. To improve construct validity (Yin, 2009), the case study format is well suited as it enables the use of multiple sources of evidence.

## 3.4 The research process explained through ADR cycles

Figure 3 is an adaptation of Sein et al.'s generic schema for organisational-dominant building of an artefact used for organisational interventions (ibid., p. 43). The figure gives an schematic overview of the research presented in this dissertation; in the following we will describe more in detail the context of how building, interacting and evaluation have taken place.

Carrying out BIE involves discovering initial knowledge creation; selecting or customising the BIE schema; executing BIE cycle(s); and assessing the need for additional cycles and if necessary, repeat (Sein et al., 2011, p. 43).

For this research the practitioner field that was the main context for problem formulations consisted of two projects that were carried out in parallel, the EU support action and community building project "Learning Analytics Community

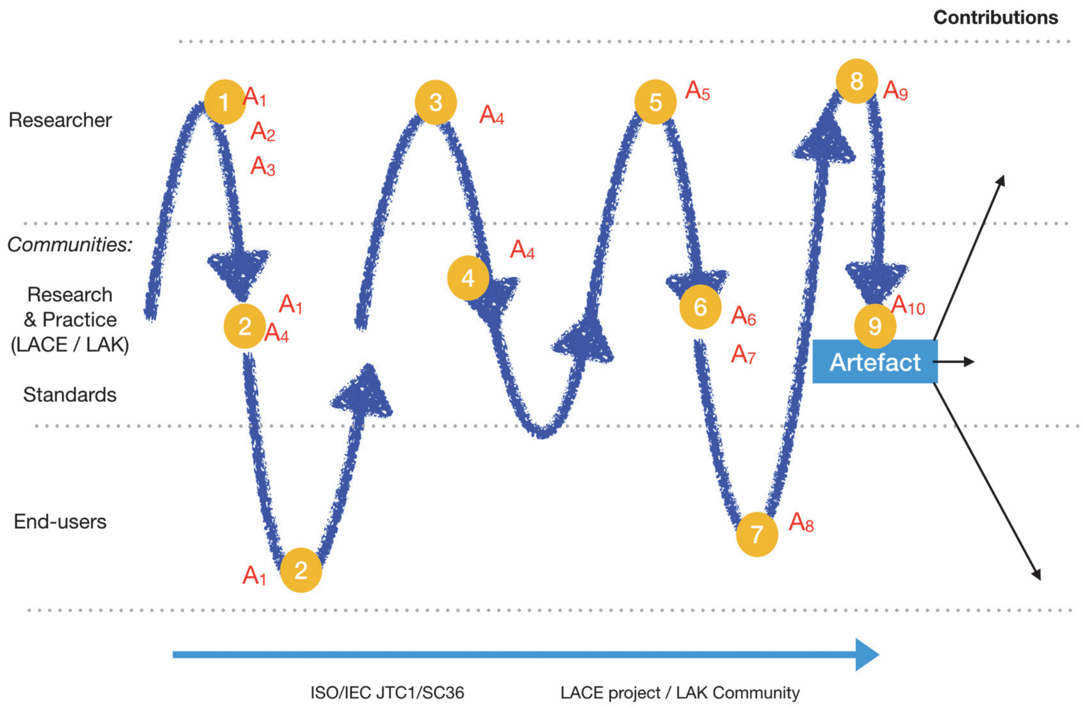



FIGURE 3. The research process with different steps and article outputs (adaptation of Sein et al., 2011)

Exchange" – LACE (2013-2016), and the standards community, spanning from national activities in Norway to international activities in the ISO/IEC JTC1/SC36 group. In this practitioner field, the issues of concern related to privacy were raised. First, the LACE project was set up as a community building effort with a world-wide scope of mapping the state-of-art and concerns of the nascent research LA community. Second, the ISO standards group established a working group on LA in 2015, and the first task was to establish a reference model for LA processes. This work soon forked into a project establishing a standard on privacy and data protection policies (of which this author was project editor). Article VII reflects on this process.

The article numbers in Figure 3 refer to the papers included in this thesis listed below:

I. Data Sharing for Learning Analytics – Exploring Risks and Benefits through Questioning
II. Privacy and data protection in learning analytics should be motivated by an educational maxim—towards a proposal

III. Privacy engineering for learning analytics in a global market — Defining a point of reference
IV. Privacy-driven design of learning analytics applications: Exploring the design space of solutions for data sharing and interoperability
V. Privacy in Learning Analytics – Implications for System Architecture
VI. Data Sharing for Learning Analytics – designing conceptual artefacts and processes to foster interoperability
VII. Interaction between Standardisation and Research – a Case Study
VIII. Are Norwegian Librarians ready to share Library Data to improve Learning?
IX. Standards for Smart Education - towards a development framework
X. Making context the central concept in privacy engineering for learning, education and training. Proposing a direction for development of privacy solutions with support of AI

In the following we describe more in detail how the research process has developed through ADR cycles based on participation in research and practice communities and input from the educational domain.

**Step 1: Problem formulation**

In a ADR cycle this is the first stage, which is trigged by "a problem perceived in practice or anticipated by researchers" (Sein et al., 2011, p. 40). The aim of problem formulation is to identify and conceptualise a research opportunity.

The LACE project did not foresee how big a concern ethics and privacy would be. A series of ethics and privacy for learning analytics (EP4LA) workshops were organised co-located with academic conferences (Hoel & Chen, 2015; Hoel, Mason, & Chen, 2015; Drachsler, Cooper, Hoel, Ferguson, Berg, Scheffel, Kismihók, Manderveld, & Chen, 2015; Griffiths, Hoel, & Cooper, 2016; Griffiths, Drachsler, Kickmeier-Rust, Steiner, Hoel, & Greller, 2016; Hoel, Chen, & Cho, 2016), and the focus of these workshops was to map and structure the issues raised about privacy and other concerns about sharing data for LA. Article I is one outcome of this activity, applying systematic questioning as a method to make sense of the problem. The special issue of Journal of Learning Analytics, co-edited by this author (Ferguson, R., Hoel, T., Scheffel, M., & Drachsler, H., 2016), also contributes to the problem formulation reflecting on the transition from research on LA to large-scale implementations of LA.

In the standards community, privacy was identified as a concern cutting across all processes of LA that was specified in the ISO/IEC TR 20748-1 *Learning Analytics Interoperability – Part 1: Reference Model,* as described in Article VII.

However, privacy is more than a concern; it is grounded in domain contexts and in cross-cultural exchange. Article II explores how education could reason about privacy from a pedagogical point of view; and Article III explores if there is a common point of reference that could make privacy solutions work in global settings.

*Literature review*

During this stage, in parallel with the mapping of issues in workshops an extensive literature review took place. There is an extensive body of research on privacy that is reviewed following the principles for literature review laid out by Fink (2005) as method to describe available knowledge for professional practice. The rigorous approach should be systematic with clear methodology, explicit in the procedures, comprehensive in the analysis and reproducible by others (Fink, 2005). The literature review followed the steps defined by Kitchenham (2004) for conducting a rigorous analysis, including the steps, (1) Identify need and define the method, (2) create research question(s), (3) conduct the search for relevant literature, (4) assess the quality and appropriateness of the studies, (5) extract data from the studies, (6) conduct data synthesis and finally (7) interpret the results and write a report.

The literature review was especially important to answer RQ2, which contributed to the definition of privacy used in this thesis, building on the concept of context integrity (Nissenbaum, 2004, 2010).

This first step concluded in formulation of research questions RQ1 - RQ4.

**Step 2: Scoping, reflection and learning / Communication**

In this research, formalising the questions and making sense of privacy issues in itself was a result. The research and practice community was at an early stage making sense of the affordances of LA. And in the case of the standards community, it was not clear at all that privacy had a role to play in carrying out the process sequence of LA. The research contributions Article I and the special issue of Journal of Learning Analytics served the purpose of communicating research opportunities and relevance (Hevner et al., 2004). So did the public deliverables of the LACE project, e.g., Griffiths, Drachsler, Kickmeier-Rust, Steiner, Hoel, and Greller (2016), and Griffiths, Hoel, and Cooper (2016).

**Step 3: Building, Intervention and Evaluation (BIE) – representing the problem space and finding solutions**

In this step the challenge in RQ3 is addressed. There is a need to find a process to go from problems to solutions, and this process needs to be built. First, the concept of a problem space was constructed, and LACE community exchange input was used to build the construct. A process for developing and evaluating was built, expressed in the Learning Analytics Design Space Model (LADS), Article IV.

**Step 4: BIE – Building and testing conceptual constructs**

In testing the LADS model a case study approach was chosen, where data from literature and from stakeholder consultations were used to test and adjust the model, described in Article IV.

**Step 5: BIE – exploring implications for system architecture**

In this dissertation research we also have explored possible technical system solutions to privacy requirements. Based on a number of requirements solicited from practitioner consultations and literature review a LA search architecture was built (Article V). The research was written up in a conference paper, discussed with the research community and also contributed to the standards community as an expert contribution.

**Step 6: BIE – a process for design of standards in the field of LA**

Participation in the national standards community highlighted issues of conceptual tools and processes regarding developing privacy by design solutions to data sharing for LA. Concepts and a process were designed, and a case study of the initial phase of a consensus process was conducted (Articles VI and VII).

**Step 7: BIE – Evaluating data sharing in a professional context within education**

Access to and sharing of data for LA challenge professional ethics and routines for groups that traditionally have not been involved in analytics. Article VIII reports on research on how librarians look upon data sharing for LA. This BIE step represents a new cycle of research focusing on contextual issues of professional ethics. Quantitative methods and descriptive statistics were used to map Norwegian research librarians attitudes to data sharing.

**Step 8: BIE – zooming out to understand the development context**

The discussion on privacy for LA is held in the context of smart technologies. Within the field of educational technology a new research field on smart technologies is struggling to clarify its foundational principles. Within the standards community where this research is based, the same challenge is met: What are the new foundation for the next generation of learning technologies? In Article IX these two discourses are explored in order to suggest a sketch for a first development framework for standards for smart education. This design exercise gives background for design of privacy solutions.

**Step 9: Reflection and learning / Communication / Formalisation of learning – a new design cycle**

This last step crystallise the research efforts in formalising the output in terms of constructs and designs in the form of published research outputs. This step also initiates a new design cycle developing new constructs to advance a contextual and negotiated policy approach to privacy in the educational domain, reported in Article X.

# 4 OVERVIEW OF INCLUDED ARTICLES

In this section the key objectives and findings of the articles included in this dissertation are described. It is also elaborated on how each paper relates to the overall research questions.

## 4.1 Article I: Data Sharing for Learning Analytics – Exploring Risks and Benefits through Questioning

Hoel, T., Chen, W., & Mason, J. (2016). *Data Sharing for Learning Analytics – Exploring Risks and Benefits through Questioning.* Journal of the Society of e-Learning. Vol.1. No.1, December 2016. ISSN 2508-7584.

**Research objectives and methods**

This research is based on data from a number of international ethics and privacy workshops organised to scope the conditions for implementing LA in education (Mason, Chen, & Hoel, 2016). Questions were gathered and subjected to a systematic qualitative analysis in order to understand what are the risks and benefits of LA in different contexts.

**Findings**

The findings of this paper confirm the pivotal role privacy issues play in conceptualisations of risks and benefits related to LA. The paper establishes a concept of a problem space and a solutions space. The former is a two-dimensional space where each problem is found in the intersection of a concern and a barrier; the latter space is where an approach dimension is added and the issues discussed in order to come up with solutions. The analysis showed that the discourse on data sharing and big data for education was still at an early stage. Conceptual issues dominate this discourse; however, the elicited questions also hold numerous challenges for technical development and implementation.

**Contribution towards overall research questions**

This article addressed RQ1: What are the characteristics of the discourse on privacy in education, and how is that discourse influenced by the general discourse on Big Data? The article gave in-depth analysis of how questions about privacy were conceptualised, the context for their discourse, and how far the questioning was reached in order to provide contributions to solutions addressing the expressed concerns. In this paper we also find concepts that will be subject to further elaboration and design, addressing RQ3: What are the conceptual artefacts and LA process description that will help the design of privacy solutions for LA?

This article also contributes to answer RQ2, which asks how privacy is to be understood in the context of education (as in opposition to other sectors of society).

## 4.2 Article II: Privacy and data protection in learning analytics should be motivated by an educational maxim—towards a proposal

Hoel, T. & Chen, W. (2018b). *Privacy and Data Protection in Learning Analytics should be motivated by an Educational Maxim - towards a proposal.* In Research and Practice in Technology Enhanced Learning. DOI: 10.1186/s41039-018-0086-8

**Research objectives and methods**

This paper explores the legal and cultural contexts that make it a challenge to define universal principles for privacy and data protection in the context of education. The paper is conceptual and explorative, raising the question if pedagogical values should be brought to bear in discussions about privacy.

**Findings**

This paper finds that reasoning about privacy that places the individual consent as the point of depature for assuring privacy will not work in an educational setting. Therefore, it is appropriate to argue data privacy from a pedagogical perspective. The paper concludes with three principles that are proposed to inform an educational maxim for privacy and data protection in learning analytics.

**Contribution towards overall research questions**

This paper contributes to answering RQ1, RQ2, and thus prepares the conceptual foundation for the design efforts reported in other papers in this thesis.

## 4.3 Article III: Privacy engineering for learning analytics in a global market — defining a point of reference

Hoel, T. & Chen, W. (2019). *Privacy engineering for learning analytics in a global market – defining a point of reference.* International Journal of Information and Learning Technology. https://doi.org/10.1108/IJILT-02-2019-0025

**Research objectives and methods**

The purpose of this paper is to explore the concept of information privacy in a cross-cultural setting to define a common point of reference for privacy engineering. The paper follows a conceptual exploration approach. Conceptual work on privacy in EBD and LA in China and the West is contrasted with the general discussion of privacy in a large corpus of literature and recent research. As much of the discourse on privacy has an American or European bias, intimate knowledge of Chinese education is used to test the concept of privacy and to drive the exploration of how information privacy is perceived in different cultural and educational settings.

**Findings**

The findings indicate that there are problems using privacy concepts found in European and North-American theories to inform privacy engineering for a cross-cultural market in the era of Big Data. Theories based on individualism and ideas of control of private information do not capture current global digital practice. The paper discusses how a contextual and culture-aware understanding of privacy could be developed to inform privacy engineering without letting go of universally shared values. The paper concludes with questions that need further research to fully understand information privacy in education.

**Contribution towards overall research questions**

This article addresses RQ1 and RQ3 creating a conceptual point of reference for design of solutions that are expected to work in a cross-cultural setting.

## 4.4 Article IV: Privacy-driven design of learning analytics applications: Exploring the design space of solutions for data sharing and interoperability

Hoel, T., & Chen, W. (2016a). *Privacy-driven design of learning analytics applications: Exploring the design space of solutions for data sharing and interoperability*. Journal of Learning Analytics, 3(1), 139–158. http://dx.doi.org/10.18608/jla.2016.31.9

**Research objectives and methods**

This paper explores the processes leading to design solutions for data sharing and interoperability in LA systems. Through design science research the first version of a conceptual tool—the Learning Analytics Design Space (LADS) Model—is developed.

**Findings**

This research designs and carries out the first validation of the LADS model, positioning the model in a emerging privacy-driven design practice motivated by the privacy issues found in LA, but also in other domains of a more and more data-driven society.

**Contribution towards overall research questions**

This article addresses RQ2 and RQ3, finding conceptual artefacts and LA process description that will help the design of privacy solutions for LA. Both conceptual artefacts and a process was designed and evaluated through a simple case study.

## 4.5 Article V: Privacy in Learning Analytics – Implications for System Architecture

Hoel, T. & Chen, W. (2015). *Privacy in Learning Analytics – Implications for System Architecture.* In Watanabe, T. and Seta, K. (Eds.) (2015). Proceedings of the 11th International Conference on Knowledge Management. ISBN 978-4-9908620-0-8

**Research objectives and methods**

This paper seeks to explore what implications privacy in LA will have for system architectures. Open architectures, practices to promote transparency and trust, mechanisms to support ownership and consent will all contribute to building trust; however, these requirements would also have to be supported by technical solutions. This paper is part of research into what privacy by design principles will mean for system architectures. This is design science research and mainly conceptual work.

**Findings**

The article contributes a search architecture for learning analytics based on open and linked data.

**Contribution towards overall research questions**

This article addresses RQ4: Where should designers of LA technologies look to develop their solutions while at the same time maintaining students' trust and privacy? The design is a technical solution suggesting a search architecture based on linked and open data. The solution is theoretical, just indicating a direction of development that could be taken in order to solve some of the many questions related to privacy when sharing data for LA.

## 4.6 Article VI: Data Sharing for Learning Analytics – designing conceptual artefacts and processes to foster interoperability

Hoel, T. & Chen, W. (2016b). *Data Sharing for Learning Analytics – designing conceptual artefacts and processes to foster interoperability.* In Chen, W. et al. (Eds.) (2016). Proceedings of the 24th International Conference on Computers in Education. India: Asia-Pacific Society for Computers in Education

**Research objectives and methods**

This paper is part of the research effort to come up with conceptual artefacts that would instantiate the concept of privacy by design within a certain context, in this paper the Norwegian standards community. This is a case study of how a national standards body group grapples with finding ways to develop best practice for data sharing for LA.

**Findings**

This paper contributes with some conceptual constructs and processes intended to support the consensus process of national standards work.

**Contribution towards overall research questions**

This article addresses RQ2, RQ3 and RQ4 in the particularly setting of a national standardisation project dedicated to come up with recommendations for data sharing related to LA. Privacy may be strengthened by consensus on certain practices within specific organisational context, e.g., a national education system. The article applies a meta perspective, as it focus on the processes that allow such consensus to evolve, and how these processes can be supported.

## 4.7 Article VII: Interaction between Standardisation and Research – a Case Study

Hoel, T. & Chen, W. (2018a). *Interaction between Standardisation and Research – a Case Study.* International Journal of Standardization Research (IJSR). Vol 16. Issue 1.

**Research objectives and methods**

This article focuses on the interaction between to practices that are have a strained relationship, but nevertheless are dependent on each other, standardisation and research. The research is part of the authors' reflection on his own practice as a standards expert. The case used is development of a standard on privacy for learning analytics, which is the justification for including the paper in this dissertation. The overall research objective of this paper (and this strand of research) is to understand and contribute to the improvement of the standardisation process related to the work items that address the needs of the educational sector.

The paper uses DSR and ADR as a methodological framework to analyse the interaction between standardisation and research.

**Findings**

The results of this study show that establishing feedback loops between standardisation, research, and development is essential in order to produce results. However, the study also shows that in individual projects, internal processes and culture in the standard setting group could be of crucial importance for the outcome.

**Contribution towards overall research questions**

This article addresses RQ3 and RQ4, however, on a meta level. There is a need for a process to establish a process that directly can lead to design solutions of technical, organisational or other nature related to our subject of interest. The article is premised on the need for research and standardisation to establish a productive relationship in order to (also) produce results related to the theme of this thesis.

## 4.8 Article VIII: Are Norwegian Librarians ready to share Library Data to improve Learning?

Hoel,T., Chen, W., & Gregersen, A.B. (2018). *Are Norwegian Librarians ready to share Library Data to improve Learning?* Journal of Information Literacy in Higher Education, Vol 10, No 1.

**Research objectives and methods**

The objective of this article is to explore how one important sector of the educational system—the university library—is prepared to share data with other sectors in order to support the general idea of learning analytics. This research uses a mixed methods approach with studies of literature and documents in addition to a questionnaire providing data for a descriptive statistical analysis.

**Findings**

Literature shows that librarians in general are highly skeptical to let any information that is not anonymised out of their hands to be used by other professions. Strong professional ethics protects the patron privacy, and sharing data about loans and search history is seen as in breach with professional codes of conduct. However, new library systems and a changing market for academic literature with publishers that want to have direct contact with their customers already gather library data outside the control of librarians. The findings show that even if librarians in general do not want to share data that reveals personal information, their resistance will depend on the consent of the students, and to which degree librarians themselves are involved in processing and analysis of the data.

**Contribution towards overall research questions**

This article contributes mainly to answering the RQ2, what is privacy and Privacy by Design - in the context of education. The article gives insight in the organisational challenges related to professional ethics a large-scale LA implementation in education will raise.

## 4.9 Article IX: Standards for Smart Education - towards a development framework

Hoel, T. & Mason, J. (2018). *Standards for Smart Education - towards a development framework.* Smart Learning Environments. Springer Open. DOI: 10.1186/s40561-018-0052-3

**Research objectives and methods**

The objective of this research is to contribute to the alignment of two design practices that mutually influence each other and contribute to development of educational technologies, the research into smart educational environment, and the standards development in this domain. The paper is conceptual; through a thorough review and evaluations of conceptualisations of smart learning environments candidate constructs and approaches are identified that could contribute to a development framework of use for standards development.

**Findings**

Two models, a cognitive smart learning model and a smartness level model, were highlighted as productive in driving development of a platform for new standards in the domain of smart learning environments. The analysis showed that while the *less smart* technologies was model-driven and based on preconceived ideas of how human intelligence work, the *smarter* technologies are more data-driven and based on machine intelligence. The more data-driven the solutions are, the more issues of privacy will be raised.

**Contribution towards overall research questions**

This article is giving answers to RQ3 and RQ4, also on a meta level. At one level the article addresses the alignment of two research agendas, the one of a smart technical research community, and the other of the IT for Learning, Education, and Training (ITLET) standards community. However, in order to develop a framework for understanding the development challenges of the two communication, the article contributes to the understanding of the context of data-driven smart technologies, of which LA tools and approaches are a small subset. Therefore, this article contributes to the understanding of where designers of LA technologies should look to develop their solutions while at the same time maintaining students' trust and privacy.

## 4.10 Article X: Making context the central concept in privacy engineering

Hoel, T. & Chen, W., & Pawlowski, J.M. (submitted for review). *Making context the central concept in privacy engineering*

**Research objectives and methods**

This paper is aiming at setting a new direction for privacy engineering with placing context in the centre of development of privacy solutions. The paper is reorienting the conceptual understanding of privacy to include a more context centric view adapted to the era of machine learning and artificial intelligence. This research is conceptual and explorative of nature but builds on DSR methodology, presenting the first of a series of design cycles for developing and validating constructs.

**Findings**

This paper contributes to a new direction of design based on the affordances of big data and machine learning, developing a contextual understanding of privacy negotiations. The paper invokes and extends the theory of contextual integrity to define privacy. Making context the central concept for privacy by design, the paper explores how artificial intelligence—more specifically data-driven machine learning—will be part of future solutions for reasoning about data sharing. Suggestions for system architectures are presented. The paper also presents a first attempt to construct a conceptual development framework for privacy engineering making context the key concept of design.

**Contribution towards overall research questions**

The contribution of this research is conceptual clarification and a proposal for a direction of development. Thus, this paper contributes to answer RQ2, RQ3 and RQ4. This paper provides a new definition of privacy; it shows how the seminal contextual integrity theory of Helen Nissenbaum (2004, 2010) could be further developed from a normative theory describing the moral appropriateness of data transfers to also a socio-technical theory that could have practical impact in the AI era; and it develops formalisms and templates that will be used in requirement solicitation, data collection, and further validation of this development proposal.

# 5 CONTRIBUTIONS

This dissertation contributes to knowledge creation on a theoretical and practical level. This section will give an overview of the contributions highlighted in summary in Figure 4, which shows how the results have emerged from the PhD research process.

Two contexts contribute to produce this modest dissertation research, firstly, the domain of learning analytics; and secondly, the settings of national and international standards work. In section 3.1 we commented on the maturity of the field of LA with reference to the DSR knowledge contribution framework of Gregor and Hevner (2013), Figure 2.

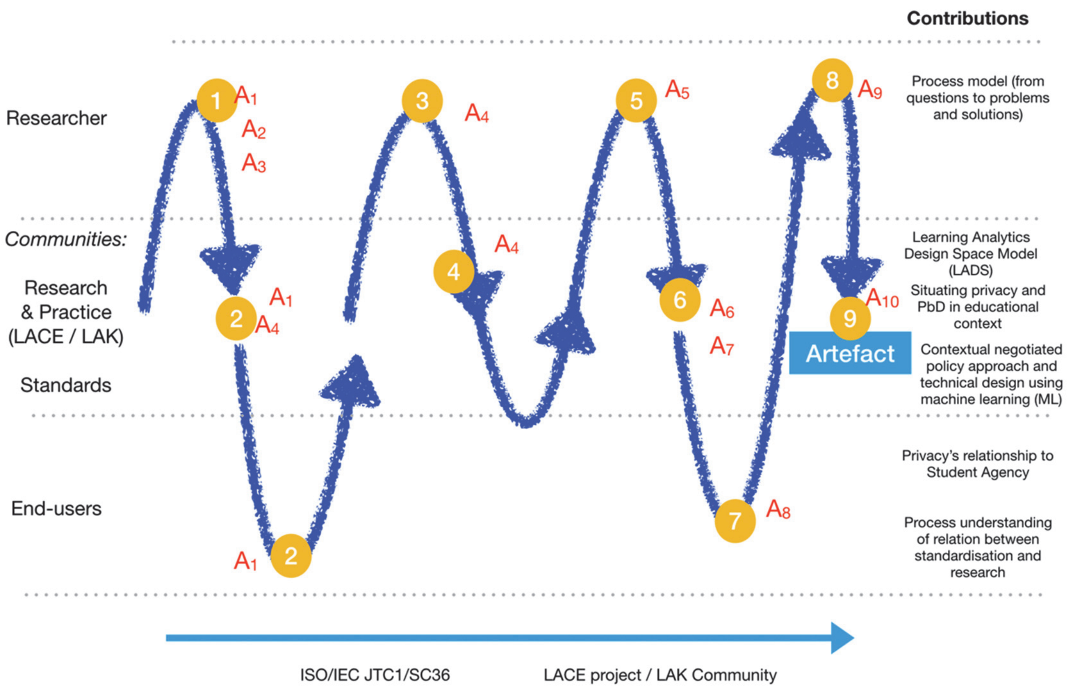



FIGURE 4. Key contributions of this PhD research

We positioned our research in the invention quadrant, inventing new solutions for new problems. By definition, in such settings PhD research contributions will be minuscule, given the scope of the projects and available resources. The second backdrop is standardisation, in which this author has worked continuously for nearly twenty years. It is therefore to be expected that some of the research builds on data from this field and follows the tradition of 'the reflective practitioner' (Schon, 1983). A number of the author's reflections have been lamenting on the lack of results and the inherent contradictions between stabilising artefacts where consensus is possible, while maintaining the ambition to contribute to innovation (Hoel, 2014; 2013b; 2013a).

The contributions of this PhD research is both theoretical and practical, providing results relevant to all communities described in Figure 4. In DSR there is a tension between focussing on contributions to theory and building useful artefacts (Baskerville et al., 2018; Peffers, Tuunanen, & Niehaves, 2018). In PhD research is is natural that the artefact design gets priority, while contributions to theory only will be moderate, mostly focussing on process improvements.

In the following we will summarise the results of our dissertation research related to the research questions, developments in the domain (the context), types of contributions, and stakeholder relevance. Our four research questions frame this dissertation research as cycles of exploration, starting with getting a grasp of privacy as a phenomenon through analysing discourse (RQ1); then contextualising the Privacy by Design maxim in education (RQ2); before developing conceptual artefacts helping design of privacy solutions (RQ3); and finally zooming out and coming back to the understanding of privacy centered around issues of trust (RQ4). Ideally, PhD dissertation research gives focussed and partial contributions to research questions that often have a wider scope. This gap points to further research needs, which we will elaborate at the end of this thesis. For now, we address the wider scope and then report on published contributions, starting with the theoretical contributions.

## 5.1 Theoretical contributions

RQ1 hinges upon discourse as data and discourse analysis as at method to make sense of imaginaries about privacy in the era of Big Data.

### 5.1.1 Privacy in the context of Big Data – framing RQ1

> It is hard to understand the contemporary datafication and digitization of education without acknowledging the prominent positions that big data and software have attained in contemporary society. Together, big data, software and algorithms in education are leading to a position where new kinds of smarter learning machines – which can learn from the data they process – are becoming imaginable, seemingly possible, and attainable… (Williamson, 2017a, p. 64).

From a position of science, technology and society (STS), Williamson (2017a) mobilise the concept of big data imaginary as a framework for understanding "the future visions that are animating and catalysing recent and ongoing technical development" (p. 18). Williamson borrows the term 'learning machines' from Foucault (1991), thus highlighting the supervisory and disciplinary role of big data in education. Big data may have a prominent position from an analytical research perspective and, at the same time, be more or less absent in the day-to-day discourse among educational practitioners (Hoel, Chen, & Yu, forthcoming). Or big data imaginaries may start to appear in strategy documents for schools and universities (Hoel & Chen, 2017b) without being recognised and debated on a practical level. Datafication, the transformation of many aspects of education into quantifiable information, and digitization, the mediation of learning environments through digital tools, happen gradually and are not associated with anything 'big'. As citizens, however, the educational practitioners are affected by big data, even not necessarily understood as such. When shopping goes online and specialty shops close down, the connection to collection and analysis of big data streams are not evident for most customers. From an individual point of view it is not easy to see that one's own few purchases are contributing to a major trend. Therefore, the privacy issue is not an urgent concern – till something unexpected happens (see concept of 'contextual trigger' in Article X). In the public discourse, it is often crises or scandals related to data safety breaches, sudden drop in trust, disclosures of unexpected broad scope of data collection, etc. that put privacy on the agenda (Griffiths, Drachsler, Kickmeier-Rust, Steiner, Hoel, & Greller, 2016; Hoel, Chen, & Pawlowski, submitted for review).

Discussing privacy in the aftermath of a scandal will frame how the individual views contextual integrity and the empowerment to protect their integrity. The Cambridge Analytica scandal dominating the public debate worldwide in the first half of 2018 (www.theguardian.com/news/series/cambridge-analytica-files) coincided with the enforcement of the European General Data Protection Regulation (GDPR), and brought privacy issues to the attention of ordinary citizens who were invited to revise privacy settings for most of their social media tools. It would be interesting to see if this general development has had any ripple effects on usage of digital tools in an educational setting.

### 5.1.2 Exploring risks and benefits of data sharing for LA (RQ1)

Privacy, as conceived in this dissertation research, is an elusive concept as it is socially constructed by individuals participating in different contexts. In Article I these constructs were captured as questions. The first contribution to the knowledge base is a framework for turning questions formulated in open discussions about data-driven educational practices into constructs that give researchers requirements for design of privacy solutions,

The main empirical findings of Article I was that educational practitioners interested in LA and new technologies were in the years 2015 - 2016 mainly concerned at a conceptual level when questioning LA. They were not ready to discuss technicalities or solutions to privacy problems.

The contribution of Article I was a process model (Figure 5) supporting the movement from open solicitation of questions, filtering and ordering of concerns to construct a problem space; and, as a next step, extracting and applying meta-questions for further analysis of questions in order to construct a solution space.

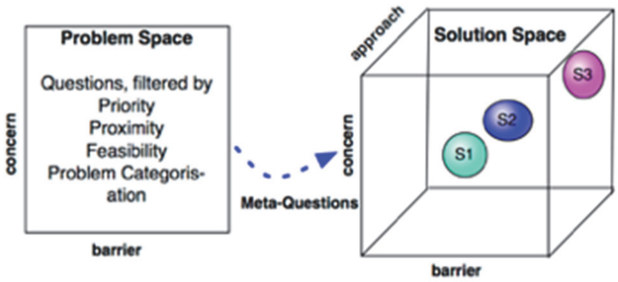



FIGURE 5. Process model – from questions describing problems to solutions

In reflecting on how problems and solutions related to privacy in LA are conceptualised Ferguson et al. (2016) made some important observations about the difference between data protection and privacy:

> Considered from the perspective of data protection, data are treated as property. From the perspective of privacy, data are much more personal, almost a part of the self and certainly very bound up with the sense of self. If we reveal these data, we reveal ourselves. If we care for and protect these data, we are to some extent caring for and protecting ourselves, particularly if we do so in response to potential threats. These potential threats appear more real and immediate in some parts of the world. (Ferguson et al., 2016, p. 11)

This means that in designing privacy solutions we need to understand how the individual, in our case the student, conceives and manages the self, as data sharing is part of a self revelation activity. Managing the self is about defining boundaries and handling threats. As stated above, threats appear more real and immediate in some parts of the world, i.e., threats are very contextual. If we take the conceived threats to the self of Big Data, we see that in parts of the world where privacy is weak, the individual or student have no illusions that data will not be gathered and analysed without consent – and they respond accordingly as discussed in Article III. This is a non trust environment. In other parts of the world, where privacy is stronger and trust to institutions stronger, we would expect that threats are handled differently. Public discourse on Big Data's handling of personal data may erupt from time to time and disrupt trust an how the individual see privacy.

### 5.1.3 Privacy by Design in the context of education (RQ2)

RQ2 asks about how privacy will be framed in education, and how PbD should be interpreted in the context of education. In the previous section we tied privacy to the individual self; within an educational setting this highlights the concept of learner agency (Slade & Prinsloo, 2015), to be explored more in detail below.

Article IV describes Privacy by Design (PbD) as a principle injected into all planning and development of LA solutions. This imperative has been strengthened with the inclusion of the PbD principle in the GDPR, see also Hoel and Chen (2016c). The Learning Analytics Design Space Model (LADS), which is a contribution to this research described in Article IV is based on the PbD principle, emphasised in the cyclic characteristic of the model. In another research (Hoel & Chen, 2016c, 2016d) we have raised the question if the PdB principle could be a lever for bringing pedagogy into the discourse on LA, and if this understanding of privacy could help build an educational maxim for privacy and data protection in learning analytics (Article II). In a paper discussed with the LA research community, Hoel, Griffith and Chen (2017) explored how different privacy frameworks could influence design of LA systems in an international and cross-cultural context, analysing the privacy discourse in Europe, Japan, South-Korea and China (see also Article III).

The theoretical contribution of the research reported in the papers referenced above is to pave the conceptual ground for design by situating privacy and the PbD principle in a pedagogical, social, cultural and political context. This is a dynamic discursive space where design must be aware of impacts on learner agency, creating opportunities for negotiation of issues like identity boundaries, information flows that maintain conceptual integrity, etc.

### 5.1.4 Developing conceptual tools on different levels of discourse (RQ3)

Article I showed that even within the LA research community the discourse about privacy was rather superficial, mainly voicing general concerns of the importance of privacy related to LA. In Article IV, Hoel and Chen (2016a, p. 142) argue that "there is a need for a conceptual tool that could help us move from barriers and concerns to well-argued solutions". In Article I, the European Interoperability Framework (EIF) is used to test the validity of meta-questions used for analysis of gathered data. This framework (EC, 2017) models interoperability on four levels, technical, semantic, organisational, and legal. In terms of conceptual tools, there is a need for constructs that could facilitate discourse on all these levels. The Learning Contexts (template model), a contribution (Figure 6) in Article VI captures this requirement related to an educational context.

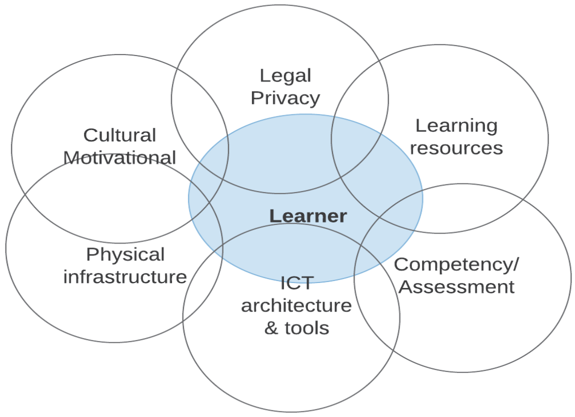



FIGURE 6. Learning Contexts (template model)

In Article V this research contributes to the discourse on PbD design of technical solutions. Article VI contributes to the design of a process for achieving consensus about privacy solutions related to data sharing.

### 5.1.5 How to build and maintain students' trust? (RQ4)

Privacy is closely connected to trust. If trusted systems were established and students felt confidence in these systems, privacy would be a lesser concern. Removal of personally identifiable information (PII) from a dataset does not necessarily create trust among a student group. A too technical or legal approach to privacy may prove counterproductive as such an approach is volatile to sudden system level collapse of trust as described above.

RQ4 addresses this wider concern and calls for more holistic solutions. In Article IV Hoel and Chen (2016a) argue that trust is not a 'thing' that, negotiated once, lasts forever; "it must be renegotiated repeatedly" (p. 152). Applying the LADS model to find a design solution candidate, the authors point in the direction of solutions that prioritizes the socio-cultural aspects of negotiation of access to data for LA. These perspectives are brought forward in Article X, where the concept of privacy is discussed in the context of AI technologies.

The focus on the learners' presence in continuous negotiations about access, sharing, and use of their own data is a leitmotif in most of the articles of this PhD research. The contribution of Article VIII was that Norwegian librarians, an important stakeholder group with strong professional positions on sharing of data for LA, were willing to balance their principled views with what is practically possible and in the self-interest of the students. Answering RQ4, asking where designers should look for developing trusted privacy solutions our research has concluded that they should look at the student and how student agency is related to privacy. On a technical level that may imply development of solutions for personal storage and management of learning activity data, e.g., Personal Learning Record Stores (Article V). On an organisational level that may imply developing support for negotiations and discourse on conditions for sharing personal data. In Article X these perspectives are integrated in a proposal for a new contextual negotiated policy approach and a technical design using machine learning.

## 5.2 Practical contributions

This dissertation research grew out of two practice fields crossing each other, the standards community and the LA research community. The latter was committed to building knowledge and supporting implementation; the former was looking for practices or insights that were ready to be stabilised. The practical contributions of this PhD research is therefore tied to these communities and is also a result of choosing ADR as the appropriate method. The results of this research are shared not only with the research community, but also with practitioners in the fields of standardisation and education.

### 5.2.1 Contributions to the standards community

More or less all the papers included in this dissertation are addressing needs experienced as a standards expert. These needs are bidirectional. Article VII describes how standardisation desperately need input from research, and how formal standardisation procedures may make the interaction with research difficult. This has also been the topic of a number of conference papers by this author (Hoel, 2013a, 2013b, 2014). However, results from standardisation needs also to be brought out to the practitioners in the domain to be validated and tested. Without this feedback the standardisation risks to be of low quality and even irrelevant to their stakeholders.

The main practical contribution of this dissertation research has been a case study highlighting the need for better interaction between standardisation and research in the field of LA and privacy, and suggesting feedback loops that could be applied to future standards projects (Article VII). Article VI also gives a contribution to the process of developing standards in this field, alerting the experts of the importance of mapping different stakeholders' interests before mapping the problem space and brainstorming for solutions.

In an attempt to condense this dissertation research in one clear message to the standards community we would say the following: Privacy is a cross-cutting concern that runs through all aspects of socio-technical design. Therefore, this needs to be reflected in all aspects of standards setting, i.e., in best practices standards, in framework standards, in technical standards, and even in protocol standards. The concern cannot be alleviated by referring it to IT security or ethical guidelines. We need also to address the technical aspects of privacy engineering, and it is the standards community's responsibility to create clarity about fundamentals to level the playing field for the stakeholders who will come up with new solutions.

### 5.2.2 Contributions to educational community

Our research (Article I) found that the educational community had flagged privacy as an issue to be aware of, or even concerned about, but without any deep understanding how the problem could be solved. A key question emerging from the research in Article I was "how we could scaffold this development in a situation where the conceptual framework is still under debate" (p. 10). The article pointed to the ISO/IEC-20748:2016 conceptual framework this author have contributed to as standardisation expert. The framework offers a workflow model of six processes—Learning Activity, Data Collection, Data Storing and Processing, Analyzing, Visualization, and Feedback Actions—all of which have privacy issues. In later research and design Hoel and Chen (2018c) have used this framework to develop heuristics for a discourse about privacy targeted at educational practitioners.

As with the standards community, this dissertation research also comes with a clear message to the educational community, in particular to the LA research community. There is a need to establish a new track of research focussing on privacy in the context of LA. If not, the achievements of ten years of research into the affordances of learning data informed analytics will be of little use. Recent international research into the privacy paradox (Tsai, Whitelock-Wainwright, & Gasevic, 2020) confirms our research that students' preferences regarding privacy are not reflected in their actual practices, a situation that is not sustainable. (In my country, Norway, an Official Report of last year—NOU 2019:23—even suggests that 'digital learning analytics' is not to the benefit of school pupils, and therefore should be a subject of a new public inquiry before it is included in a new educational act.) This clearly demonstrates the need for the LA research community to start engaging in how privacy-by-design can be part of learning analytics development.

## 5.3 Limitations and future work

This section serves as closing remarks, acknowledging the complexity of the subject field of this research, the limitations of the contributions made, and the need for further work. We will address the big picture of big data in education, the conceptual understanding of privacy, the need for tools to navigate the problem space, and finally, where to look for solutions.

**The big picture**

Big Data is a new phenomenon and nobody knows the impact data-driven technologies and practices will have on society at large, and education in particular. Williamson claims that "[e]ducational data science and its applications are turning educational institutions – schools, colleges and universities alike – into metrological platforms that perform a constant scientific form of measurement of learning processes (Williamson, 2017a, p. 121). In our research related to privacy, we are not concerned if this is a good or bad development, or even if the foresight described by Williamson is a correct. Our observation is that this will generate a completely new privacy landscape. In Norway, and most likely in most western countries, the problem for LA researchers has not been the glut of data, but the lack of data, mainly originating from institutionally run learning management systems (Hoel, 2017). Data from different sensors, from swipe cards (access to buildings), from library use, from social media, etc have been out of bounds for educational researchers and practitioners due to resistance from professional groups (Article VIII), lack of legal access, no chance of getting consent from data subjects, and other reasons. However, it is our belief that with the ability to make use of the full set of big data in education the access to a wider set of data will gradually be opened up, with or without the explicit consent of the students. In Hoel and Chen (2017b) we have looked into the different legitimations for educational institutions to access student data, and when consent is a necessity to gather and process data. The point here being that this is a matter of negotiations, especially when the actions following analysis approach the boundaries each student has defined around her identity. These are highly dynamic and malleable features, and we see an interesting research gap in trying to understand how development on different levels will influence the actual data sharing of student information available for LA.

**Understanding privacy**

In section 2.1 we used Nissenbaum's contextual integrity theory (Nissenbaum, 2004) to define privacy. However, privacy is a slippery concept as O'Hara and Shadbolt (2008) state in their book with the telling title 'The Spy in the Coffee Machine: The End of Privacy as we know it". These authors were wary of defining privacy, "because it would be hard – we suspect impossible – to give necessary and sufficient conditions, especially as technology changes the conditions so rapidly" (p. 22). The understanding of one's privacy used to be very physical and connected to one's body, as the Norwegian term for privacy, 'privatlivets fred' (the peacefulness of one's private life) indicate. Now with technology, the body 'disappears'; instead, we are are interacting with the technological representations of ourself, which lead to all kinds of issues related to establishing identity. "A physical presence leaves behind few signs; a handshake in a closed room leaves no trace, except in memory. Information, on the other hand, persists" (O'Hara & Shadbolt, 2008, p. 2). And information can be shared.

When the Australian Computer Society (ACS) recently wanted to address privacy challenges from technical point of view it was data sharing they focussed on (ACS, 2017). Using data sharing as the entry point of analysis ACS saw challenges broadly categorised as "data format and meaning; legal obligations; privacy; data security; and concerns about unintended consequences of data sharing" (p. 7). The basic data sharing framework they developed is described in Figure 7, showing an increasing access to data with ever fewer restrictions: knowledge about the existence of the data set; details about the data set; ability to interrogate aggregated, perturbed, or obfuscated data; ability to access aggregated, perturbed, or obfuscated data; access to data; and ability to share data.

These features are set in a personal context, and in a real world context. This dissertation research has only encircled this research space. It is a big research challenge to use this kind of frameworks in an educational context to see what kind of political, legal, organisational, and technical solutions should be designed in order to satisfy the principle of Privacy by Design and the other principles now implemented by law in Europe.

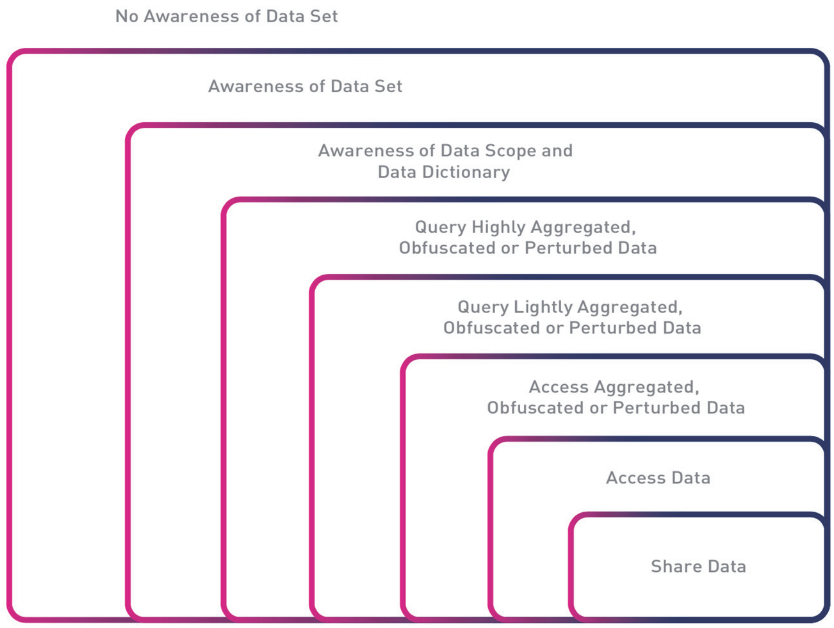



FIGURE 7. Basic data sharing framework (Source: ACS, 2017)

**Conceptual tools supporting the discourse**

In this dissertation research a few conceptual tools are developed to support discourse about privacy in education. This effort is continued by the author and colleagues also recently, by developing a toolkit for exploring privacy issues using the ISO 20748 LA framework model as a scaffold (Hoel & Chen, 2018c). We see, however, that we have merely scratched the surface when it comes to serve the big need for guided discourse about privacy when LA solutions now are being implemented at scale. There is a need for a robust framework that builds on both a good conceptualisation of privacy and understanding of the LA process cycles in different political, legal, organisational and technical environments.

**Solutions building trust**

The ultimate goal of our design efforts is to build trust. But trust is another of these elusive concepts that are only to be understood in the proper context. While privacy may be seen as everything or nothing (Solove, 2006), it makes sense to think of it as related to an individual and her context. Trust, on the other hand, seems to be related to the system in which the individual acts. So, the big question for this research is what contribute to building trust at a system level.

Reflecting on this question we might build up a set of research questions that in an educational setting is not being adequately addressed in current LA research. Following the structure of the European Interoperability Framework (EC, 2017), trust in education could be explored from these dimensions:

*Legally*, trust is built by establishing legal norms that prevent privacy violations. To guide the law toward a more coherent understanding of privacy Solove (2006) developed a taxonomy to understand privacy violations (Figure 8). Williamson (2017a) uses this model to discuss how LA systems may potentially cause harm along all the dimensions under data collection, information processing, information dissemination, and invasions.

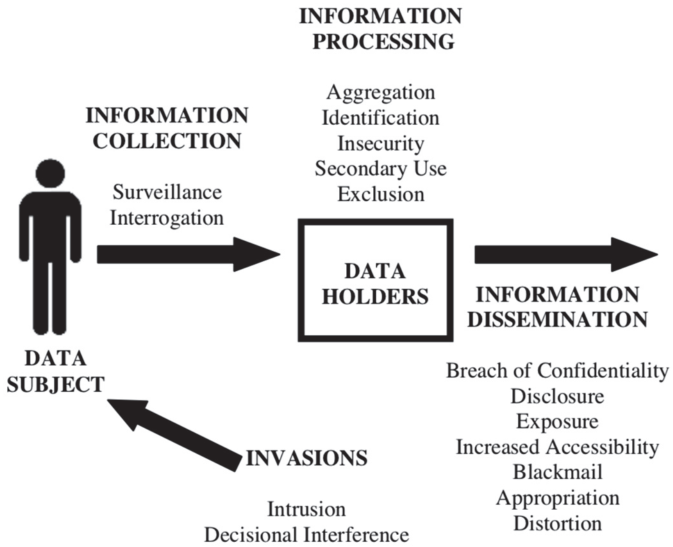



FIGURE 8. Taxonomy model of privacy violations (Solove, 2006)

The ISO 20748 (Figure 9) framework model of LA processes bears a resemblance to the Solove model. The heuristics Hoel and Chen (2018c) have developed to support discussions on ethics and privacy for LA addresses all the potential harms situations in Solove's taxonomy. However, there is a need for research into the implementation of privacy laws in education, especially after the European GDPR came into effect.

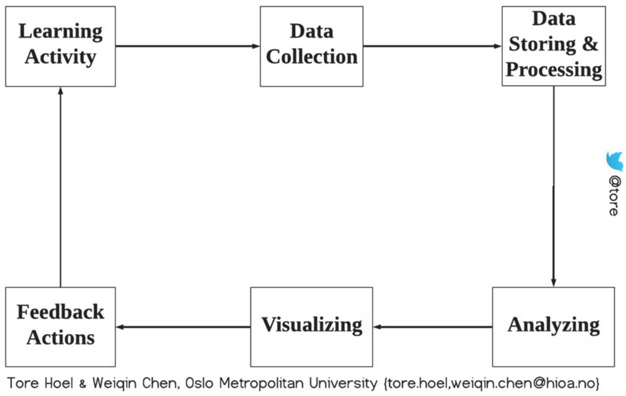



FIGURE 9. ISO/IEC 20748 LA framework model

*Organisationally*, trust is promoted by establishing learning and teaching settings where privacy is not a concern, by design and by default. The GDPR establishes some measures that schools, colleges and universities must take to ensure privacy, e.g., related to accountability. It is a need for research into organisational practices for implementing GDPR and other best practice advice. In our dissertation research we have tried to pinpoint some of the characteristics of education in relation to privacy, e.g., the fact that learning in an institutional setting is long term and therefore quite different from for example simple consumer transactions which tend to be used in public debates on data protection.

Understanding what sets learning and teaching apart from other societal activities that are being tracked and utilised for big data is essential in order to learn how organisational settings should be designed to build trust. In this thesis we have on several occasions pointed towards learner agency as key to how privacy is experienced. Learner agency is understood differently in various pedagogical traditions and various cultural and political settings. It is an important research field to explore how learner agency is related to privacy and trust, and how this could be described in conceptual frameworks that could support organisational development.

*Semantically*, it is important to clarify the sources of trust in an educational context. Trust in relation to LA is per definition to have trust in numbers. Datafication of education raises immediately the discussion on the epistemological validity of basing actions on quantitative measurements alone (Ozga, 2015). Again, as with the dimension discussed above, there is a need to ground solutions design in pedagogical strategies and to build a bridge from pedagogy to computer and data science.

Semantic issues are raised also when privacy for LA is discussed from a cross-cultural and international perspective. Cross-cultural studies will show that all the key concepts we have discussed in this dissertation, like privacy, trust, contextual integrity, learner agency, etc have very different interpretations. We see that when trying to establish ethical principles for design of autonomous and intelligent systems (IEEE, 2017). Even if the intentions to base recommendations in truly global ethical principles are the best, one risks being criticised for being too westerly oriented.

*Technically*, trust is built by designing systems that the learner understands. This dissertation research has contributed in a very small way to this discussion suggesting a direction for design built on open systems, user control and open data (Article V), and on use of contextually negotiated policies supported by machine learning and smart contracts (Article X). There is nothing indicating that this as dominant direction of current development. So, there is a need for continued research on trust in building architectures.

## SUMMARY IN FINNISH

Tätä väitöskirjaa puolustetaan verkossa Covid-19-pandemian aikana. Ennennäkemättömän kriisin ratkaisemiseksi olemme halunneet hyväksyä ratkaisuja, joita ei ollut ajateltavissa vain joitakin viikkoja ennen pandemian puhkeamista. Verkko-opetuksesta on tullut uusi normaali ja hyvin harvat kysyvät, miten tämän toiminnan jättämät tietojäljet vaikuttavat yksityisyyteen. Viruksen leviämisen torjumiseksi kotimaani kansalaisia rohkaistaan lataamaan mobiilisovellus, joka raportoi kaikista heidän askeleistaan nostaen seurannan tasolle, jota koskaan ennen ei ole nähty. Tämä tohtorintutkimus auttaa vaatimattomalla tavalla ymmärtämään, miksi tietosuojasta on tullut tämän kriisin uhri. Opinnäytetyö tarjoaa käsitteelliset puitteet ymmärtää, miten konteksti ajaa uusien tiedonjakokäytäntöjen hyväksymistä sekä miten kontekstin parempi ymmärtäminen voisi olla osa tämän ongelman ratkaisua.

Viime vuosikymmenen alussa oppimisanalytiikasta tuli kuuma aihe yhteisössä, joka on sitoutunut koulutustekniikkoihin. Tutkimus ja yhteisörakentaminen kulkivat aidolla tavalla käsi kädessä. Kirjoittajalle tästä tuli tilaisuus osana kansainvälisiä pyrkimyksiä tutkia, kuinka koulutuksen tietoistaminen voi vaikuttaa oppimiseen, koulutukseen ja harjoitteluun, engl. LET (learning, education and training). ITLET – LETin tietotekniikka – on lyhenne, joka yhdisti kirjoittajan toiseen käytäntöyhteisöön, standardiyhteisöön, joka myös toimi tämän tutkimuksen taustana. Oppimisanalytiikan ja –tiedon yhteisö, engl. LAK (learning analytics and knowledge) community, huomasi pian, että tietosuojakysymykset saattavat olla esteenä data-analytiikan laajalle levittämiselle koulutuksessa, mutta standardiyhteisö pyrki luomaan käsitteellisen ymmärryksen erilaisista oppimisanalytiikkaan liittyvistä prosesseista. Tämä avasi tutkimuskentän tälle väitöstutkimukselle, joka on pyrkinyt asettamaan yksityisyyden käytännön huolenaiheeksi kaikissa analysointiprosesseissa: suunnittelusta (kuinka tiedot voivat auttaa ymmärtämään oppimistapahtumia) tiedonkeruuseen, tietojen tallentamiseen ja käsittelyyn, analysointiin, visualisointiin sekä tulosten syöttämiseen takaisin oppijoille ja heidän tilanteeseensa.

Tämä tutkimus tehdään teknisen, kulttuurisen, sosiaalisen, taloudellisen ja pedagogisen tietämyksen poikkileikkauksena perustuen Design Science Research ja Action Design Science –menetelmiin. Tulokset ovat kuitenkin pääosin käsitteellisiä tässä ilman tutkimusyhteisön tai ryhmän tukea tehdyssä väitöstutkimuksessa. Suunnittelutieteet käyvät läpi useita tutkimussyklejä mutta me emme ole suorittaneet kaikkia tämän tutkimusperinteen jaksoja, joten meillä ei ole esittää testattuja ja sovellettavissa olevia ratkaisuja. Puolustukseksemme voimme sanoa, että ilman hyvin perusteltua kehityksen lähtökohtaa mikä tahansa hyvin testattu tutkimustulos voi olla hyödytön, koska tilanne voi olla väärä. Siksi olemme keskittyneet tutkimuksessamme tiedon jakamisen ja yksityisyyden perusperiaatteisiin oppimisanalytiikan alueella.

Vaatimattomat panoksemme tähän väitöstutkimukseen ovat sekä teoreettisia että käytännöllisiä. Tietosuoja määritellään suurten tietojen yhteydessä; asiayhteyden eheyden teoriaa laajennetaan koskemaan ‘asiayhteyden laukaisijan’

käsitettä, ja suunnitteluehdotuksissa tutkitaan yksityisyyden käytänteiden roolia tiedon jakamisen sääntelyssä. Tiedonjaon riskejä ja etuja tutkitaan oppimisen analytiikan suunnittelutilamallin kehittämiseksi. Lisäksi kehitetään muita käsitteitä helpottamaan tiedonjakamiseen liittyvää tieteellistä keskustelua

Väitöskirja sisältää 10 artikkelia, joiden panokset (mukaillen väitöskirjan esitarkastajan professori Michail Giannakosin lausuntoa) ovat seuraavanlaisia:

**Artikkeli I:** Tunnistetaan koulutuksen yksityisyyttä koskevan keskustelun ominaispiirteet ja yleisen Big Data –keskustelun vaikutukset siihen.

**Artikkeli II:** Laaditaan kolme periaatetta, joiden avulla voidaan maksimoida yksityisyys ja tietosuoja oppimisen analytiikassa, ja valmistellaan alustaa käsitteellisen perustan kehittämiselle.

**Artikkeli III:** Tarjoaa uuden kontekstuaalisen ja kulttuuritietoisen ymmärryksen yksityisyydestä tietosuojatekniikasta tiedottamiseksi.

**Artikkeli IV:** Tunnistaa keskeiset käsitteet ja prosessin, joka auttaa suunnittelemaan ratkaisuja yksityisyyden suojalle oppimisanalytiikassa. Ne suunniteltiin ja arvioitiin tapaustutkimuksen avulla.

**Artikkeli V:** Tutkii tärkeitä elementtejä, joita oppimistekniikoiden suunnittelijoiden tulisi etsiä kehittääkseen teknisiä ratkaisuja, jotka ylläpitävät opiskelijoiden luottamusta ja yksityisyyttä.

**Artikkeli VI:** Ehdotetaan käsitteellisiä rakenteita ja prosesseja, joiden tarkoituksena on tukea konsensusprosessia tietojen jakamisen standardisoimiseksi oppimisanalytiikassa.

**Artikkeli VII:** Esittää että palautesilmukoiden luominen standardisoinnin, tutkimuksen ja kehittämisen välillä luottamuksen ja tiedon jakamisen yhteydessä on lopputuloksen kannalta välttämätöntä oppimisanalytiikassa.

**Artikkeli VIII:** Tarjoaa tietoa ammattietiikkaan liittyvistä organisatorisista haasteista, joita oppimisanalytiikan laajamittainen toteutus koulutuksessa herättää.

**Artikkeli IX:** Edistää ymmärrystä siitä, mihin oppimisanalytiikan suunnittelijoiden tulee tähdätä voidakseen kehittää teknisiä ratkaisuja, jotka säilyttävät opiskelijoiden luottamuksen ja yksityisyyden.

**Artikkeli X:** Tarjoaa seuraavien prosessien virallistamisen: vaatimusten kartoitus, tiedonkeruu ja validointi. Lisäksi esitellään järjestelmäarkkitehtuureja, jotka käsittelevät tiedon jakamista.

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## REFERENCES


ACS (2017). Data Sharing Frameworks (pp. 1–104). Report from The Australian Computer Society. Retrieved from https://www.acs.org.au/content/dam/acs/acs-publications/ACS_Data-Sharing-Frameworks_FINAL_FA_SINGLE_LR.pdf

Baskerville, R., Baiyere, A., Gergor, S., Hevner, A., & Rossi, M. (2018). Design Science Research Contributions: Finding a Balance between Artifact and Theory. Journal of the Association for Information Systems, 19(5), 358–376. http://doi.org/10.17705/1jais.00495

Beer, D. (2016). Metric Power. Palgrave Macmillan UK: London DOI:10.1057/978-1-137-55649-3

Beer, D. (2016). How should we do the history of Big Data? Big Data & Society, 3(1), 205395171664613–10. http://doi.org/10.1177/2053951716646135

Belanger, F., & Crossler, R. E. (2011). Privacy In The Digital Age: A Review Of Information Privacy Research In Information Systems. Mis Quarterly, 35, 1–63.

Bansal, G., Zahedi, F. M., & Gefen, D. (2015). The role of privacy assurance mechanisms in building trust and the moderating role of privacy concern. European Journal of Information Systems, 24(6), 624–644. http://doi.org/10.1057/ejis.2014.41

Breiter, A., & Hepp, A. (2017). The Complexity of Datafication: Putting Digital Traces in Context. In Communicative Figurations (1st ed., Vol. 8, pp. 387–405). Cham: Springer International Publishing. http://doi.org/10.1007/978-3-319-65584-0_16

British Standards Institute. (2016). Guide to the ethical design and application of robots and robotic systems. BS 8611:2016.

Creemer, R. (2017). What did Xi Jinping say about cyberspace? Online: https://chinacopyrightandmedia.wordpress.com/2017/10/19/what-did-xi- jinping-say-about-cyberspace. Posted 2017-10-19.

Creswell, J. (2004). Educational Research: Planning, Conducting, and Evaluating Quantitative and Qualitative Research. Upper Saddle River, New Jersey: Prentice Hall.

Dinev, T., Xu, H., Smith, J.H., & Hart, P. (2013). Information privacy and correlates: an empirical attempt to bridge and distinguish privacy-related concepts. European Journal of Information Systems, 22:3, 295-316. DOI: 10.1057/ejis.2012.23

Drachsler, H., & Greller, W. (2016). Privacy and analytics – it's a DELICATE issue. Presented at the Proceedings of the Sixth International Conference on Learning Analytics & Knowledge - LAK '16. http://doi.org/10.1145/2883851.2883893

Drachsler, H., Cooper, A., Hoel, T., Ferguson, R., Berg, A., Scheffel, M., Kismihók, G., Manderveld, J., & Chen, W. (2015). Ethical and privacy issues in the application of learning analytics. In: 5th International

Learning Analytics & Knowledge Conference (LAK15): Scaling Up: Big Data to Big Impact, 16-20 March 2015, Poughkeepsie, NY, USA.
EC. (2017). European Interoperability Framework - Implementation Strategy. COM(2017) 134 final
Ferguson, R., Hoel, T., Scheffel, M., & Drachsler, H. (2016). Guest editorial: Ethics and privacy in learning analytics. Journal of Learning Analytics, 3 (1), 5–15. http://dx.doi.org/10.18608/jla.2016.31.2
Fink, A. (2005). Conducting Research Literature Reviews: From the Internet to Paper (2nd ed.). Thousand Oaks, California: Sage Publications.
Gregor, S., & Hevner, A. R. (2013). Positioning and Presenting Design Science Research for Maximum Impact. Mis Quarterly, 37(2), 337–355.
Gregor, S., & Jones, D. (2007). The Anatomy of a Design Theory. Journal of the Association for Information Systems, 312–335.
Griffiths, D., Drachsler,H., Kickmeier-Rust, M., Steiner, C., Hoel, T., Greller, W. (2016) Is Privacy a Show-stopper for Learning Analytics? A Review of Current Issues and Solutions. Learning Analytics Review 6 ISSN:2057-7494 LACE project
Griffiths, D., Hoel, T. & Cooper, A. (2016) Learning Analytics Interoperability: Requirements, Specifications and Adoption. Public Deliverable D7.4 from the LACE project (European Commission Seventh Framework Programme, grant number 619424).
Hartong, S. (2017). Towards a topological re-assemblage of education policy? Observing the implementation of performance data infrastructures and “centers of calculation” in Germany. Globalisation, Societies and Education, 16(1), 1–18. http://doi.org/10.1080/14767724.2017.1390665
Hevner, A. (2007). A Three Cycle View of Design Science Research. Scandinavian Journal of Information Systems, 2007, 19(2):87-92, 1–6.
Hevner, A., March, S. T., Park, J., & Ram, S. (2004). Design science in information systems research. Mis Quarterly, 28(1), 75–105.
Heath, J. (2014). Contemporary Privacy Theory Contributions to Learning Analytics. Journal of Learning Analytics, 1(1), 140–149. http://doi.org/10.18608/jla.2014.11.8
Hoel, T. (ed.) (2017). SN/TR 4183:2017 Datakilder og betingelser for deling av data for læringsanalyse.
Hoel, T. (2014) Lack of openness as a potential failure in standardisation management – lessons learnt from setbacks in European learning technology standardisation presented 2014-03-24 at I-ESA Workshop on Standards Management workshop
Hoel, T. (2013b). Standards as enablers for innovation in education – the breakdown of European pre-standardisation In Proceedings 2014 - Kaleidoscope 2014 - Living in a converged world - Impossible without standards? http://handle.itu.int/11.1002/pub/80a5593d-en.
Hoel, T. (2013a). Paradoxes in LET standardisation – towards an improved process published in Wong, L.-H. et al. (Eds.) (2013). Proceedings of the

21st International Conference on Computers in Education. Indonesia: Asia-Pacific Society for Computers in Education
Hoel, T. & Chen, W. (2019). Privacy engineering for learning analytics in a global market – defining a point of reference. International Journal of Information and Learning Technology. https://doi.org/10.1108/IJILT-02-2019-0025
Hoel, T. & Chen, W. (2018a). Interaction between Standardisation and Research – a Case Study. International Journal of Standardization Research (IJSR). Vol 16. Issue 1.
Hoel, T. & Chen, W. (2018b). Privacy and Data Protection in Learning Analytics should be motivated by an Educational Maxim - towards a proposal. In Research and Practice in Technology Enhanced Learning. DOI: 10.1186/s41039-018-0086-8
Hoel, T. & Chen, W. (2018c). Advancing the Delicate Issue of Ethics and Privacy for Learning analytics. In Companion Proceedings 8th International Conference on Learning Analytics & Knowledge (LAK18). Link to poster paper. Link to full proceedings. Link to PDF of poster and support material.
Hoel, T. & Chen, W. (2017a). Innovating Learning Analytics Policies in Norway - a case study. Draft workshop paper presented at LAK17 workshop on LA Policies.
Hoel, T. & Chen, W. (2017b). Towards Developing an Educational Maxim for Privacy and Data Protection in Learning Analytics. Presented at EC-TEL Workshop on Ethics and Privacy for Learning Analytics 12 September 2017, Tallinn, Estonia.
Hoel, T., & Chen, W. (2016a). Privacy-driven design of learning analytics applications: Exploring the design space of solutions for data sharing and interoperability. Journal of Learning Analytics, 3(1), 139–158. http://dx.doi.org/10.18608/jla.2016.31.9
Hoel, T. & Chen, W. (2016b). Data Sharing for Learning Analytics – designing conceptual artefacts and processes to foster interoperability. In Chen, W. et al. (Eds.) (2016). Proceedings of the 24th International Conference on Computers in Education. India: Asia-Pacific Society for Computers in Education
Hoel, T. & Chen, W. (2016c). Implications of the European Data Protection Regulations for Learning Analytics Design. presented at CollabTech 2016, Kanazawa, Japan September 14-16, 2016
Hoel, T. & Chen, W. (2016d). The Principle of Data Protection by Design and Default as a lever for bringing Pedagogy into the Discourse on Learning Analytics Workshop paper in Chen, W. et al. (Eds.) (2016). Proceedings of the 24th International Conference on Computers in Education. India: Asia-Pacific Society for Computers in Education
Hoel, T. & Chen, W. (2015). Privacy in Learning Analytics – Implications for System Architecture — In Watanabe, T. and Seta, K. (Eds.) (2015). Proceedings of the 11th International Conference on Knowledge

Management. ISBN 978-4-9908620-0-8. Presented at ICKM 15 in Osaka, Japan, 4 - 6 November 2015. ickm.kis.osakafu-u.ac.jp

Hoel, T., Chen, W., & Gregersen, A.B. (2018). Are Norwegian Librarians ready to share Library Data to improve Learning? Journal of Information Literacy in Higher Education, Vol 10, No 1.

Hoel, T., Griffiths, D., & Chen, W. (2017). The influence of data protection and privacy frameworks on the design of learning analytics systems (pp. 243–252). Proceedings of the Seventh International Learning Analytics & Knowledge Conference, New York, New York, USA: ACM Press. http://doi.org/10.1145/3027385.3027414

Hoel, T., Chen, W., & Cho, Yong-Sang (2016) Privacy Requirements for Learning Analytics – from Policies to Technical Solutions. Paper presented at Workshop on Ethics and Privacy for Learning Analytics, Monday, April 25th 2016 at the 6th International Conference on Learning Analytics and Knowledge (LAK ’16), Edinburgh, United Kingdom

Hoel, T., Chen, W., & Mason, J. (2016). Data Sharing for Learning Analytics – Exploring Risks and Benefits through Questioning. Journal of the Society of e-Learning. Vol.1. No.1, December 2016. ISSN 2508-7584.

Hoel, T. & Chen, W., & Pawlowski, J.M. (submitted for review). Making context the central concept in privacy engineering for learning.

Hoel, T., Chen, W., & Yu, L. (forthcoming). Teachers perceptions of data management as educational resource. A comparative case study from China and Norway.

Hoel, T. & Mason, J. (2018). Standards for Smart Education - towards a development framework. Smart Learning Environments. Springer Open. DOI: 10.1186/s40561-018-0052-3

Hoel, T., Mason, J., & Chen, W. (2015). Data Sharing for Learning Analytics – Questioning the Risks and Benefits. In Hangzhou, China, November 30 - December 4, 2015 - www.icce2015.zjut.edu.cn , published in Ogata, H. et al. (Eds.) (2015). Proceedings of the 23rd International Conference on Computers in Education. China: Asia-Pacific Society for Computers in Education

Horn, M. (2014). inBloom’s collapse offers lessons for innovation in education. Forbes. Retrieved from http://www.forbes.com/sites/michaelhorn/2014/12/04/inblooms-collapse-offers-lessons-for- innovation-in-education/

House of Lords. (2018). AI in the UK: ready, willing and able? HOUSE OF LORDS Select Committee on Artificial Intelligence. Report of Session 2017–19.

IEEE. (2017). The IEEE Global Initiative on Ethics of Autonomous and Intelligent Systems. Ethically Aligned Design: A Vision for Prioritizing Human Well-being with Autonomous and Intelligent Systems, Version 2. http://standards. ieee.org/develop/indconn/ec/autonomous_ systems.html.

ISTPA. (2007) Analysis of Privacy Principles: Making Privacy Operational v2.0. https://www.oasis- open.org/committees/download.php/55945 ISTPAAnalysisofPrivacyPrinciplesV2.pdf
ISO. (2019). Information technology for learning, education and training — Learning analytics interoperability — Part 4: Privacy and data protection policies. ISO/IEC TS 20748-4.
Kharif, O. (2014). Privacy fears over student data tracking lead to InBloom's shutdown. Bloomberg. Retrieved from http://www.bloomberg.com/news/articles/2014-05-01/inbloom-shuts-down- amid-privacy-fears-over-student-data-tracking
K.N.C. (2014). Withered inBloom. The Economist. Retrieved from http://www.economist.com/blogs/schumpeter/2014/04/big-data-and-education
Kitchenham, B. (2004) Procedures for performing systematic reviews. Technical Report Keele University TR/SE-0401 and NICTA 0400011T.1, Software Engineering Group, Department of Computer Science, Keele University,
Lester, J., Klein, C., Rangwala, H., & Johri, A. (2017). Learning Analytics in Higher Education. ASHE Higher Education Report, 43(5), 9–135. http://doi.org/10.1002/aehe.20121
Lowry, P. B., Dinev, T., & Willison, R. (2017). Why security and privacy research lies at the centre of the information systems (IS) artefact: proposing a bold research agenda. European Journal of Information Systems, 26(6), 546–563. http://doi.org/10.1057/s41303-017-0066-x
Mason, J., Chen, W., & Hoel, T. (2016). Questions as data: illuminating the potential of learning analytics through questioning an emergent field. Research and Practice in Technology Enhanced Learning, 1–14. http://doi.org/10.1186/s41039-016-0037-1
Ministry of Education (2017). Framtid, fornyelse og digitalisering. Digitaliseringsstrategi for grunnopplæringen 2017–2021. Norwegian Ministry of Education whitepaper.
Mullarkey, M. T., & Hevner, A. (2019) An elaborated action design research process model, European Journal of Information Systems, 28:1, 6-20, DOI: 10.1080/0960085X.2018.1451811
Nissenbaum, H. (2010). Privacy in Context: Technology, policy, and the integrity of social life. Stanford, CA: Stanford University Press.
Nissenbaum, H. (2004). Privacy as contextual integrity. Washington Law Review, 79(119), 101–139.
NOU (2019:23). Ny opplæringslov. Online: https://www.regjeringen.no/no/dokumenter/nou-2019-23/id2682434/
Nunamaker Jr, J.F., Chen, M. & Purdin, T. (1990). Systems development in information systems research. Journal of Management Information Systems, 7(3).
OASIS. (2016). Privacy Management Reference Model and Methodology (PMRM) Version 1.0. http://docs.oasis-open.org/pmrm/PMRM/v1.0/cs02/PMRM-v1.0-cs02.html

O'Hara, K. & Shadbolt, N. (2008). The Spy in the Coffee Machine: The End of Privacy as we know it. Oneworld Oxford. ISBN: 978-1-85168-554-7

Ozga, J. (2015). Trust in numbers? Digital Education Governance and the inspection process. European Educational Research Journal, 15(1), 69–81. http://doi.org/10.1177/1474904115616629

Peffers, K., Tuunanen, T., & Niehaves, B. (2018). Design science research genres: introduction to the special issue on exemplars and criteria for applicable design science research. European Journal of Information Systems, 27(2), 129–139. http://doi.org/10.1080/0960085X.2018.1458066

Peffers, K., Tuunanen, T., Rothenberger, M. a., & Chatterjee, S. (2007). A Design Science Research Methodology for Information Systems Research. Journal of Management Information Systems, 24(3), 45–77.

Sclater, N. (2016). Developing a code of practice for learning analytics. Journal of Learning Analytics, 3(1), 16–42.

Sclater, N., & Bailey, P. (2015). Code of practice for learning analytics. London, UK: JISC.

Schon, D., The Reflective Practitioner: How Professionals Think in Action, Temple Smith, London, 1983.

Sein, M. K., Henfridsson, O., Purao, S., Rossi, M., & Lindgren, R. (2011). Action Design Research. Mis Quarterly, 35(1), 37-56

Selwyn, N. (2015). 'Theres so much data: Exploring the realities of data-based school governance. European Educational Research Journal, 15(1), 54–68. http://doi.org/10.1177/1474904115602909

Selwyn, N. (2014). Data entry: towards the critical study of digital data and education. Learning, Media and Technology, 40(1), 64–82. http://doi.org/10.1080/17439884.2014.921628

Siemens, G., & Gasevic, D. (2012). Guest editorial-learning and knowledge analytics. Educational Technology & Society, 15(3), 1–2.

Slade, S., & Prinsloo, P. (2015). Student vulnerability, agency and learning analytics: an exploration. Journal of Learning Analytics, Special Issue on Ethics and Privacy.

Smith, H. J., Dinev, T., & Xu, H. (2011). Information Privacy Research: An Interdisciplinary Review. Mis Quarterly, 35(4), 989–1015.

Spiekermann, S., & Korunovska, J. (2017). Towards a value theory for personal data. Journal of Information Technology, 32(1), 62–84. http://doi.org/10.1057/jit.2016.4

Solove, D. J. (2006.). A Taxonomy of Privacy. University of Pennsylvania Law Review, 154(3), 477–564.

Tes Reporter. (2017). Machines 'will replace teachers within 10 years'. 11 September 2017 https://www.tes.com/news/machines-will-replace-teachers-within-10-years

Tsai, Y.-S., Whitelock-Wainwright, A., & Gasevic, D. (2020). The privacy paradox and its implications for learning analytics (Vol. 79, pp. 230–239). Presented at the LAK '20: 10th International Conference on Learning

Analytics and Knowledge, New York, NY, USA: ACM. http://doi.org/10.1145/3375462.3375536
Venable, J., Pries-Heje, J., & Baskerville, R. (2016). FEDS: a Framework for Evaluation in Design Science Research. European Journal of Information Systems, 25:1, 77-89. DOI: 10.1057/ejis.2014.36
Williamson, B. (2018a). Personalized precision education and intimate data analytics. Blog post 16 April 2017. https://codeactsineducation.wordpress.com/2018/04/16/personalized-precision-education/
Williamson, B. (2018b). The hidden architecture of higher education: building a big data infrastructure for the "smarter university." International Journal of Educational Technology in Higher Education, 15(1), 1–26. http://doi.org/10.1186/s41239-018-0094-1
Williamson, B. (2017a). Big Data in Education. Sage Publishing. ISBN: 9781473948006
Williamson, B. (2017b). Moulding student emotions through computational psychology: affective learning technologies and algorithmic governance. Educational Media International, 54(4), 1–22. http://doi.org/10.1080/09523987.2017.1407080
Williamson, B. (2016). Digital education governance: data visualization, predictive analytics, and "real-time" policy instruments. Journal of Education Policy, 31(2), 1–19. http://doi.org/10.1080/02680939.2015.1035758
Williamson, B. (2015). Educating the smart city: Schooling smart citizens through computational urbanism. Big Data & Society, 2(2), 205395171561778. http://doi.org/10.1177/2053951715617783
Yin, R. K. (2009). Case study research: Design and methods. Thousand Oaks, CA: Sage.
Yin, R. K. (2011). Applications of case study research. Thousand Oaks: Sage publications, Inc.

# ORIGINAL PAPERS

# I

# DATA SHARING FOR LEARNING ANALYTICS – EXPLORING RISKS AND BENEFITS THROUGH QUESTIONING

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# Data Sharing for Learning Analytics – Exploring Risks and Benefits through Questioning

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**ABSTRACT**

Moving learning analytics from the research labs to the classrooms, lecture halls, and digital learning spaces requires data sharing. Routine production and consumption of data is no limited to controlled settings as data can be sourced from an increasing diversity of data points and combined or aggregated from these sources within and often beyond the institution. This scaling up of learning analytics raises a host of questions on behalf of the data subjects and therefore informs requirements for design of new solutions and practices. This paper analyses a corpus of more than 250 questions gathered by a European project that organized international workshops and facilitated community exchange. It explores how these questions could inform both the problem space of data sharing and the solution space yet to be fully scoped by research and development within this emerging field. The analysis shows that the discourse on data sharing and big data for education is still at an early stage. Conceptual issues dominate this discourse; however, the elicited questions also hold numerous challenges for technical development and implementation. In concluding we propose a short inventory of what the emerging solution space may entail and suggest a path for further work.

**Keywords:** learning analytics, interoperability, questioning, data sharing, data ownership, data protection, data governance

## 1. Introduction

We are now living in an era in which data is proliferating at extraordinary volumes and potentially sourced from anything and anywhere, thus providing new opportunities for data sharing, innovation, learning and teaching. From large-scale, longitudinal datasets to school-level administrative data, and to real-time big data systems, digital technologies are playing an increasing role in the administration of educational data, and in the organization of classrooms and online courses.

[1]

Numerous digital devices can capture and render any activity or utterance into data, a situation that broadens the scope for data sharing beyond issues of systems interoperability to data provenance and governance. In other words, data sharing gives cause to consider the origins and destinations of data. Data-intensive computing is described as the "4th paradigm" of science [2] and, in recent parlance it is now a world of big data in which access to rich datasets is not constrained by access to supercomputers. Given such a context it is no surprise that the associated discourse includes predictions that big data will change our understanding about causality [3] or that data science will change the nature of evidence [4]. Nonetheless, educational governance is quickly transitioning to include a cluster of issues concerning digital education activities.

### 1.1 Defining Learning Analytics

In responding to this new data-driven era Learning Analytics (LA) is an emergent field of educational research, technology development and educational practice. As such, it aims to "to inform and empower learners, instructors and organization about performance and goal achievement, evaluate the use and effectiveness of educational resources, and facilitate decision-making accordingly, by providing recommendations for improving them" [5]. A widely-accepted definition of LA highlights "the measurement, collection, analysis and reporting of data about learners and their contexts, for purposes of understanding and optimizing learning and environments in which it occurs" [6]. It is the access to data that allow LA procedures to "retrospectively monitor and track the different digital traces related to the context, interpret and map the real current state of these data, organize them, use these data (e.g., decide adaptations, recommend, provide feedback, guide the learner), and predict their future state" [5, 7].

### 1.2 New Complexity brings new questions

Significantly within educational contexts, data has also become a digital learning resource as much as the content it may be associated with. This situation introduces a new complexity to the design of learning technology systems because with the growth of LA there is now a meshing of content and data. This is particularly so from the perspective of the learner. Moreover, given that data relevant to teaching and learning can now be sourced from an increasing diversity of data points issues of data governance need to be addressed. *Do educational institutions have a right to collect data about students and staff without consent? In what ways can institutions of formal learning legitimately access data from third parties for purposes of improving student learning outcomes?* These kinds of questions are a natural response to the ongoing innovation and disruption associated with digitally-enabled learning.

As we try to make sense of the emergent patterns of order and disorder, and balance risk with functional gain in the systems we deploy, we need to ask questions. But which questions? How do we determine that we are asking the kinds of questions that might inform us in improving the designs of information technologies when we do this? What assumptions are we making? Can we assume that systems interoperability is necessarily a good thing given that data shared may also be data compromised? What consequences does data sharing have for systems governance, given that data is produced from an increasing diversity of datapoints? What do we need to consider in the design and deployment of new technologies that are now developed in this era of data-driven learning, education and training?

### 1.3 Smart Education

While the big data era in education may just be beginning, there are signs of early large-scale technical solutions being deployed in schools and universities and a growing awareness that more change is coming. This data-driven era is also conceived as being instrumental to facilitating smart education [8]. Within the global context, however, the emergence of learning analytics is part of a bigger trend of "massive digitisation and datafication of education" in which the "technologies of digital education governance are socially, politically and economically produced, and also socially, politically, and economically productive" [1]. Thus, it is to be expected that this dynamic development will be met by questions and even resistance. On this topic there already exists a substantial body of questions in the public record [9, 10, 11].

A practical response is to make use of all the questions arising by specifying requirements for design and further development. We therefore aim to present a preliminary analysis of this crucial moment in the history of learning technologies, pausing to consider design foundations for a new generation of tools and practices. We are asking, and scrutinising, what questions are being asked. How are these questions framed? What research domains are called for to address such questions? Are there relevant analytical frameworks available to support the development of the seemingly most relevant questions?

We are therefore, using questions to guide our research while also examining the content of those questions. The contribution of this research is an overview of the current concerns and barriers related to LA, which will contribute to a more informed design of the different processes related to LA procedures.

## 2. Background

A prominent first question is, what is it about big data that is going to change education? in responding to this question some of the clues come from elsewhere, given that data analytics has found traction particularly in the business world, a clear trend that has been underway for nearly a decade. Observing this a European politician recently remarked: “If big data has revolutionised advertising, it can certainly help us improve education!” Such a statement has utility as political rhetoric but the archetypal food chain with data associated with every item you buy is hardly a suitable prototype for the application of data analytics in education. Or is it? Perhaps it is more reasonable to characterise the situation for educational institutions in terms of small, rather than, big data, given that there are certainly differences between selling soap and grafting knowledge, including many subtle aspects and contested notions about purpose, methods, and values. Nonetheless, it seems appropriate to be clear about what we mean by these terms. We concur largely with Kitchin (2014) in identifying big data as being defined by its ‘volume, velocity and variety’ [12], and with Williamson (2016) who explains that the term also indicates datasets that are continuously generated and are ‘combinable, flexible and scalable’ [1]. By situating this term within an educational context Cope and Kalantzis frame its core characteristic in terms of “new possibilities [for] educational evidence and research in the era of digitally-mediated learning” [4].

### 2.1 Data Sharing – Big Data and Small Data in Education

Many applications of learning analytics are found to require data sharing to realise their potential [13, 14]. For example, the presence of large-scale data is often a prerequisite for educational data mining techniques or multivariate statistics [4]. Alternatively, it is often the case that the data required to undertake learning analytics either resides in or is produced by different software systems, and that data from a variety of different sources is vital. Although the data from an institutional learning platform or a MOOC may be considered large and varied, the scale and coverage of the datasets that can be retrieved may be insufficient to allow the potential of learning analytics to be fully realised because of the great variety of learner and contextual attributes. For example, Verbert et al. demonstrated that the activities of learners on a single course is likely to be so diverse that a learning resource recommender system would be practically useless if only based on data at this scale [15]. Thus, this challenge of acquiring data from multiple sources applies to both learning science research and to potential products and services built around data generated through learning activities. This situation motivates the idea that data sharing between organisations, or indeed, individuals – potentially including public and private sector bodies – is an important enabler for effective learning analytics, while also maximising the benefit from data created. Data sharing is also indicated by cloud computing models of service and IT provision, where expertise or technology is provided by a separate organisation to the education provider. In this scenario, it is the service as well as the data associated with it that are of value.

A distinctive difference between the archetypal big data corporation and educational establishments is, therefore, a disposition and requirement for data sharing. Occupying the spaces between these archetypes are the government agencies currently pursuing the promise of open data in the deployment of online public services. Although examples of data sharing clearly exist, it is also the case that conversations about data sharing with various stakeholders often raise questions and sometimes expose previously un-asked questions that should be addressed [13]. There is, therefore, substantial work to do to properly characterise the problem-space, before determining or testing the options or innovations in the solution-space.

### 2.2 Making Sense of the Data

Making sense of data has typically been one of the key challenges of scientific research and a core activity of analysis for university researchers. As the era of big data gets underway this imperative remains; however, what has changed is that making sense of data is moving into the everyday concerns of a wider group of stakeholders that includes the broader community. In many ways social media has prepared us for this era through providing simple visual cues for seeing how many ‘likes’ or visits a blog post may attract. A prominent example in our daily newspapers are questions of metadata (essentially data about data) associated with an individual’s internet and telephone activity, which have not only entered the mainstream of political discourse but also been enacted through legislation [16]. While access to really big data in education may not be as straightforward as proponents of the latest of LA tools seem to think [17], there is no doubt increasingly larger volumes and varieties of data will be available for analysis. As Cope and Kalantzis point out, it is not only the fact that the grain size of recordable and analysable data has become smaller, the sources of evidence are now more varied and increasingly ubiquitous with implementations:

> …including computer-adaptive and diagnostic tests, automated essay scoring, learning games, social interaction analyses, affect meters, body sensors, intelligent tutors, simulations, semantic mapping, and learning management system data. [And] [a]t the same time, n=1 becomes a viable sample size, because massive amounts of data can be gleaned to create a composite picture of an individual student. [4]

No doubt, future educationists will handle increasing volumes of data, but there is a big leap to transforming such data into knowledge and well-considered actions. With network connected sensors embedded in nearly all hardware the surveillance society has arrived by stealth. But, if the individual's main concern is to guard against personally identifiable information being leaked, a key aspect of what is at stake with the new era of big data in education is missed. One scenario is that in the near future we will no longer need (summative) tests as source of evidence-of-learning "because the data that we have drawn from the learning process is itself sufficient evidence" [18]. When all assessment becomes formative and driven by algorithms, and the data analysis loops back to take the learning process in new directions new questions arise. What model then of 'me' as a learner governs the actions prescribed by the LA algorithms, and how do I talk to a robot if I think I may have been misunderstood?

In some of the naïve acclaim of the benefits of big data in education [3] one gets the impression that 'data smashing' will produce results that emerge directly from the data. But as Cope and Kalantzis point out, in reality, the opposite is true [18]. Theory is needed to form the right questions. Again, questions are the first mover.

To explore the questioning related to the introduction of big data to education under the heading of learning analytics we use questions gathered by the European Learning and Community Exchange (LACE) project as its data. The project has organised workshops both in Europe and internationally, where questions have been solicited. In addition, the project has also carried out a survey among LA experts, asking them to come up with issues related to the challenges of accessing and sharing data for learning analytics.

The rest of the paper is organised as follows: first, related work is reviewed and a methodology of our investigation is outlined. Next, the data used in this study is described and the results of the data analysis presented. The results are then discussed followed by findings and positions with conclusions within a broader perspective.

## 3. Related Work

In recent years, computers have been introduced to nearly all classrooms in most of the world – certainly this is the case in the developed world. While desktop computers may have influenced formal learning, it is the mobile revolution that is having most impact upon how we socialise, communicate and learn. This impact is far reaching as it easily blurs the boundaries between formal and informal learning. Design of traditional learning spaces has often proceeded from the assumption that learning is largely confined to formal spaces like traditional classrooms and lecture halls [19]. Challenging this assumption, "Current views on learning acknowledge that much, if not most, learning does not occur in formally designated learning spaces [20], but rather, in informal spaces not necessarily originally envisaged as learning spaces" [19]. Moving towards a more data-driven support for learning and education will make it essential to articulate where learning takes place to determine what design requirements are implied in the production and consumption of data. For example, Cavoukian and Jonas [21], and Hoel and Chen [22] address the issue of how to ensure that privacy requirements are dealt with explicitly at the design stage.

Thomas argues that we have failed to recognise the primacy of 'physical situatedness' to our conceptions of learning itself, and that our difficulty in understanding and articulating the nature of learning is partly brought about by our inability to articulate where learning takes place [19]. When understanding the scope of place and space are essential to understand the nature of learning in our age, the concept of context becomes a key analytical construct [23, 24, 25]. (Warburton, 2009; Clark & Maher, 2001). Mason highlighted this frontier in considering the potential of metadata to describe both the nouns and the verbs of learning, education, and training [25]. More recently, Scoble and Israel describe the 'Age of Context', as the new era formed by forces like sensors, wearables, location services, social software, and data – all forces that also will impact the future of education [26].

### 3.1 Learning Contexts and Contextual Integrity

When the learner's 'situatedness' is represented in a stream of activity data concerns about privacy often arise. The public debate on privacy tends to swing between two positions: the liberty of individuals to control their personal information on the one hand and who might have legitimate access to such personal information. Another perspective, with focus on "contextual integrity", moves the debate beyond control and limitation promoting respect for context as a benchmark for privacy online:

When we find people reacting with surprise, annoyance, indignation, and protest that their privacy has been compromised, we will find that informational norms have been contravened, that contextual integrity has been violated [27].

This perspective emphasises context as social domain, and warns against giving primacy to context as technology system or platform, as business model or business practice, or as sector or industry. By applying context integrity as a social phenomenon, the negotiable aspects of privacy are foregrounded. From this perspective, the institution may not have violated the informational norm if the roles of the actors involved, (e.g., students, teachers, or administrators) are acknowledged; the agreed information types are used; and the agreed data flow terms and conditions are followed. Seeing privacy from the perspective of maintenance of contextual integrity has many implications for design, both of organisational and technical solutions [21]. Underlining the social dimension of privacy aligns with an understanding of learning as conversational activity – see for example Laurillard's conversational framework for the effective use of learning technologies [28].

### 3.2 Questioning

It is a common experience that prior to becoming comfortable with new tools and new ways of working one can be caught 'off balance' or unprepared. If captured and used with the right approach this moment of delocation or de-situatedness could be useful for learning itself. In such moments numerous questions can arise that could be the in situ learning material to be used. Our focus on questions has been inspired by the work of Rothstein and Santana in their exposition of the Question Formulation Technique (QFT) as a process to stimulate student inquiry and questioning skills [29] This technique follows a simple sequence of activities that begins with open brainstorming of all possible questions that are relevant to an agreed question focus. Rothstein and Santana argue that formulating one's own questions is "the single most essential skill for learning" – and one that should be taught to all students in order to empower them with basic critical thinking skills.

### 3.3 From Problem Space to Solution Space

Questions may be understood as obvious ways to express concerns about issues and to identify barriers to achievement of organisational goals. Following Chen and Daclin [30], Hoel and Chen [31] introduced the notions of Problem Space and Solution Space as an analytical framework for moving from problem statements to design proposals. The Problem Space is two dimensional, where each problem is found in the intersection of a concern and a barrier. The Solution Space adds another dimension, the proposed approach to solve the problem.

In moving from problems to solutions different approaches could be chosen to make sense of an amorphous set of issues scattered around the Problem Space. Enterprise Interoperability Analysis looks at conceptual, technological and organisational barriers as the categories for barrier [30]. A report by the LACE project on Data Sharing Requirements has made use of the European Interoperability Framework, which analyses interoperability in terms of Technical, Semantic, Organisational, and Legal aspects [13].

## 4. Methodology

The purpose of this study is to propose candidate concepts and processes that connect questions with solutions in the domain of LA, which can be conceived as a subset of learning technologies. To achieve this, a number of methodological considerations inform this study.

In exploring the topics and issues outlined in the previous sections we investigate how to move from identifying key questions to specifying design requirements in a particular field of educational systems design [32]. To do this it is essential to understand how questions are articulated from a situated practitioner's perspective, recognising that context is key in analysing responses to the questions. Indeed, it is from questions that inquiry deepens and in some cases the most appropriate response to a question is not an answer but yet another question [29].

In moving from the Problem Space to suggestions of how to organise the Solution Space regarding data sharing in LA we apply a simple iterative procedure described in Figure 1. The questions are first prioritised according to an expert's view on how important the issue is. Then the questions are ranked according to proximity of the problem and the feasibility of addressing the issues. Categories for classifying these dimensions are drawn from Cooper and Hoel [13]: proximity is categorised as horizon, approaching, or blocker; and feasibility as uncomplicated, concerted efforts needed, or challenging. When questions have been ranked for priority, proximity and feasibility a filtered set of the highest priority questions are selected for analysis. We have then analysed the questions extracting common topics of concern. The grouping of concerns is then used to construct a limited set of meta-questions that constitute the organised Problem Space, and which is brought forward as requirements for design of the Solution Space (Figure 1).

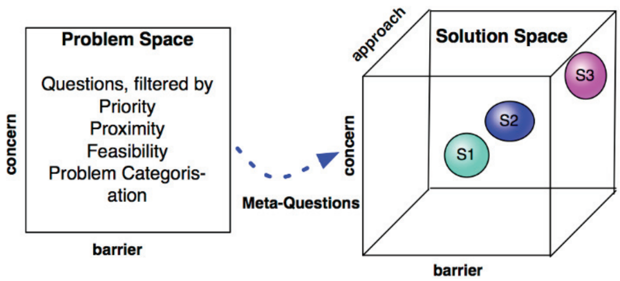


Figure 1. From Questions describing Problems to Solutions – a process model

This study also been informed by multi-case study methodology, as articulated by Yin [33], and uses qualitative methods for text analysis [34]. This work also fits within a Design Science Research tradition [35, 36] as it is positioned in the first Relevance Cycle (addressing requirements and field testing) of the three research cycles of Design Science [36].

The next section presents the case studies that produce the data for the analysis. A snapshot of the filtered result of the analysis of the questions is shown. In the following section, possible directions for solutions are discussed.

## 5. Case studies – outcome of workshops on requirements for learning analytics

Three cases from related but separate activities have produced a large amount of questions and concerns of bringing learning analytics to the mainstream of schools and universities.

### 5.1 International Workshops

The first case-study is the outcome of a series of workshops and discussions that took place during 2014 and 2015. The European project LACE, the SURF Learning Analytics Special Interest Group (SIG), the Apereo Foundation and the European Association of Technology Enhanced Learning SIG dataTEL organised a series of ethics and privacy for learning analytics (EP4LA) workshops in the Netherlands, USA, France and United Kingdom1. The questions were solicited by asking participants to fill out a Google form, and by extracting questions from meeting minutes. Furthermore, in two workshops on learning analytics at ICCE 2014 and 2015 in Japan and China, the Question Formulation Technique was used to gather data [29, 37].

The resulting list of more than 90 questions from these events highlights that the issues of concern for participants mostly cluster around privacy and ethics, data access, and transparency.

### 5.2 A Taxonomy of Ethical, Legal and Logistical Issues

The resulting list of more than 90 questions from these events highlights that the issues of concern for participants mostly cluster around privacy and ethics, data access, and transparency.

Based on workshops to discuss the ethical and legal issues of learning analytics organised by Jisc in the United Kingdom, Apereo and the LACE Project, Sclater has developed a taxonomy of issues based on input and comments from experts [38]. The issues are grouped in categories reflecting a lifecycle view on LA, starting with issues of ownership and control to seeking consent from students, ensuring transparency, maintaining privacy, ensuring validity in the data and the analytics, enabling student access to the data, carrying out interventions appropriately, minimising adverse impacts and stewarding the data. Sclater has grouped the issues related to ethics, legality and logistics; and he has ranked them in terms of importance. Finally, he has identified six stakeholder groups, whose responsibilities for responding are identified. In total, the taxonomy classifies 85 questions.

### 5.3 Group Concept Mapping Study

As part of the work to explore issues related to data sharing for learning analytics a group concept mapping survey was initiated in April 2015 gathering statements on enablers and barriers for data sharing, and sorting and rating them according to importance and feasibility. In this study 75 statements were gathered. The concerns fell into broad categories now known from the case studies above, consent, transparency, access, privacy and anonymity, codes of practice, control of data use, benefits and usefulness, data quality, data governance, ethical responsibility, and technical issues of software design.

## 5.4 Using Questions as Data for Requirements

The three case-studies, in all, raise 250 questions articulated in discussions with stakeholders and the LA research and stakeholder community on how to advance learning analytics for the benefits of schools and universities. Despite the case studies referred to above proposing their own categories to group issues we have started with a clean slate by analysing each question through several cycles in order to understand more about the respondents' positioning in relation to the perceived benefits and risks of learning analytics.

After having rated each question according to priority in terms of relevance to the issue or concern raised, 120 questions received a score of 7 or 6 using a 1 - 7 scale, where 7 represented the highest priority. These 120 questions were analysed for proximity of the issue, using three categories:

1) *Horizon*: the issue will have impact but it could reasonably be addressed with low- level effort at present.
2) *Approaching*: the issue will have impact in the mid-term and neglecting it could make matters worse in the future, for example by flawed technologies or practices coming into use. The issue deserves early attention.
3) *Blocker*: the issue is a blocker to meaningful progress.

Of the highest priority questions 23 were seen to address issues that the authors of this paper regarded as blocker of meaningful progress, while 46 were seen as addressing approaching issues, and 51 issues that were on the horizon for early solutions (Figure 2).

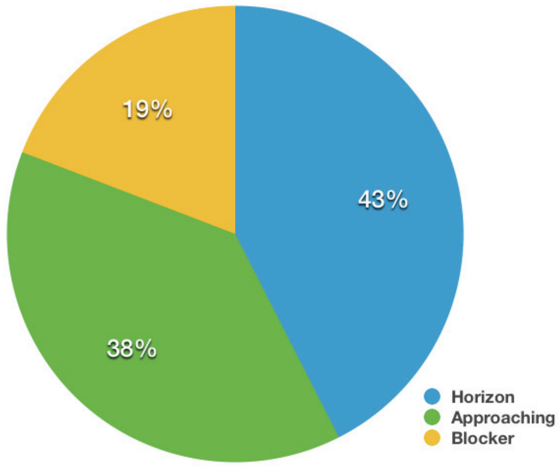


Figure 2. Distribution of questions related to proximity of the issue

The next step was to rate the 120 questions in terms of feasibility level. The following categories were used, in decreasing feasibility:

1) *Uncomplicated*: projects/initiatives could be established with a high likelihood of achieving useful outcomes in a single cycle of action.
2) *Concerted efforts needed*: this would likely require several cycles of development, with the parameters for deciding what success looks like largely uncontentious and known, or could be determined early in any project.
3) *Challenging*: work is required to properly understand the issues in order to guide action and it may not yet be clear what is feasible. Action may be contentious or limited action would be possible without better problem definition, although this would probably involve an iterative process of: define, act, refine.

Of the highest priority questions 11 were seen to address issues that these authors regarded as challenging to solve, while 33 were seen to need concerted efforts, and 76 were judged to be uncomplicated to solve (Figure 3).

Interestingly, 8 questions that were considered to be a blocker of progress were rated as uncomplicated to solve, while 8 were considered to be less than challenging, possible to solve through several cycles of development and concerted efforts.

To construct the Problem Space after having sorted the 120 questions according to proximity and feasibility the questions were analysed for similarities related to the concerns they addressed. Working through all questions a number of times resulted in seven broad issue categories, three of them being addressed in more than 80 percent of the questions. The most prevalent group of issues centred around Implementation, Transparency, and Codes of Practice. The other two big groups were Defining benefits and boundaries of LA, and Ownership of data. Less prevalent were the issue groups of Individual vs. Collective (i.e., understanding learning as a group activity with pedagogical and ethical ramifications it may be difficult to opt out of); Risk aspects of LA; Business case of LA; and Validity of LA.

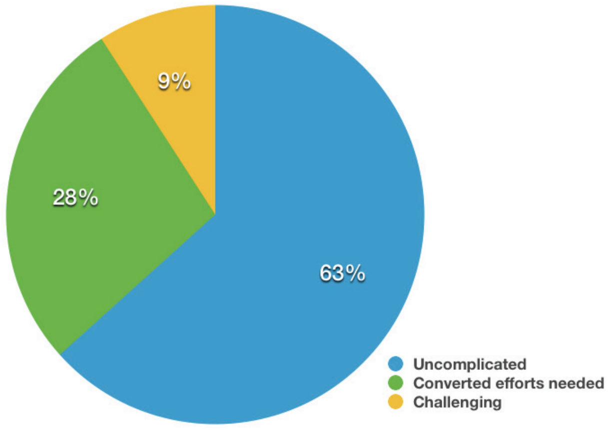


Figure 3. Distribution of questions related to solution complexity

Re-analysing these issue groups with the situatedness of the questions still present resulted in five 'meta-questions' that would serve as a bridge between the Problem Space and the Solution Space:

- **Validity**: How do we ensure the validity of learning analytics, e.g., how do we make sure we measure the 'right activities' as a basis for analytics?
- **Risk-based**: How do we understand and support learning as a risk-based activity, in which the interests of the individual always have to be balanced with the interests of the collective?
- **Ownership:** How is ownership to data for learning analytics defined (and supported through design), including the question of consent to and conditions for data sharing (e.g., deletion of data after a course is finished)?
- **Implementation**: What are best practices of implementation in the field of learning analytics, including transparency of data sharing, algorithms and predictive models, etc.; and how are these best practices developed and maintained in Codes of Practice?
- **Business case**: What are the implications for the learners of different business models for learning analytics services, e.g., of data sharing with third party organisations?

Table 1 shows an excerpt of the 120 'high priority questions' with their proximity and feasibility scores, and with the classification of the questions according to Problem Space structure.

Table 1. 10 Questions on learning analytics concerns and barriers from three European Case studies, part of the corpus of 250 questions analysed

| Question | Priority | Proximity | Feasibility | Emerging Problem Space |
|---|---|---|---|---|
| Can the user withdraw consent to share data at any time? | 6 | 3 | 3 | Individual vs Collective; Risk handling. |
| Do students have the right to withdraw from data collection and analysis after previously giving their consent? | 7 | 2 | 3 | Individual vs Collective; Risk handling. |
| Can all data regarding an individual (except that necessary for statutory purposes) be deleted? | 6 | 3 | 2 | Risks; Individual vs. Collective; Anonymisation. |
| To what extent should students be able to access the analytics performed on their data? | 7 | 2 | 2 | Defining benefits; Ownership |
| What are the concerns when outsourcing the collection and analysis of data? Who owns the data? | 7 | 3 | 1 | Defining benefits and boundaries; Ownership |
| To what extent do we provide students the option to update their data and provide extra (possibly qualitative) data? | 6 | 3 | 1 | Ownership; Defining benefits and boundaries |
| What data should students be able to view, i.e. what and how much information should be | 6 | 2 | 1 | Ownership; Implementation. Transparency. Codes of |

| | | | | |
|---|---|---|---|---|
| provided to the student? | | | | Practice |
| Are interconnected datasets a threat to personal and democratic principles? | 6 | 1 | 1 | Risks; Individual vs. Collective. |
| What should students be told about the potential consequences of opting out of data collection and analysis of their learning? | 6 | 1 | 1 | Risks; Individual vs. Collective. |
| Can students be identified from metadata even if personal data has been deleted? | 6 | 1 | 1 | Risks; Individual vs. Collective. |

As a check of the completeness of the list of meta-questions the 130 questions not prioritised for full analysis were checked to see if there were issues not covered. Most of these questions were found to fall into the established categories. Furthermore, these questions of lesser priority would, it seems, be addressed by providing answers to the questions of implementation, best practices, transparency, and codes of practice.

## 6. Discussion

Risks and benefits can be seen as two sides of the same coin in much the same way as threats and opportunities are often cast in organizational strategic plans. Concerns are easily expressed as questions; hopes, visions and benefits are often part of another discourse or serve as a silent backdrop for questioning. Our study suggests that despite the hype it is still early days for LA, and there is a lot to be learnt by investigating both the perceived benefits and risks. With a clearer understanding of what LA could do in education there would be no need to ask if and to what extent students should have access to the analytics performed on their data. This question, however, goes to the core of learning both as a pedagogical and ethical practice. It is not difficult to give a principled answer to this question; on the other hand, in order to provide technical solutions concerted work needs to be initiated by a wider group of stakeholders who would draw up visions, describe practices and establish rules. A great many of the questions in this study could be addressed by establishing what is termed best practices of implementation. Elaborate and technical instructions for how to crunch and visualise numbers and interpret dashboards are not in question, at least not at this moment in time. We have found what is asked for is best practices that position the learners, teachers and the other actors as individuals in a pedagogical, ethical and organisational context. What are the learning spaces where LA will be applied, and what are the boundaries for its use? It is obvious that transparency plays an important role in this picture, but it will take time and effort to turn transparency into a hard requirement that is built into tools and practices as technical and process features.

When the European community exchange (LACE) was initiated nobody knew that ethics and privacy would be such a strong and cross-cutting theme in the discussions. Now that outcomes have been documented it is clearly a challenging issue that could be a true blocker of progress if not solved. Solving this issue is closely linked with defining the benefits of LA for learning (for the learner). The key to solving it lies, in our opinion, in the context integrity perspective on privacy combined with an understanding of learning as a risk-based activity. The learner is typically situated within a ‘learning collective’ and has to learn to live with a certain level of risk; however, the learner should not accept any infringement of personal integrity by violation of informational norms through unjustified sharing of data. To find solutions to this issue a wide range of development needs to be undertaken, covering legal, organisational and technical domains.

The questions of ownership of data and consent to data sharing may seem easy to solve as the answers could be deduced from law. Legal clarification, however, is only part of the solution of this concern that is expressed in so many ways in this study. Ownership is often tightly bound to control, and as long as the learners, their parents, and the teachers are not provided with means of control it does not matter what the law states. User-managed access to data is a proposed idea that is supposed to give a user “a unified control point for authorizing who and what can get access to their online personal data, content and services, no matter where all those things live on the web” [39]. Research is needed to determine whether this is a viable idea for integration in LA solutions, and if not, which other technical solutions should be developed. The concerns about data ownership and consent are not met before there are both organisational and technical solutions, in addition to legal answers to these questions.

## 7. Conclusions and Outlook

This study has completed an analysis of questions gathered from three case-studies associated with community exchange activities related to the emergent field of LA. The case-studies aimed at mapping questions asked about learning analytics; constructing a taxonomy of ethical, legal and logistical issues in order to prepare codes of ethics [38]; and mapping enablers and barriers to data sharing, whereas this paper set out to explore the problem space formed by questions raised in this community and what implications this might have for moving towards a solution space. This study touches upon the same categorisation of the issues as the case studies, e.g., privacy and ethics, transparency, ownership and control, validity, etc. But the drive towards solutions results in a five-point list of meta-questions that is suggested as a bridge from questions as expressions of concern to hard requirements for solving the problems.

A first test whether these meta-questions are appropriate to guide the design of new approaches as indicated in Figure 1 would be to see if all levels of interoperability as described in the European Interoperability Framework (EIF) are reflected in the meta-questions [40]. Cooper and Hoel found that this framework emphasises a unified view on interoperability and provides a useful structure to consider issues of data sharing [13]. EIF puts four levels of interoperability within a political context of cooperating partners with compatible visions, aligned priorities, and focused objectives, as shown in Table 2 that align the meta-questions to interoperability level and raises questions of appropriateness for further design.

Aligning the meta-questions with the different interoperability levels makes it clear that the issues raised through questioning learning analytics are mostly on a conceptual level, addressing contextual issues related to LA supported learning activities. It seems that the participants that took part in questioning are not ready yet to discuss the technicalities of data sharing, as there are so many issues of legal, organisational and semantic nature that are still unanswered.

Taking a broader perspective, and looking back at the challenges that the experts have been grappling with and who provided questions to this study, we see that the landscape of learning technology development and interoperability has moved to a more complex state. The advent of data-driven education, where data helps to understand the learning processes better, but also is itself a learning resource, has shifted the focus from systems interoperability, content repositories and learning objects to issues of governance and due diligence associated with the use of data for teaching and learning purposes. This explains why the community is struggling to define the Problem Space and one still must wait before the Solution Space is constructed with a clear plan of action for further development.

If we were to investigate the next cycle of this design science research, asking what discourse on LA would bring us from questions of rationale to questions of process the authors will offer the following suggestions. Eventually, the more abstract why questions must be put to rest, and the focus shifted to what should be done, and how? So our key question emerging from this is how we could scaffold this development in a situation where the conceptual framework is still under debate. One option that has already undergone international scrutiny is to use the conceptual framework developed by the ISO/IEC sub-committee 36, which offers a workflow model of six processes, Learning Activity, Data Collection, Data Storing and Processing, Analyzing, Visualization, and Feedback Actions (ISO/IEC-20748:2016). In Figure 4 the meta-questions developed in this paper are applied for each process in the LA workflow.

Table 2. How the meta-questions align with interoperability levels

| Interoperability level (EIF) | Meta-Question | Implications for Design and Development of the Solution Space |
|---|---|---|
| Legal Interoperability | Risk-based; Ownership | Rights and responsibilities of the individual vs the group or the institution; and ownership to data require legislative alignment and clarification. |
| Organisational Interoperability | Validity; Risk-based; Ownership; Implementation; Business Case | All issues covered by the meta-questions address the need for organisational and process alignment. |
| Semantic Interoperability | Implementation | Best practices require semantic alignment so that precise meaning of exchanged information is understood by all parties. |
| Technical Interoperability | Ownership; Risk-based | Technical requirements were not explicitly stated in any of the 250 questions, and the need for technical alignment was only indirectly present in the meta-questions. Most clearly, technical solutions are needed for exchange of information about ownership to data. Also the |

| | | |
|---|---|---|
| | | idea of learning as a risk-based activity offers technical design challenges. |

In further work, each process needs to be defined, and requirements sought to inform the modelling of the process properties. By introducing the meta-questions and the workflow model as a scaffold we will support a more holistic design ensuring that the concerns and their solutions are not limited to only the LA process that is discussed at the moment. For example, if consent to share data for analysis is the main concern it might be wrong to focus mainly on the de-identification efforts as part of the Data Storing and Processing process. The solution might as well be sought in the Learning Activity or the Data Collection processes, where the conditions for release of relevant data would be defined.

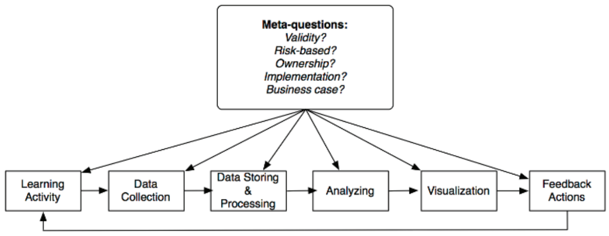


Figure 4. Meta-questions related to Learning Analytics process cycle

Further development of this work will zoom in on the different sub-processes of learning analytics, using the questions analysed in this paper to inform requirements development.

## List of Abbreviations

| | |
|---|---|
| EIF | European Interoperability Framework |
| ICCE | International Conference on Computers in Education |
| ICT | Information and Communication Technology |
| IEC | International Electrotechnical Commission |
| ISO | International Organization for Standardization |
| LA | Learning Analytics |
| LACE | Learning Analytics Community Exchange |
| LMS | Learning Management System |
| MOOC | Massive Open Online Course |
| SIG | Special Interest Group |
| SURF | Collaborative ICT organisation for Dutch higher education and research |
| QFT | Question Formulation Technique |

## References

[1] Williamson, B. Digital education governance: An introduction. European Educational Research Journal, 15(1), p.4. 2016.

[2] Hey, T., Tansley, S., & Tolle, K. The fourth paradigm: Data-intensive scientific discovery. Redmond WA: Microsoft Research. 2009.

[3] Mayer-Schönberger, V., & Cukier, K. Big data: A revolution that will transform how we live, work, and think. New York: Houghton Mifflin Harcourt. 2013.

[4] Cope, B., & Kalantzis, M. Interpreting Evidence-of-Learning: Educational research in the era of big data. Open Review of Educational Research, 2(1), 218–239. 2015

[5] Papamitsiou, Z., & Economides, A. A. Learning Analytics for Smart Learning Environments: A Meta-Analysis of Empirical Research Results from 2009 to 2015. In Learning, Design, and Technology (pp. 1–23). Cham: Springer International Publishing. 2016.

[6] LAK11. Call for Papers. 1st International Conference on Learning Analytics and Knowledge. 2011

[7] Economides, A. Adaptive context-aware pervasive and ubiquitous learning. International Journal of Technology Enhanced Learning, 1(3), 169–192. 2009.

[8] Huang, R., Yang, J., & Hu, Y. From Digital to Smart: The Evolution and Trends of Learning Environment. Open Education Research, 1, 75-84. 2012.

[9] Swenson, J. Establishing an ethical literacy for learning analytics. In Proceedings of the Fourth International Conference on Learning Analytics and Knowledge (pp. 246-250). ACM. 2014.

[10] Slade, S., & Prinsloo, P. Learning analytics ethical issues and dilemmas. American Behavioral Scientist, 57(10), 1510-1529. 2013.

[11] Dringus, L. P. Learning Analytics Considered Harmful. Journal of Asynchronous Learning Networks, 16(3), 87-100. 2012.

[12] Kitchin, R. The Data Revolution: Big Data, Open Data, Data Infrastructures and their Consequences. London: Sage. 2014.

[13] Cooper, A. & Hoel, T. Data Sharing Requirements and Roadmap. Public Deliverable D7.2 from the LACE project. 2015.

[14] Griffiths, D., Hoel, T. & Cooper, A. Learning Analytics Interoperability: Requirements, Specifications and Adoption. Public deliverable from LACE project. 2016.

[15] Verbert, K., Drachsler, H., Manouselis, N., Wolpers,

M., Vuorikari, R., & Duval, E.: Dataset- driven research for improving recommender systems for learning. In Proceedings of the 1st International Conference on Learning Analytics and Knowledge (pp. 44–53). New York, NY, USA: ACM Press. 2011.
[16] Australian Government. Telecommunications (Interception and Access) Amendment (Data Retention) Act 2015. 2015.
[17] Larusson, J. The “Unexpected New” of Education Technology. Blog post published on Pearson’s Research & Innovation Network website. 2015.
[18] Cope, B., & Kalantzis, M. Sources of Evidence-of-Learning: Learning and assessment in the era of big data. Open Review of Educational Research, 2(1), 194–217. 2015.
[19] Thomas, H. Learning spaces, learning environments and the displacement' of learning. British Journal of Educational Technology, 41(3), 502–511. 2010.
[20] Cross, J. Informal learning: rediscovering the natural pathways that inspire innovation and performance. San Francisco, CA: Pfeiffer. 2007.
[21] Cavoukian, A., & Jonas, J. Privacy by design in the age of big data. Information and Privacy Commissioner of Ontario, Canada. 2012.
[22] Hoel, T. & Chen, W. (2015). Privacy in Learning Analytics – Implications for System Architecture. In Watanabe, T. and Seta, K. (Eds.) Proceedings of the 11th International Conference on Knowledge Management. Theory and Practice for Knowledge Management. 2015.
[23] Warburton, S. Second Life in higher education: Assessing the potential for and the barriers to deploying virtual worlds in learning and teaching. British Journal of Educational Technology, 40(3), 414-426. 2009.
[24] Clark, S., & Maher, M. L. The role of place in designing a learner centred virtual learning environment. Computer Aided Architectural Design Futures 2001- Proceedings of the Ninth International Conference held at the Eindhoven University of Technology, Eindhoven (pp. 187-200). Springer Netherlands. 2001.
[25] Mason, J. Context and Metadata for Learning, Education, and Training, in R. McGreal (Ed.) Online Education Using Learning Objects, pp. 168-182 London: RoutledgeFarmer. 2004.
[26] Scoble, R. & Israel, S. Age of Context: Mobile, Sensors, Data and the Future of Privacy. CreateSpace Independent Publishing Platform. 2013.
[27] Nissenbaum, H.: A Contextual Approach to Privacy Online. Journal of the American Academy of Arts Sciences, 1–18. 2011.
[28] Laurillard, D. Rethinking university teaching: A conversational framework for the effective use of learning technologies. Routledge. 2013.
[29] Rothstein, D., & Santana, L. Make Just One Change: Teach Students to Ask Their Own Questions. Cambridge, MA: Harvard Education Press. 2011.
[30] Chen, D., & Daclin, N. Framework for enterprise interoperability. Proceedings of IFAC Workshop EI2N. 2006.
[31] Hoel, T. & Chen, W. Learning Analytics Interoperability – looking for Low-Hanging Fruits, in Liu, C.-C. et al. (Eds.) Proceedings of the 22nd International Conference on Computers in Education. Japan: Asia-Pacific Society for Computers in Education. 2014.
[32] Hars, A., & Zhong, J. Conversation Systems for Requirements Engineering. AMCIS 2001 Proceedings, 255, 1321-1326. 2001.
[33] Yin, R. K.: Case Study Research, Design and Methods, 4th edition. Sage Publications. 2008.
[34] Wodak, R., & Meyer, M. (Eds.). Methods for critical discourse analysis. Chicago, IL: Sage. 2009.
[35] Hevner, A., March, S. T., Park, J., & Ram, S. Design science in information systems research. Mis Quarterly, 28(1), 75–105. 2004.
[36] Hevner, A. A Three Cycle View of Design Science Research. Scandinavian Journal of Information Systems, 19(2):87-92, 1–6. 2007.
[37] Mason, J., Chen, W., & Hoel, T. Questions as data: illuminating the potential of learning analytics through questioning an emergent field. Research and Practice in Technology Enhanced Learning, 11(1), 1-14. 2016.
[38] Sclater, N. A taxonomy of ethical, legal and logistical issues of learning analytics v1.0. 2015.
[39] Kantara Intiative (nd.). Home page for the User Managed Access specification
[40] European Commission. European Interoperability Framework (EIF) for European public services. *Annex 2 to the Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of Regions 'Towards interoperability for European public services'*. 2010.

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# II

# PRIVACY AND DATA PROTECTION IN LEARNING ANALYTICS SHOULD BE MOTIVATED BY AN EDUCATIONAL MAXIM - TOWARDS A PROPOSAL

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# Privacy and data protection in learning analytics should be motivated by an educational maxim—towards a proposal

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**Abstract**

Privacy and data protection are a major stumbling blocks for a data-driven educational future. Privacy policies are based on legal regulations, which in turn get their justification from political, cultural, economical and other kinds of discourses. Applied to learning analytics, do these policies also need a pedagogical grounding? This paper is based on an actual conundrum in developing a technical specification on privacy and data protection for learning analytics for an international standardisation organisation. Legal arguments vary a lot around the world, and seeking ontological arguments for privacy does not necessarily lead to a universal acclaim of safeguarding the learner meeting the new data-driven practices in education. Maybe it would be easier to build consensus around educational values, but is it possible to do so? This paper explores the legal and cultural contexts that make it a challenge to define universal principles for privacy and data protection. If not universal principles, consent could be the point of departure for assuring privacy? In education, this is not necessarily the case as consent will be balanced by organisations' legitimate interests and contract. The different justifications for privacy, the legal obligation to separate analysis from intervention, and the way learning and teaching works makes it necessary to argue data privacy from a pedagogical perspective. The paper concludes with three principles that are proposed to inform an educational maxim for privacy and data protection in learning analytics.

**Keywords:** Privacy, Data protection, Learning analytics, Data privacy

## Introduction

A data-driven educational future has to navigate the stumbling blocks of privacy and data protection. Educationalists often find that dealing with these thorny issues are the prerogative of other professions such as lawyers or computer scientists and that pedagogical perspectives are not represented in the discourse. In preparing for the digital futures of learning analytics (LA), adaptive education, multimodal learning support and other data-driven approaches educationalists need to develop what we have termed an educational maxim for privacy and data protection in this field.

Privacy and data protection measures are often promoted and justified by laws and regulations. Two recent events have created international awareness about the importance of privacy, the 'Facebook–Cambridge Analytica data scandal' (n.d.), and the General Data Protection Regulation (GDPR) of the European Union (European

Commission 2016), which came into effect in May 2018. The first event prompted social media users to ask themselves about their own data sharing practice; while the GDPR prompted most companies, also outside of Europe, to revisit their data protection rules in order to avoid huge economic penalties in case of data breaches.

The discussion on privacy we now see spurred by these events is just the pinnacle of more than 50 years of international debate on privacy. In the USA, in the 1960s, 'privacy' was invoked as a key term for summing up 'the congeries of fears raised by the (mis)use of computers' (Bygrave 2010). Privacy was not the only term; a 'variety of other, partly overlapping concepts have been invoked too, particularly those of 'freedom', 'liberty' and 'autonomy' (ibid., p. 167). Today, in other parts of the world the backdrop of privacy may be less that of liberal values than of avoiding loss of face in privacy breach scandals (as an example, see the news story 'Jack Ma's Ant Apologizes for Baiting Users Into Credit System' (Chen 2018)). When raising the discussion of privacy and data protection in a new context—i.e. learning analytics—we have to factor in the very complex global data protection scene where legal regulations are debated on a background of diverse political, cultural, economical and even philosophical ideas.

The question raised in this paper, is whether there also are pedagogical ideas that should be brought to bear when designing privacy policies and solutions for educational big data. For example, are there educational specific requirements that will justify a practice that goes beyond what is required by law? If this *extra* requirement is found, it should ideally be summarised in an educational maxim that ideally would resonate well enough to bridge some of the gaps we find between different legislations and cultures related to how privacy is valued or conceptualised.

This paper aims at exploring the grounds for this educational 'extra' that would allow us to be bold in involving the students in self-managing their own data used for learning analytics. We do this exploration on the backdrop of a heterogeneous international landscape regarding the rights of the individual and the value of privacy. To construct the foundation for an educational maxim for privacy related to educational big data this conceptual analysis builds on issues and concerns identified in design of LA applications. Subject of scrutiny will be different positions on how privacy may be invoked and promoted in technology enhanced learning in different international settings. The questions leading up to the proposal of grounding privacy for LA in an educational maxim are the following:

- Is reference to privacy as an individual universal right the answer to data management and control?
- Is consent the mechanism to use to get access to data?
- Is maintaining privacy a question of negotiation, and if so,
- What are the opportunities for pedagogical reasoning and justification of certain privacy related practices?

These questions describe the structure of this paper, which concludes with three principles that could be used to further develop an educational maxim for data privacy in learning analytics. In the next section, we give a practical context for why this research needs to be undertaken.

## Research background through a practical case

This section brings a snapshot of development of an ISO standard on Privacy. ISO/IEC JTC1/SC36, the ISO committee working on interoperability standards for learning, education and training has a working group 8 focusing on learning analytics. In the first working draft of a new technical specification on privacy and data protection, it was admitted that privacy is difficult to define restrictively 'as privacy is an elusive concept that means different things in different countries around the world. What is seen as an intrusion into the private life or affairs of an individual, and whether gathering of data about the individual is seen as undue or illegal varies with cultural context' (T. Hoel, personal communication, August 2018). The editors of the draft specification suggested that privacy problems should be looked at 'in a LET [learning, education and training] context to be able to specify privacy and data protection principles for LET that address specific problems and support a good learning environment for the individuals involved'. The editors suggested the following principle for development:

> 'The educational context of LA requires that the right to be informed is not interpreted restrictively; it is a pedagogical value of its own to be as open as possible about data collection and processing.'

And regarding the legal requirements of notification of the data subject of data collection, the first working draft stated:

> 'Age of the students, the educational setting, matters of authority, and other reasons could influence how notification of data collection and processing will be conceived. The educational context is, however, an opportunity to clarify [for the students] privacy and data protection issues related to use of LA' (T. Hoel, personal communication, August 2018).

From this working draft, it is clear that the authors of the standard try to carve out an educational argumentative space that would allow for certain policy principles regarding privacy. In this space, one finds arguments about involvement of students, openness, and what we could term educational opportunity ('you should teach about big data, data management, and privacy – here you have an opportunity to do so') (Pangrazio and Selwyn 2018).

## A universal right to privacy using educational technologies?

Even if educational policies often are the purview of local authorities, when we talk about educational technologies—like LA—we are dealing with global solutions that have to cater for all political and cultural climates. In this section, we examine privacy and data protection in an international perspective, starting by asking if there is a universal right to privacy.

Milberg et al. (1995) stated that it could be reasonably argued that protection of personal information privacy was a 'hypernorm', a principle fundamental to human existence. 'If this is so, then managers have an obligation to protect personal information privacy in every system and in every country, regardless of distinctions in national levels of concern or of regulatory approaches' (Milberg et al. 1995, p. 73). However, research on the relationships among nationality, cultural values, personal information privacy concerns and information privacy regulations led Milberg et al. (1995) to conclude on a more pragmatic note: 'Executives may choose to reject the ethical "hypernorm" argument (…) But the threat of negative impacts on the bottom line, driven by both market forces and the legislative agenda, should be sufficient to prod them towards a more enlightened view of the personal information privacy management domain' (p. 73).

Further research by Milberg et al. (2000) found that most firms took a primarily reactive approach to managing privacy 'by waiting for an external threat before crafting cohesive policies that confront their information practices' (p. 49).

When ideals meet stakeholders' interests trade-offs are inevitable. Milberg et al. (2000) find that '[a] right to privacy' has been taken to include a number of 'interests' that converge and diverge, and they use targeted marketing as an example of trade-offs between the privacy interests and how society's economic and social systems function:

> 'While organizations argue that they have the right to conduct business, consumers and privacy advocates often claim the right to be free of unwanted solicitations. While organizations claim the right to use information technology to improve efficiency, consumers often exhibit the desire to control the flow and dissemination of their personal information. While businesses claim the right to record information generated from their transactions, consumers increasingly want to know that this information has been gathered and stored and to control its uses' (Milberg et al. 2000, p. 36).

Trade-offs between ideals and reality may not be the best way to understand how privacy and related interests with regard to the processing of personal data are protected internationally. Alternatively, one could see how these issues are conceptualised in different countries, and how the different discourses express values that are taken up by different regulatory policies. A full analysis of this kind is beyond the remit of this paper. However, a study by Bygrave (2010) exploring the prospects for regulatory consensus found that data protection laws in various countries 'expound broadly similar core principles and share much common ground in terms of enforcement patterns' (Bygrave 2010, p. 198). Nevertheless, 'extensive harmonisation at the global level is extremely unlikely to occur in the near future' (ibid., p. 199). The reason for this lack of harmonisations is the strength of 'ingrained ideological/cultural differences' (ibid., p. 199).

Even if extensive harmonisation of international privacy laws is hard, and a number of countries lack such laws all together, there is a global trend towards privacy legislation due to the growing impact of the digital economy. Table 1 shows the status of data protection laws in ten Asian countries. Six of them have data protection laws that have been amended recently; the other four countries have plans to pass laws or address privacy issues in closely related laws (as China).

Whom should privacy serve? Even if privacy legislation around the world draws on common ideas and principles, there are clear differences in the way privacy is conceptualised. In the USA, most discourse on privacy and privacy rights tends 'to focus only on the benefits these have for individuals *qua* individuals' (Bygrave 2010, p. 171) (…) while German jurisprudence 'emphasises that the value of data protection norms lies to a large degree in their ability to secure the necessary conditions for active citizen

**Table 1** Status data protection laws in some Asian countries (Primary source: DLA Piper 2017)

| Country | Data protection law? | Future plans |
|---|---|---|
| China | No | No comprehensive data protection law. However, Cybersecurity Law (2017) first national-level law that addresses cybersecurity and data privacy protection. |
| India | No | Draft Personal Data Protection Bill published 2018 |
| Indonesia | No | Draft personal data protection law published 2018. |
| Japan | Yes (2017) | |
| Malaysia | Yes (2013) | |
| Philippines | Yes (2012) | |
| Singapore | Yes, only private sector (2012) | |
| Thailand | No | Draft is being reviewed (as of 2016). |
| Taiwan | Yes (2012) | |
| South Korea | Yes (2011) | |

participation in public life; in other words, to secure a flourishing democracy' (ibid., p. 172). While Germany has had the most comprehensive and well-established legislative platform for data protection, USA has had an absence of comprehensive data protection legislation. Germany has had to harmonise with the other European countries after GDPR came into effect. Globally, it is expected that GDPR will have an influence on future legislation in countries also outside of Europe. One example is India, where the draft (MEITY 2018) clearly mimics some of the features of GDPR (e.g. the principles of purpose and collection limitations, privacy by design), but stops short of EU's privacy-safeguarding regulations in the matter of individual's right to object to collection and/or processing of their personal information.

The formal normative basis for the data protection laws may well be derived 'mainly from the catalogues of fundamental human rights' (Bygrave 2010, p. 180); however, when it comes to applying these principles in international instruments one should note that an important motivation for developing international privacy frameworks are promoting the exchange of goods and services across borders. Bygrave (2010) claims that in the Asian Pacific region, the approach 'appears to foster data protection regimes less because of concern to protect basic human rights than concern to engender consumer confidence in business' (Bygrave 2010, p. 188).

Hoel et al. (2017b) analysed three privacy frameworks, which have inspired legal development in all parts of the world and put the frameworks and selected countries on a scale with values between a focus on the individual and a focus on the organisation (Fig. 1).

The case studies of the LA privacy discourse in Europe and Asia (Japan, Korea and China) (Hoel et al. 2017) showed that concerns about the rights of the individual in relation to control of data emanating from the learner are in some respect a western phenomenon. In the east, where the interests of the individual more often are projected against the interest of the group the organisation is more prominent in the discourse on who should benefit from LA.

In this section, we have seen that even if the concern for data privacy is shared among the general public around the world there is a long way to go from concern, at least in the abstract, to finding a common normative basis for establishing data protection policies. The global ideological landscape does not invite to subscription of human

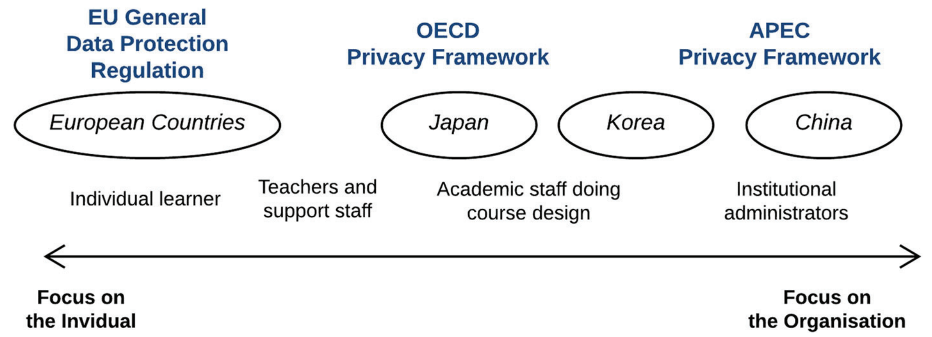

**Fig. 1** Individual vs. organisational focus of LA beneficiaries, privacy frameworks and countries

rights ideas or other shared normative ethics principles to motivate regulatory consensus on data protection. Lately, both societal and individual arguments have made the discussion on privacy more complex. War on terror, national security, promotion of trade and new digital economies are all factors that demand extensive sharing of personal data. We also see that the users of ICT services are willing to undermine their own rights as soon as they see short time benefits of opening up access to their personal data (Hazari and Brown 2014). In the next sections, we will explore how involvement of the individual could be used to justify data sharing.

## Educational data privacy by asking for consent

> ‘Obtaining valid consent from data subjects in connection with the use of personal data for analysis and profiling purposes is the best insurance against violating data protection legislation. The new European Data Protection Regulation also proposes restricting the opportunities for the processing of personal data on legal grounds other than consent’ (Datatilsynet 2013, p. 49).

We find it interesting that the Norwegian Data Protection Authority uses the phrase ‘best insurance’ in their 2013 report *Big Data - privacy principles under pressure*. Risk minimisation is the word of the day now as industry and public organisations alike for some time, under threats of heavy fines, have prepared for compliance with GDPR, setting up accountability systems, documenting what information one holds, assigning data protection officers, and taking other organisational measures. However, risk management is a different strategy than invoking rights, and such a strategy certainly chooses the organisational perspective, as opposed to the individual perspective that comes with arguing from rights. So, what does it mean when the Norwegian Data Protection Authority states as their primary recommendation to meet the challenges of big data: ‘consent [is] still the point of departure’ (Datatilsynet 2013)? Is consent, *in the context of LA*, the primary point of departure?

Focussing on consent means bringing the individual into the centre of the discussion. And that means the individual as an actor with rights to decide on data management, not as an object in need of protection by others. However, consent in the age of Big Data is not straight forward. The Norwegian data protection authority points to claims, ‘that the constant demand for consent on the Internet paradoxically may result in poorer protection for the individuals' (ibid, p. 50). Now, with the new GDPR asking for wide-ranging consent it may be a lesser problem if you live in a European country. The new Regulation has strengthened the protection from giving your rights away by ticking boxes when launching software solutions. The problem with consent, we would argue, does not so much lie in hollowing out the consent mechanism as with the fact that consent is not the sole legal ground for access to personal data. And pretending it is, will confuse the individual and undermine the individual's ability to manage one's own data.

In an educational setting, there are a number of stakeholders with legitimate rights to a person's data, driven by the fact that the student has an obligation to go to school or has registered for a course, and in practice entered a contractual relation with an (business) organisation. It is not clear cut what the legal grounds for access to data are; let us say for an administrator, a teacher, or a third party. Data about a student starts to build up from the moment the student does a web search in the course catalogue, right up to the clicks made browsing through learning resources, passing tests, and getting an exam. An educational institution is a business organisation with student records, which are not under the full control of the students. Nobody will contest that right of the institution to store and analyse data about who is registered for what course, and who ends up with what exam results. But what about the results of micro tests? There are no clear boundaries between data generated that are solely the student's prerogative to manage, and data that the institution, the teacher, has a right to process (Zeide 2017). These are issues that are subject to negotiations between parties that will base their positions on both legal, moral and pedagogical grounds.

We asked if consent is the primary point of departure within an educational context, and we have answered no. If we overlay the discussion in this section with the observations made in section 3 on the normative basis for privacy in a global perspective (Fig. 2) we see that the role given to consent (and to the individual) could vary a lot in different cultural, political, legal and regional contexts. There is a need to explore more in detail how different scenarios will play out for consent from learners in connection with use of personal data for learning analytics. And we also see there is a need to explore the educational perspective on data privacy.

## Balancing interests for educational big data analysis

Once leaving the abstract reflection on privacy and entering the field of practical data handling we see that the context and the purpose of data collection are important for

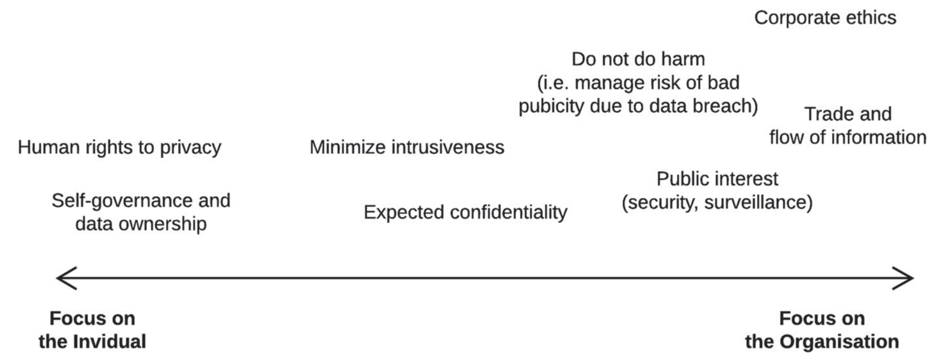


**Fig. 2** Normative basis for privacy policies

how data privacy should be handled. As an example, let us compare how equally sensitive personal data gathered from passing through an airport, visiting a hospital, and taking part in education are handled. Public interests will trump any objection from the individual to be scanned by security cameras in the airport. In contrast, in a hospital, the individual has an absolute right to be a party to the data processing, and in extreme cases have the right to refuse to be given lifesaving treatment. Health and education are quite similar in that the individual is very much 'part of the treatment', and therefore consent should be sought. However, there are differences. Some education is compulsory. If consent is not the justification for processing personal data, there must be another, e.g. contract, legal obligations, vital interests of the organisation, public interest, or legitimate interest of the data controller.

Figure 3 describes how a decision to ask for consent is a balancing act weighing different interests considering the different justifications for collecting and processing personal data.

In education, especially in the new data-driven practices involving use of online platforms and sensor data, we do not think the data controller will be justified *never* to ask for consent invoking legal obligation or vital interests (the right side of the continuum in Fig. 3). Contract or legitimate interests (e.g. business reasons) on the other hand, would be convenient to invoke, to allow data collection and processing without too much interference of the individual. However, if demands from the students to be involved are getting strong also business reasons will drive the balance to the left in Fig. 3.

We would assume that educational institutions will justify their data processing either by consent or legitimate interests, e.g. stated in a contract. What are the limits to using legitimate interests, and are there any reasons related to LA that would speak against consent as a default justification for collecting data from learning activities?

In terms of legitimate interests, Cormack (2016a) sums up how European law specifies requirements for this justification to be used:

> Where personal data are processed for legitimate interests, there must be a clearly stated purpose, the processing must be necessary for that purpose, the impact and risk for the individuals whose data are processed must be minimised, and any remaining impact or risk must be justified by a balancing test against the claimed interest. Interests, even though legitimate, cannot justify processing that involves an inappropriate risk to the individuals whose data are processed. (Cormack 2016a).

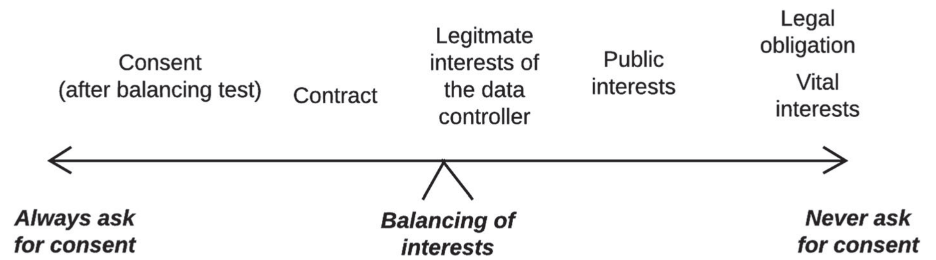


**Fig. 3** Balancing of interests, asking for consent to process personal data

The schools and universities need to know what they want to achieve with data analysis, otherwise they do not pass the 'necessity test': information that is not necessary for the declared purposes should not be collected (Cormack 2016b). And there is no way out for the institutions to turn to the students and ask for a blanket acceptance of collecting data. The students need to know what they are asked about, to be able to balance the benefits and risks of the proposal. Data-driven techniques, not guided by questions or hypothesis, where the ideas of possible interventions first appear after the data are collected and processed do not give much in terms of specific purpose descriptions for justifying the process before it is started.

The students need to be actively involved, as we see when LA is set up to personalise learning. Cormack makes it clear that legitimate interests cannot be used to justify any activity where the intention is to personalise a service or otherwise affect individual users, 'since this would contradict the requirement that the impact on individuals be minimised' (Cormack 2016a).

> Once the organisation has identified patterns in data that enable it to identify and design such an intervention, however, it should also have sufficient information to seek valid consent from those individuals who may be affected by it. Whereas at the time the data were collected the results of data-driven analysis and their consequences could not be foreseen or explained to individuals, now they can. Consent can now be fully informed. Offering a choice between personalised and generic versions of the service should increase the likelihood that consent to personalisation is freely given. (Cormack 2016a).

The constraints of the law and the intrinsic qualities of data-driven practices that LA is part of seem to drive LA implementers towards what Sclater (2017) has called a hybrid approach: using *legitimate interests for analysis and consent for intervention*. Cormack (2016a, 2016b) has argued that the solution, which came up in the discussion of consent related to the developed of GDPR, termed 'downstream' consent should be applied: 'consent can also be requested "downstream", when the purpose of the processing changes' (Article 29 Data Protection Working Party 2011). Upstream there is the analysis of the data, trying to identify patterns; downstream are the interventions to be taken when one knows what the problem is, it is still not acted upon, and one is able to communicate clearly to the student options that the student could agree to.

The approach proposed by Cormack (2016a, 2016b) dividing the monolithic 'big data' process into two stages (analysis, to find patterns; and intervention, to identify and affect relevant individuals) opens up a need for examining the educational specific consequences and opportunities when applied on LA. This is the focus of the last part of this paper.

## Pedagogical opportunities arising from LA data privacy

In theory, a separation of LA into two processes, analysis and intervention seems simple. Analysis justified by legitimate interests is the prerogative of the institution; students are first involved when clear actions can be outlined with opt-in and opt-out options to consent to. To perceive this as two distinct processes with no overlapping stakeholders and no interfering sub-processes seems, however, to be too far from real life in education. What about the teachers, are they part of the analysis process? What about access to data? Does data for analysis come only from institutional systems, like Student Information Systems or Learning Management Systems? How does the institution get access to data from non-institutional and informal learning settings, e.g. mobile and cloud learning platforms outside the control of the school or university, social media, other sensor data relevant for learning?

Contrasting the hybrid model of analysis and intervention with the LA process model developed by ISO/IEC JTC1/SC36 (Fig. 4), we see that three important sub-processes precede the analysis stage. In order to be able to do analysis one needs to decide upon which learning activities to monitor; to collect the data that serve as proxies for the activities under study; and as a last important step also imbued with a host of privacy and data protection issues, decide upon how the data should be stored and processed before analysis.

It feels strange to exclude these introductory processes from exchange with the students under the pretext that the analysis of these activities is within the legitimate interest of the institution. On the other hand, it might well be that conversations about what is going on prior to and during analysis are part of activities that are crossing different professional and educational discourses with associated norm sets. Learning analytics is different from traditional academic analytics, which does not aim at actionable insights feeding back to the individual learner (Gasevic et al. 2015). Therefore, analysis cannot only be an administrative task, or a pure research activity. And with teachers on board doing analysis, this is definitely also a pedagogical activity, which involves the learners. To see how it involves learners, and how it is different from intervention, we first need to look at what characterises intervention.

It is the risks to the learner, caused by the institution acting upon the knowledge from analysis that make it necessary to ask the learner to consent to processing of personal data, giving him or her the opportunity to opt out when the nature of the proposed intervention is clarified. Even if these deliberations have a legal flair to them, they are mainly of pedagogical nature. The worst scenario from a student's perspective is probably illegal: that predictive profiling could be subject to automated processing leading for example to exclusion (Hoel and Chen 2016). Most likely, interventions would be to present the learner with different alerts and prods (e-mails or messages); visualisations showing progress, position relative to different student cohorts, etc.; and recommendations for what to read next, what tests to take next, etc. Some of these interventions will be executed by machine, but most likely the majority will involve interaction between the students and the teachers.

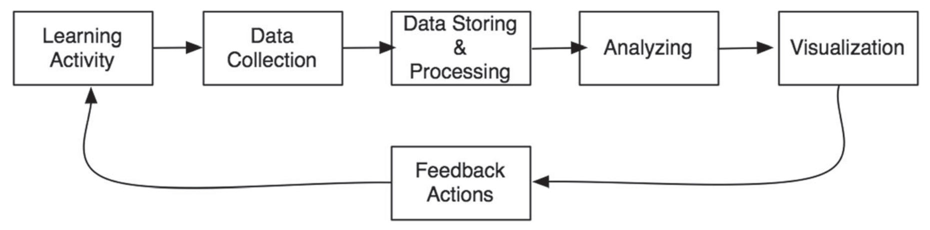


**Fig. 4** LA process model developed by ISO/IEC JTC1/SC36 (ISO 2016)

A comparative case study of educational big data practices in Norway and China (Hoel et al. 2018) substantiates that the pedagogical reality in some cultures may prove difficult to fit within strict legal schemas of what data could or should be used for analytics. In Tongzhou, a district of Beijing, we found that teachers had an almost unlimited appetite for information about their students. In some instances, they also had instruments to gather data for psychological profiling that was not directly related to specific learning activities or subject areas. The contrast to Norwegian primary and secondary education was sharp, as the Oslo teachers expressed interest primarily in information about knowledge acquisition and subject-related issues in school. Off school activities, use of social media, family relations, etc. were not something Oslo teachers wanted to gather data about on a regular basis. Both the Tongzhou and the Oslo teachers had strong pedagogical motivation for their interest in student activity data.

In conclusion, looking back to the LA process model (Fig. 4), both analysis (and the preceding sub-processes) and intervention will involve extensive interaction with the students. We have difficulties seeing that questions of data access and handling are dealt with inside a secluded administrative and research logic without involvement of students and teachers, and their virtual learning agents. That being said, we see the value of keeping the separation between analytical and intervention concerns, being forced to execute the balancing test, weighing the benefits and risks of collecting and processing personal data. We believe that different normative models could live side by side. Table 2 summarises the focus and questions of the different models governing data handling.

The legal model tells you to wait to ask for consent until the individual has a chance to make an informed choice based on alternative proposals for intervention. The research model tells you to ask for permission to gather information, to follow the fair processing principles and to keep the data safe. The administrative model tells you to use anonymised aggregated data and follow strict legal procedures when dealing with personal information. Most importantly, the pedagogical model tells you to support the student's own learning and use every opportunity to enhance the learning experience by bringing in relevant tasks and material. Data for learning analytics is as such an opportunity to enhance students' data literacy.

## Conclusions and future work

We introduced this study with the challenges faced by an international group of standards experts trying to motivate global norms for privacy and data protection in the

**Table 2** Models for handling data in educational setting

| Model for data handling | Model focus | Question asked |
|---|---|---|
| Legal model | Justified purpose for data collection? | Are the risks to the individual balanced with the benefits to the individual and the system? |
| Research model | Consent, fair data handling, and safe data keeping | Have participants agreed to be part of the research? |
| Administrative model | Handling of personally identifiable information | Are the data de-identified and kept safe? |
| Pedagogical model | Learning gain | Are collected data relevant for understanding and optimising learning and the environments in which it occurs? |

context of learning analytics. How do we find a common ground for policy development when we have countries where all learning activity data seem to be available for analysis (e.g. China), and countries that are reluctant to allow library data to be analysed because of privacy issues, and questions whether learning analytics is legal in the first place (e.g. Norway) (Hoel et al. 2018; Hoel and Chen 2017; Hoel et al. 2017)? It would help to build consensus about privacy and data protection policies if these also could be argued from an educational perspective, not only from universal or individual rights perspectives.

In this paper we have demonstrated that privacy as a 'hypernorm' yields when pressured by corporate, commercial, or national security interests. Likewise, consent as general justification for collection and processing of personal data is not applicable in an educational setting unless the process is carefully staged, separating analysis from intervention. The discussion of justifications for accessing and processing learning activity data has shown that we from the very beginning are within a space of negotiations, using a variety of justifications based on ethics, law, national policies, and pedagogies. Therefore, we should in LA make an effort of making the pedagogical justification for privacy policies more explicit.

This result of our explorations, the positioning of privacy and data protection for LA in an argumentative space of continuous negotiations, gives hope for achieving an international consensus on educational privacy policies. From our discussion in this paper the following principles emerge as starting point for further development:

1. Privacy and data protection in LA are achieved by negotiating data sharing with each student.
2. Openness and transparency are essential and should be an integral part of institutional policies. How the educational institution will use data and act upon the insights of analysis should be clarified in close dialogue with the students.
3. Big data will impact all society. Therefore, in negotiating privacy and data protection measures with students schools and universities should use this opportunity to strengthen their personal data literacies.

These principles have strong grounding in discourse and practice on privacy. The first principle is in accord with the theory of contextual integrity proposed by Nissenbaum (2014).

> The theory of contextual integrity is a theory of privacy with respect to personal information because it posits that informational norms model privacy expectations; it asserts that when we find people reacting with surprise, annoyance, indignation, and protest that their privacy has been compromised, we will find that informational norms have been contravened, that contextual integrity has been violated. (Nissenbaum 2014, p. 25).

The second principle is in accordance with the best practice guidelines we now see published by educational institutions informing about how LA will be implemented (Sclater 2016; Open University UK 2014).

The third principle connects to the discussion on twenty-first century skills and competences for new millennium learners (Ananiadou and Claro 2009). In Norwegian education, for more than a decade digital literacy has been defined as one of the central competences needed in the future, and the ability to use digital tools was defined as a basic skill (Sefton-Green et al. 2009; Krumsvik 2008, 2009). Understanding how student data are used is part of digital literacy (Pangrazio and Selwyn 2018).

We would suggest that these principles are further developed and expressed in a LA privacy maxim for education. The conceptual and explorative research presented in this paper has limitations as expected when addressing a new field of enquiry. We will therefore follow up this research with more empirical studies of how different countries develop privacy policies in education, and how we can develop solutions for privacy in LA that could be accepted across cultures. This paper has shown that there is a need to understand how data privacy policies for LA connect to pedagogical practices. How future design of LA tools could use this educational argumentative space will be subject of further studies.

**Abbreviations**
GDPR: General Data Protection Regulation; LA: Learning analytics

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The authors have contributed evenly to this work. Both authors read and approved the final manuscript.

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**References**

Ananiadou, K., & Claro, M. (2009). *21st Century Skills and Competences for New Millennium Learners in OECD Countries (Vol. 41)*.
Article 29 Data Protection Working Party, Opinion 15/ 2011 on the definition of consent (01197/11/EN WP 187) 19.
Bygrave, L. A. (2010). Privacy and data protection in an international perspective. Scandinavian Studies in Law. Online: http://www.scandinavianlaw.se/pdf/56-8.pdf, http://www.scandinavianlaw.se/pdf/56-8.pdf. Accessed 2 Aug 2017.
Chen, L.Y. (2018). Jack Ma's ant apologizes for baiting users into credit system. Bloomberg. 4 January 2018. https://www.bloomberg.com/news/articles/2018-01-04/jack-ma-s-ant-apologizes-for-baiting-users-into-credit-system
Cormack, A. (2016b). A data protection framework for learning analytics. *Journal of Learning Analytics*, 91–106 https://doi.org/10.18608/jla.2016.31.6.
Cormack, A. N. (2016a). Downstream consent: A better legal framework for big data. *Journal of Information Rights, Policy and Practice, 1*(1). https://doi.org/10.21039/irpandp.v1i1.9.
Datatilsynet. (2013). Big Data – privacy principles under pressure. September 2013. Online: https://www.datatilsynet.no/globalassets/global/english/big-data-engelsk-web.pdf. Accessed 24 July 2017.
European Commission. (2016). REGULATION (EU) 2016/679 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 27 April 2016 on THE protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing directive 95/46/EC (general data protection Regulation).
Facebook–Cambridge Analytica data scandal. (n.d.). Retrieved 21 August 2018 from https://en.wikipedia.org/wiki/Facebook–Cambridge_Analytica_data_scandal
Gasevic, D., Dawson, S., & Siemens, G. (2015). Let's not forget: Learning analytics are about learning. *TechTrends, 59*(1), 64–71 https://doi.org/10.1007/s11528-014-0822-x.
Hazari, S., & Brown, C. (2014). An empirical investigation of privacy awareness and concerns on social networking sites. *Journal of Information Privacy and Security, 9*(4), 31–51 https://doi.org/10.1080/15536548.2013.10845689.

Hoel, T., & Chen, W. (2016). Implications of the European data protection regulations for learning analytics design. Workshop paper presented at the international workshop on learning analytics and educational data mining (LAEDM 2016) in conjunction with the international conference on collaboration technologies (CollabTech 2016), Kanazawa, Japan - September 14–16, 2016. Retrieved March 24, 2017, from http://hoel.nu/files/LAEDM_Kanazawa_Sep2016_Hoel_Chen_final_w_header.pdf

Hoel, T., & Chen, W. (2017). *Innovating Learning Analytics Policies in Norway - a case study. Draft workshop paper presented at LAK17 workshop on LA Policies*.

Hoel, T., Chen, W., & Gregersen, A. B. (2018). Are Norwegian librarians ready to share library data to improve learning? *Nordic Journal of Information Literacy in Higher Education, 10*(1). https://doi.org/10.15845/noril.v10i1.269.

Hoel, T., Chen, W., & Griffiths, D. (2017). *Is international consensus about privacy policies for learning analytics possible? Draft workshop paper presented at LAK17 workshop on LA policies*.

Hoel, T., Chen, W., & Yu, L. (2018). *Is big data going to change education? A comparative case study from Norway and China. Manuscript submitted for publication*.

Hoel, T., Griffiths, D., & Chen, W. (2017). *The influence of data protection and privacy frameworks on the design of learning analytics systems (pp. 243–252). Presented at the the Seventh International Learning Analytics & Knowledge Conference, New York*. New York, USA: ACM Press https://doi.org/10.1145/3027385.3027414.

ISO. (2016). ISO/IEC TR 20748–1:2016 Information technology for learning, Education and Training -- Learning analytics interoperability -- Part 1: Reference model.

Krumsvik, R. (2008). Situated learning and teachers' digital competence. *Education & Information Technologies, 13*(4), 279–290.

Krumsvik, R. (2009). Situated learning in the networked society and the digitised school. *European Journal of Teacher Education, 32*(2), 167–185.

MEITY. (2018). THE PERSONAL DATA PROTECTION BILL, 2018. Ministry of Electronics and Information Technology, India. Online: http://meity.gov.in/content/personal-data-protection-bill-2018

Milberg, S. J., Burke, S. J., Smith, H. J., & Kallman, E. A. (1995). Values, personal information privacy, and regulatory approaches. Communications of the ACM, 38(12), 65–74. https://doi.org/10.1145/219663.219683

Milberg, S. J., Smith, H. J., & Burke, S. J. (2000). Information privacy: Corporate management and National Regulation. *Organization Science, 11*(1), 35–57 https://doi.org/10.1287/orsc.11.1.35.12567.

Nissenbaum, H. (2014). Respect for Context as a Benchmark for Privacy Online: What It Is and Isn't. In "The Future of Privacy", Foundation Télécom, Institute Mines-Télécom, 1–128. Online: http://cvpip.wp.mines-telecom.fr/files/2014/02/14-02-The-futur-of-privacy-cahier-de-prospective.pdf. Accessed 8 Aug 2017.

Open University UK (2014). Policy on Ethical use of Student Data for Learning Analytics. Online: https://help.open.ac.uk/documents/policies/ethical-use-of-student-data/files/22/ethical-use-of-student-data-policy.pdf. Accessed 9 Aug 2017.

Pangrazio, L., & Selwyn, N. (2018). "Personal data literacies": A critical literacies approach to enhancing understandings of personal digital data. *New Media & Society, 8*(5), 146144481879952–146144481879919 https://doi.org/10.1177/1461444818799523.

DLA Piper. (2017). Data Protection Laws of the World. http://www.dlapiperdataprotection.com. Accessed 21 Aug 2018.

Sclater, N. (2016). Developing a code of practice for learning analytics. *Journal of Learning Analytics*, 16–42 https://doi.org/10.18608/jla.2016.31.3.

Sclater, N. (2017). Consent for learning analytics: some practical guidance for institutions. Blog post, February 16, 2017. Online: https://analytics.jiscinvolve.org/wp/2017/02/16/consent-for-learning-analytics-some-practical-guidance-for-institutions.

Sefton-Green, J., Nixon, H., & Erstad, O. (2009). Reviewing approaches and perspectives on "digital literacy". *Pedagogies, 4*(2), 107–125.

Elana Zeide (2017), The Limits of Education Purpose Limitations, 71 U. Miami L. Rev. 493 Online: http://repository.law.miami.edu/umlr/vol71/iss2/8. Accessed 8 Aug 2017.

# III

# PRIVACY ENGINEERING FOR LEARNING ANALYTICS IN A GLOBAL MARKET – DEFINING A POINT OF REFERENCE

by

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# Privacy engineering for learning analytics in a global market – defining a point of reference

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**Abstract:**

**Purpose –** Privacy is a culturally universal process; however, in the era of Big Data privacy is handled very differently in different parts of the world. This is a challenge when designing tools and approaches for the use of educational Big Data and learning analytics in a global market. The purpose of this paper is to explore the concept of information privacy in a cross-cultural setting to define a common point of reference for privacy engineering.

**Design / Methodology / Approach – The paper follows a conceptual exploration approach. Conceptual work on privacy in educational big data and learning analytics in China and the West is contrasted with the general discussion of privacy in** a large corpus of literature and recent research. As much of the discourse on privacy has an American or European bias, intimate knowledge of Chinese education is used to test the concept of privacy and to drive exploration of how information privacy is perceived in different cultural and educational settings.

**Findings –** The findings indicate that there are problems using privacy concepts found in European and North-American theories to inform privacy engineering for a cross-cultural market in the era of Big Data. Theories based on individualism and ideas of control of private information do not capture current global digital practice. The paper discusses how a contextual and culture-aware understanding of privacy could be developed to inform privacy engineering without letting go of universally shared values. The paper concludes with questions that need further research to fully understand information privacy in education.

**Originality / value –** As far as we know, this paper is the first attempt to discuss—from a comparative and cross-cultural perspective—information privacy in an educational context in the era of Big Data. The paper presents initial explorations of a problem that needs urgent attention if good intentions of privacy supportive educational technologies are to be turned

into more than political slogans.

**Keywords:** – Information privacy, Educational Big Data, Learning analytics, Cross-cultural studies, Privacy engineering

# 1 Introduction

The starting point of this work is a box labeled 'privacy rules' found in a Chinese blueprint for a learning analytics technical architecture. We asked ourselves: What rules? What privacy? What should engineers build? And we banged our heads against the black box, not being able to unpack the concept of privacy rules, being *lost in translation* (did we talk about the same thing?). We were unable to gain any insight into the different contexts within which the need was ascribed, nor any of the practical requirements that could be construed from that need.  In this conceptual paper we aim at defining a point of reference for understanding privacy in the context of educational big data[1] (EBD) or learning analytics (LA). We will use our experience working in China as a way to drive and test the exploration of the concept of information privacy with the ultimate aim to enable privacy engineering for global education.

Privacy is recognised as a challenge dealing with Big Data (Polonetsky and Tene, 2013). For some countries in the West privacy has been seen as a show-stopper for learning analytics (Griffiths et al., 2016). It is well known that the discourse on privacy is more central in Europe than in China, especially with the introduction of GDPR (Bennett, 2018). However, when looking more closely at what is happening in real life in terms of collecting and sharing traces of online activity the differences between China and Western countries tend to diminish. Enormous amounts of data are collected and shared all over the globe. What may be different is who collects data, and who has right to access the data (e.g., government or private companies); and what is the ascribed use (surveillance or profit, or both). If this is the case, two questions arise—one related to technology, and one to education: Is privacy in terms of individual control over personal information possible in the era of Big Data? Is students' information privacy too dependent upon culture and political system to be able to define a universal point of reference for EBD or LA?

Why are these questions important? First, it may not be possible to create practical implementations of a particular definition of privacy. If this is the case, then a strong emphasis on privacy in the design and adoption of LA solutions may be reduced to ideological or political markers which signal the virtue of policy maker, but with limited value in terms of actionable requirements for engineering. Second, if students react

[1] Educational Big Data is the term used in China for learning analytics, connecting the analytics more to Big Data and "Internet Plus" political narratives.

negatively to the infringement of norms related to collection and sharing of data exhaust from their learning behaviour, then this will have importance for the design and deployment of data-driven tools and practices in a global market. What do these considerations imply for the 'privacy rules' box in the Chinese blueprint? If the box in the drawing is just a political nod to an international audience, then in terms of practical system design point it has little relevance (although it may be necessary to understand this obfuscation in order to understand the way in which the designed system works in its social context). If, on the other hand, 'privacy' addresses real concerns that affect usage behaviour we need to define the term in a way that allows us to be specific about requirements and 'rules' whatever market we operate in.

This paper presents a conceptual exploration of how the concept of privacy can give rise to design requirements in the context of global EBD and LA. An underlying assumption is that the discourse on privacy till now (Slade et al., 2019; Ifenthaler and Schumacher, 2016; Rubel and Jones, 2016; Drachsler and Greller, 2016; Young, 2015) has not succeeded in providing *implementable* requirements for tools and practices in an international market with different political systems, cultures, and pedagogical approaches.

There is a need to discuss the concept of privacy in a cross-cultural context, and to see if Big Data changes the way we understand the concept of 'information privacy'. The rest of the paper is organised as follows: First we review the literature on information privacy to see how definitions hold up in cross-cultural settings and in defining design requirements. Then we examine how Big Data and cultural differences influence the concept of privacy. In Section 4 we use our findings so far to discuss what privacy engineering will imply in an educational context, legally, conceptually, and technically. The paper concludes with a proposal for a research agenda to develop a point of reference for privacy engineering for EBD and LA in a global market.

# 2 Information privacy as design requirement – conceptual exploration

In other work we have explored how privacy is conceptualised by the less than a decade young field of Learning Analytics and Knowledge research, which organise yearly conferences and sponsor the Journal of Learning Analytics (Hoel and Chen , 2018, 2016, 2015; Hoel et al., 2017). This body of literature is contrasted with the general discussion of 'privacy' in the huge corpus of research on this issue that goes back more than a century (Warren and Brandeis, 1890). To add the cross-cultural dimension to our exploration we have reviewed literature on 'privacy' and 'China' and other cultural and geographical markers. However, the literature review for this conceptual paper is not done to provide a representative description of privacy as a concept, but to offer ideas and highlight direction for future inquiry as the focus of a conceptual paper is "on integration and proposing new relationships among constructs" (Gilson and Goldberg, 2015). In this paper we have used intimate knowledge about the Chinese educational system acquired through participant observation to drive and test how the privacy constructs hold up for use in global settings.

Smith, Dinev, and Xu (2011) note that "the recent evolution of the concept of privacy in general—and information privacy in particular—follows the evolution of information technology itself" (p. 990). Westin (2003) identified different eras of privacy development, the last from 1990 to 2002 influenced by the rise of the Internet, Web 2.0, the terrorist attach of 9/11/2001, and the dramatical changed landscape of information exchange. It is a matter of discussion if Big Data represents a distinct new era; however, the point here is to observe the dynamic nature of the concept of information privacy, and how any use of the concept requires a deep understanding of the technological context of information handling. It is widely accepted that, as a concept, privacy is in disarray (Solove, 2002; Smith et al., 2011). "The distinction between physical and information privacy is seldom clarified in public debate or, for that matter, in many areas of research" (Smith et al, 2011, p. 991). Solove observed that "widespread discontent over conceptualizing privacy persists even though the concern over privacy has escalated into an essential issue for freedom and democracy" (Solove, 2002, p. 1089). In analysing a big corpus of privacy articles and books Smith et al. (2011) concluded that a richer focus on international dimensions of privacy research is needed. In this paper, we want to address this international dimension by loosening the grip of value-based—some would say, Western liberal (Bennett, 2018)— discourse on privacy. Instead, we will narrow the perspective to engineering requirements, and what Smith et al. (2011, p. 993) call cognate-based conceptualization of privacy – "related to the individuals mind, perceptions and cognition rather than to an absolute moral value or norm".

Our ambition is to unpack the concept of information privacy to allow engineers serving a global market to make more specific statements about privacy and technology. This is not a new idea. Palen and Dourish (2003) wanted to do so for human-computer interaction (HCI) analyses, offering a framework and vocabulary to foster discussion between technology users, designers and analysts. Their framework suggested analysis of three boundaries, – disclosure, identity, and temporality. Spiekermann and Cranor (2009) introduced a privacy responsibility framework consisting of three spheres: user (the individual and her devices). recipient (company). and joint sphere (where the control is shared). These spheres were related to system operations (data transfer, storage, and processing). They described two approaches to engineering, "privacy-by-policy" (focusing on implementation of the notice and choice principles). and "privacy-by-architecture" (minimizing collection of identifiable personal data and emphasizing anonymization and client-side data storage and processing).

The degree to which these two approaches hold up in the era of Big Data will be discussed in the next section. Both groups of authors build on Altman's influential privacy theory (Altman, 1975). which states that privacy is neither static nor rule-based, stressing the dialectic and dynamic process of selectively controlling the access to the self. How does this value of 'controlling access to the self' stand the *Chinese test;* is this a universal value that should underpin all design?

To get an understanding of how Chinese users look at the role of the self in information privacy we need to look at great many factors of history, culture, economy, policy, and law related to the higher level concept of general privacy. First, we have to acknowledge that most privacy studies "are based in the United States and are written in English, leading to language-based assumptions about privacy terminology" (McDougall, 2004, p. 1). In the Western tradition, Li et al. (2017) point out, the concept of privacy is said to arise out of an 1890 article by Samuel Warren and Louis Brandeis where privacy is described a right to privacy as the right of an individual to be left alone. In Chinese, privacy (yinsi) is an imported word, consisting of two words (yin – 'hidden from view'; and si – 'private' or 'do not want to disclose in public'). Yinsi has not necessarily positive connotations; a more narrow interpretation of yinsi is 'shameful secret'. Li et al. (2017) claim that Chinese privacy laws can be understood through the lens of 'saving face'. China does not have a separate privacy law, but privacy is acknowledged by the courts as a value worth protecting, and there are a number of laws that could be used to that end (e.g., tort legislation). Looking at what is protected, China differs from the West. The legal system has often sided with protecting the rights, values, and morals of the community over protecting the privacy rights of the individual; "privacy law and regulation in Chinese culture supports the individual's role in the community rather than protecting the individual against the community as in the West" (Li et al., 2017, p. 12).

From a Western point of view, the Chinese government's massive surveillance and intrusion into personal information (Wang and Yu, 2015) may seem over the top if the aim is to support the individual's role in society. However, one cannot a priori assume that there is a conflict between the individual and the government in these matters. From a privacy point of view, if the system protects against the citizen's right of reputation, the government intrusion on the private sphere might be seen as both in the interest of the public and the citizen.

In a society where the concept of 'self' is tied more to the family this will influence how privacy is viewed. According to McDougall (2004). privacy in traditional China resides primarily in the family unit, which is distinct from the public sphere. Seen through the lens of 'saving face' the Chinese privacy laws can be seen as a protection from exposing personal information. This perspective is still compatible with Altman's definition of privacy as a "dynamic process of selectively controlling the access to the self" (Altman, 1975). The individualistic perspective so prevalent in American privacy research (Marwick and boyd, 2014). is softened by Altman's further development of his theory in relationship to culture. His framework emphasizes the dialectic and boundary control features of privacy, "whereby people can make themselves accessible or inaccessible to others" (Altman, 1977, p. 82). Privacy is a culturally universal process, but it is also highly culturally specific and contextual (Altman, 1975, 1977; Palen and Dourish, 2003). In a Chinese context, Altman's pre-Internet definition of privacy could need updating to "… accessible or inaccessible to *some significant* others". The individual could hope to control accessibility within certain contexts that are important for their self-esteem; however, absolute control in today's Internet society is an illusion. Some would claim this is also the case in a Western context after Edward Snowdon's disclosure of contemporary surveillance (Page, 2016).

The idea of selective control gives priority to context. The most recognized contextual privacy theory is developed by Nissenbaum (2010) revolved around the concept of 'contextual integrity'. The norms that govern "the flow of personal information in a given context" (Nissenbaum, 2010, p. 127) are dependent on the type of information being shared; the social roles of the sender, subject, and recipient; and how information is transmitted. Nissenbaum's theory holds up to our *China test*, as it gives room for social norms that are rooted in Chinese culture and political context.

In the next section we will explore the individual's room for manoeuvre in the era of Big Data; what our discussion so far shows is that the contextual aspects of privacy needs a better understanding.

# 3 Big data and privacy

In the era of Big Data, the challenges of privacy become more visible—on conceptual, technical, legal, and political levels. The privacy challenges need to be addressed on all these levels, which have implications for how we approach privacy engineering. In order to turn information privacy into actionable design requirements for engineering we need to leave an idealised world of absolutes and see how higher level values, laws, technologies, and users' practices interact in a globalised setting. Grounding privacy protection policies within the individualistic and liberal notion of 'privacy' may, according to Bennett (2018) overlook what is at stake in the broader debate over contemporary surveillance.

> Thus, data protection law does not halt surveillance; it manages it. It may produce a fairer and more efficient use and management of personal data, but it cannot effectively control the voracious and inherent appetite of modern organizations for more and more increasingly refined personal information, especially when those data are central to the business models of the platform economy (Bennett, 2018).

When jaywalking has the immediate effect of exposing name and picture of the culprit on a gigantic public screen (Niu, 2017) a Chinese citizen will have no illusions of privacy being protected by the laws. Before European citizens feel overly protected by the new General Data Protection Regulation (GDPR) they should take a second to ponder the implications of the full title of the regulation: "Regulation of the European parliament and of the Council on the protection of individuals with regard to the processing of personal data and *on the free movement of such data*" (European Commission, 2012). Bennett (2018, p. 244) observes that "contemporary information privacy legislation is designed to manage the processing of personal data, rather than to limit it".

What if the individual does not want privacy? Users information technology in the networked society may have other priorities than the older generation. Marwick and boyd (2014) looked at how teenagers negotiate context in social media and found, "simply put, they are trying to be in public without always being public" (Ibid., p. 1052). This complies with the Chinese laws that "protect Chinese citizens from having their personal information exposed, thus allowing individuals to present their identity (or personal information) to the community in ways that they choose" (Li et al., 2017, p. 2). Young people see value in being online; however, they also "have a sense that data are reused and repurposed in myriad ways" (Pangrazio and Selwyn, 2018, p. 7). In experiments, Pangrazio and Selwyn (Ibid.) worked with young mobile media users to move them towards a practice of 'informed resistance' towards privacy threats. They found that their participants remained unenthusiastic about the 'agentic' choices that they were attempting to support them in making.

> [M]anaging personal data also requires advanced technical skills and ongoing maintenance. The question then becomes *should* it be up to the individual to ensure their data privacy? Self-responsibilization might be beyond the individual, suggesting that more collective and centralized approaches to data privacy are the only realistic way forward. (Pangrazio, and Selwyn, 2018, p. 8)

Neither technical skills nor technical solutions are going to solve information privacy. Young (2015) observes that the notion of anonymity as a "placeholder for privacy" (Ibid., p. 560) is becoming increasingly questionable, such that existing consent to the collection, analysis and use of personal data is "effectively illusory" (Ibid., p. 561). She found "there is also no empirical evidence that suggests that "de-identification works either in theory or practice" (Ibid., p. 561).

Rubinstein (2013, p. 1) argues that GDPR relies too heavily on an informed choice model and data minimization, "and therefore fails to fully engage with the impeding Big Data tsunami". Data minimization and anonymization were pivotal engineering instruments in the Spiekermann and Cranor approach that we introduced in the previous section (Spiekermann and Cranor, 2009). If these measures are not working in the era of Big Data, what are the alternatives to promote privacy? The discourse framework suggested by Palen and Dourisch (2003) for HCI could only be part of a solution. Rubenstein's proposal is to combine legal reform with encouragement of new business models premised on consumer empowerment and supported by a personal data ecosystem.

Our understanding of information privacy is not set in stone. The rest of the paper will explore possible developments from a legal, conceptual, and technical point of view.

# 4 Envisioned privacy developments – in an educational context

When de-identification of personal information is an illusion and the 'big data tsunami' makes us run to save face we could, as well, give up the idea of information privacy? Or in the words of Sun Microsystems' CEO, Scott McNealy, "You have zero privacy anyway. Get over it!" (Sprenger, 1999). However, this is not the adequate response to handling risks in society (Rauhofer, 2008). This was shown in debate spurred by Paul Ohm's 2009 article "Broken Promises of Privacy: Responding to the surprising failure of anonymization". Even if the danger of re-identification is immanent with Big Data, 'good enough' approaches work (Ohm, 2009; Narayanan and Felten, 2014; Cavoukian and Castro, 2014). Real life is more than worst cases.

In this paper we are concerned with privacy engineering, defined by Kenny and Borking (2002) as "a systematic effort to embed privacy relevant legal primitives into technical and governance design". In the following, we will discuss how we foresee this being done in an educational context with both Chinese and Western students in mind.

### 4.1 Legal development

What legal primitives are relevant to education in a global setting? First, international privacy legislation is dynamic, with GDPR just being implemented in Europe with ramifications for the understanding of privacy also in other parts of the world trading with Europe (Bennett, 2018; Hoel and Chen, 2018). This means that ideas of the individual's role in managing personal information, data minimization, etc are recognised (even if they are not part of national legislation). and that they may influence policy development around the globe, e.g., institutional codes of ethics. This consensus around principles of a code of practice, information collection, information processing and information dissemination is demonstrated in international standardization developing requirements for privacy and data protection for learning analytics (ISO 20748-4:2019). Second, laws are interpreted, and this leaves space for privacy engineering that addresses sector or culturally specific interests. We have argued (Hoel and Chen, 2018) that privacy in an educational context should be led by pedagogical principles. This means that student agency should be strengthened by negotiating data sharing with each student; supporting openness and transparency, and promoting personal data literacies. This proposal takes the 'privacy-by-policy' approach (see Section 2, Spiekermann and Cranor, 2009) one step further and contextualize the Fair Information Principles of the OECD and APEC frameworks (Hoel and Chen, 2018) for education. There is no doubt that also in Chinese education for the 21st century values like transparency, notice, student agency, have priority (Stanaland and Lwin, 2013) and could be integrated into a digital literacy curriculum.

In choosing what legal primitives should inform engineering there is still a need for conceptual work, which principles will be discussed in the next section.

### 4.2 Conceptual development

The cultural diversity of a global market requires systems that are capable of runtime cultural adaptation. That means technologies must be 'cultural aware', which in turn means that we need to formalise our understanding of culture (as well as law, social norms, and pedagogy) in a model that can be implemented in systems that can handle different contexts.

In HCI, the concept of context and how it relates to culture has been discussed for years (Dourish, 2001). Context is a notoriously fuzzy concept having an infinite dimension that does not allow it to be described completely. Blanchard et al. (2011) launched the concept of 'centred context', "seen as a limited context, whose focus is on the description of specific, more or less complex, dimensions (for instance the spatial one, the social one, the cultural one, and so on"(Ibid., p. 13). This concept allows a modelling of dimensions that could be useful for adaptive systems. Blanchard et al. (2011) have proposed to structure the cultural domain with an upper ontology and discuss methods to do so.

We suggest that the ontology engineering approach of Blanchard et al. (2011) could be used to create an upper ontology of the concept of privacy as well. Culture-aware learning technologies using EBD and LA would need a number of upper ontologies describing culture, privacy, pedagogy, emotions (affective domain). etc. In such an ontology key concepts in European legislation, like purpose limitation and data minimization, would need to be defined in a way that allows design of adaptive technologies that also work in a Chinese context.

In EBD and LA, it is no surprise that technology itself plays an important role in what ways privacy is constrained. This is the topic of the next section of this paper.

### 4.3 Technical development

In Rubinstein's proposal for an international solution to the big data privacy problem he included a personal data ecosystem (Rubinstein, 2013). Rubinstein left to others to specify what such a system involves, and there is no lack of proposals being debated as the consequences of Big Data start to be understood. Even if we have pointed to the pedagogical opportunity of strengthening learner agency and personal digital literacy we do not think the privacy challenges could only be met with measures taken by the individual. Privacy needs to be built into the technology, much according the principles of Privacy-by-Design promoted by GDPR (Cavoukian, 2012).

This challenge is taken on board by Tim Berners Lee, who as we all know played an important role in inventing the most used Internet technology, the World Wide Web. He is now involved in building a technology that "changes the current model where users have to hand over personal data to digital giants in exchange for perceived value" (Berners-Lee, 2018). Berners-Lee's ambition is to challenge what Shoshana Zuboff has termed 'surveillance capitalism' (Zuboff, 2019). evolving the web in order to restore balance—by giving every one of us complete control over data, personal or not. Berners-Lee wants to build an Internet protocol that enables users to decouple content from the application itself, giving the users freedom to choose where their data resides. Seamless switching between apps and personal data storage servers will avoid vendor lock-in and secure innovation, while giving the user control of their data. It is in the same vein other researchers are exploring how blockchain technologies can be used in education to allow students to exercise control of their own learning records (Grech and Camilleri, 2017; Ocheja et al., 2019).

Tools for EBD and LA are just starting to hit the market, and privacy aspects are still open for design. This is therefore the right time to make sure that technical design of EBD and LA solutions are based on a sound understanding of information privacy in a global setting.

# 5 Conclusions – towards a research agenda

A 'black box' labelled 'privacy rules' introduced this paper. With China and a Western country like Norway in mind, we know that rules regulating students' daily life are very different. In China, "dorms' face recognition gets thumbs-up for convenience" (Ma and Lin, 2018); while in Norway, student id app users are assured that "the data is stored locally on your device and you may delete them whenever you want" (Felles studentsystem, 2018). Even if the output of privacy rules differs enormously between the two countries this paper supports the idea that it is worthwhile to specify input for privacy engineering that allows design of solutions that could be implemented both in China and Norway.

Through comparative analysis and reflection, we have found that there are limitations in European and North-American privacy theories when the aim is to inform privacy engineering for a global market of analytics tools and services. This finding also implies that the discourse we have had till now on privacy in the context of EDB and LA research has limitations. Too much focus has been on discussing values and norms, and too little effort has been on getting knowledge about students' perceptions and cognition of privacy in the actual settings where EDB and LA systems are used. This is also a limitation of this study, which only explore concepts and do not generate empirical findings. However, before we can engage in empirical studies, we need to have our theoretical constructs right.

This paper rejects that privacy is something that only can be found in liberal societies based on individualistic culture. As Altman concluded

> (a) people in all cultures engage in the regulation of social interaction—sometimes being accessible to others and sometimes being inaccessible to others, and (b) the behavioral mechanisms by which accessibility is controlled are probably unique to the particular physical, psychological, and social circumstances of a culture. (Altman, 1977, p. 82)

Altman's observations hold also in a digital age. However, in the era of Big Data it is not enough to analyse relationships among friends and family members; we need analysis of cross-cultural networked practices in the shadow of what Zuboff has termed the 'Big Other". Zuboff (2015, p. 81) describes the Big Other as "a ubiquitous networked institutional regime that records, modifies, and commodifies everyday experience from toasters to bodies, communication to thought, all with a view to establishing new pathways to monetization and profit".

If we find that what Zuboff describes is more than a shadow, that surveillance capitalism is a social formation of global reach, this will also impact the agenda for student privacy. Notwithstanding East or West, the challenge will be to design tools for education that promote knowledge about the use of data and the students' own relation to its use. In order

to know more about what input to be fed into the *privacy rule box* future cross-cultural research should focus on
*A) Aspects of contextual integrity:* What types of learning activity data are collected and shared? What norms govern the flow of personal data in education? What roles do students, teachers, technologies, and other actors play?
*B) Aspects of culture and policies that constrain educational priorities:* What role does student agency play in education? And what educational priorities could influence design of learning tools?
*C) Aspects of technological development:* What technologies could strengthen the students' ability to negotiate boundaries related to data sharing?

Finally, our cross-cultural perspective on privacy engineering has made us aware of the need to discuss the relationship between EDB and LA, the two concepts we have used to capture both Chinese and Western discourse on these issues. EBD comes with a notion of Big Data, and nowadays, more and more ideas of the use of Artificial Intelligence (AI). The discourse on LA on the other hand, seems to have a narrower scope in line with the much used definition[2] coined by the Society for Learning Analytics Research (SoLAR) (Siemens, and Gasevic, 2012). The SoLAR definition does by no means exclude use of AI, however, LA could be more focussed on "understanding and optimising" specific learning tasks that could be described by use of 'small data'.  A more limited and targeted use of analytics related to pedagogically well-defined *learning moments* may imply less challenging privacy issues than Big Data approaches, where data collection tends to come first and pedagogical reasoning second.

# Reference List

Altman, I. (1975), *The environment and social behavior: Privacy, personal space, territory and crowding.* Monterey, CA.: Brooks/Cole.

Altman, I. (1977), "Privacy Regulation: Culturally Universal or Culturally Specific?" *Journal of Social Issues*, 33(3), 1–19.

Bennett, C. J. (2018), "The European General Data Protection Regulation: An instrument for the globalization of privacy standards?" *Information Polity*, 23(2), 239–246. http://doi.org/10.3233/IP-180002

Berners-Lee, T. (Sep 29, 2018), "One Small Step for the Web…", available at: https://medium.com/@timberners_lee/one-small-step-for-the-web-87f92217d085 (accessed 10

[2] Learning analytics is the measurement, collection, analysis and reporting of data about learners and their contexts, for purposes of understanding and optimising learning and the environments in which it occurs.

March 2019)

Blanchard, E. G., Mizoguchi, R., and Lajoie, S. P. (2011), “Structuring the Cultural Domain with an Upper Ontology of Culture”, *Handbook of Research on Culturally-Aware Information Technology*, Vol. 14, pp. 179–212, IGI Global. http://doi.org/10.4018/978-1-61520-883-8.ch009

Cavoukian, A. and Castro, D. (2014), “Big data and innovation, setting the record straight: de-identification does work”, Privacy by Design, Ontario, Canada.

Cavoukian, A. (2012), “Privacy by Design: From Rhetoric to Reality”, available at: https://www.ipc.on.ca/images/Resources/PbDBook-From-Rhetoric-to-Reality.pdf, accessed 13 February 2015.

Dourish, P. (2001), “Seeking a foundation for context-aware computing”, *Human-Computer Interaction*, 16(2), 229-241.

Drachsler, H. and Greller, W. (2016), “Privacy and learning analytics – it's a DELICATE issue”, *6th Learning Analytics and Knowledge Conference 2016*, April 25-29, 2016, pp. 89- 98. Edinburgh, UK. DOI: http://dx.doi.org/10.1145/2883851. 2883893.

European Commission. (2012), REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on the protection of individuals with regard to the processing of personal data and on the free movement of such data . COM(2012) 11 final.

Felles studentsystem, (2018), “Privacy Policy”, available at: https://www.fellesstudentsystem.no/english/applications/student-id/privacy-policy.html, (accessed10 March 2019).

Gilson, L. and Goldberg, C. B. (2015), “Editors' Comment: So, What Is a Conceptual Paper?” Group  and Organization Management, 1–5. http://doi.org/10.1177/1059601115576425.,

Grech, A. and Camilleri, A. F. (2017), “Blockchain in Education”. Publications Office of the European Union (pp. 1–136).

Griffiths, D., Drachsler, H., Kickmeier-Rust, M. D., Steiner, C. M., Hoel, T., and Greller, W. (2016), “Is Privacy a Show-stopper for Learning Analytics? A Review of Current Issues and Solutions”, *LACE Review* (pp. 1–32).

Hoel, T. and Chen, W. (2018), “Privacy and Data Protection in Learning Analytics should be motivated by an Educational Maxim - towards a proposal”, *Research and Practice in Technology Enhanced Learning*, DOI: 10.1186/s41039-018-0086-8.

Hoel, T., Griffiths, D., and Chen, W. (2017), The influence of data protection and privacy frameworks on the design of learning analytics systems (pp. 243–252), Proceedings of the Seventh International Learning Analytics and Knowledge Conference, New York, New York, USA: ACM Press. http://doi.org/10.1145/3027385.3027414

Hoel, T., and Chen, W. (2016), Privacy-Driven Design of Learning Analytics Applications: Exploring the Design Space of Solutions for Data sharing and Interoperability. Journal of Learning Analytics, 3(1), 139–158. http://dx.doi.org/10.18608/jla.2016.31.9

Hoel, T. and Chen, W. (2015), “Privacy in Learning Analytics – Implications for System Architecture”, in Watanabe, T. and Seta, K. (Eds.) (2015), Proceedings of the 11th

International Conference on Knowledge Management, ISBN 978-4-9908620-0-8, presented at ICKM 15 in Osaka, Japan, 4 - 6 November 2015 ickm.kis.osakafu-u.ac.jp

Ifenthaler, D. and Schumacher, C. (2016), "Student perceptions of privacy principles for learning analytics", Educational Technology Research and Development, 64(5), 923–938. http://doi.org/10.1007/s11423-016-9477-y.-

ISO/IEC 20748-4:2019, "Information technology for Learning, education, and training — Learning Analytics Interoperability — Part 4: Privacy and data protection requirements".

Kenny S. and Borking J, (2002), "The Value of Privacy Engineering", *The Journal of Information, Law and Technology* (JILT): available at: http://elj.warwick.ac.uk/jilt/02-1/kenny.html, (accessed 10 March 2019).

Li, T., Bronfman, J. and Zhou, Z. (2017), "Saving Face: Unfolding the Screen of Chinese Privacy Law", *LawArXiv, 19 Aug. 2017*, https://doi.org/10.31228/osf.io/ndyus

Ma, Z. and Lin, Y. (2018), "Dorms' face recognition gets thumbs-up for convenience", *China Daily*, available at: http://global.chinadaily.com.cn/a/201809/15/WS5b9c4583a31033b4f465630c.html, (accessed 10 March 2019).

McDougall, B. S. (2004), "Privacy in Modern China", *History Compass*, 2(1), Blackwell Publising, http://doi.org/10.1111/j.1478-0542.2004.00097.x

Marwick, A. E. and boyd, D. (2014), "Networked privacy: How teenagers negotiate context in social media", *New Media & Society*, 16(7), 1051–1067, http://doi.org/10.1177/1461444814543995.

Narayanan, A. and Felten, E. W. (2014), "No silver bullet: De-identification still doesn't work", available at: http://www.randomwalker.info/publications/no-silver-bullet-de-identification.pdf, (accessed 10 March 2019).

Nissenbaum H.F. (2010), *Privacy in Context: Technology, Policy, and the Integrity of Social Life*. Stanford, CA: Stanford University Press.

Niu, J., (2017), "Shenzhen targets jaywalking with face recognition", available at: http://www.china.org.cn/china/2017-04/20/content_40658907.htm, (accessed 13 February 2019].

Ocheja, P., Flanagan, B., Ueda, H., and Ogata, H. (2019), "Managing lifelong learning records through blockchain", *Research and Practice in Technology Enhanced Learning*, 14(1), 11. http://doi.org/10.1186/s41039-019-0097-0.

Ohm, P. (2009), "Broken promises of privacy: Responding to the surprising failure of anonymization", *UCLA Law Review*, 57, 1701.

Page, D. (2016), "The surveillance of teachers and the simulation of teaching", *Journal of Education Policy*, 32(1), http://doi.org/10.1080/02680939.2016.1209566.

Palen, L. and Dourish, P. (2003), "Unpacking "privacy" for a networked world", in *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (CHI '03), ACM, New York, NY, USA, 129-136, DOI=http://dx.doi.org/10.1145/642611.642635.

Pangrazio, L. and Selwyn, N. (2018), ""It's Not Like It's Life or Death or Whatever": Young People's Understandings of Social Media Data", *Social Media + Society*, 4(3), 205630511878780–9. http://doi.org/10.1177/2056305118787808.

Polonetsky, J. and Tene, O. (2013), "Privacy and Big Data: Making Ends Meet", *Stanford Law Review Online*, 66, 25.

Rauhofer, J. (2008), "Privacy is dead, get over it! 1 Information privacy and the dream of a risk-free society", *Information & Communications Technology Law*, 17(3), 185–197. http://doi.org/10.1080/13600830802472990.

Rubel, A. and Jones, K. M. L. (2016), "Student privacy in learning analytics: An information ethics perspective", *The Information Society*, 32(2), 143–159, http://doi.org/10.1080/01972243.2016.1130502.

Rubinstein, I. S. (2013), "Big Data: The End of Privacy or a New Beginning?", *International Data Privacy Law*, 3(2), 74–87, http://doi.org/10.1093/idpl/ips036.

Siemens, G. and Gasevic, D. (2012), "Guest editorial-learning and knowledge analytics", *Educational Technology and Society,* 15(3), 1–2.

Slade, S., Prinsloo, P., and Khalil, M. (2019), "Learning analytics at the intersections of student trust, disclosure and benefit", 1–1. *Proceedings of the 9th Learning analytics and Knowledge Conference 2019 (LAK 19), Tempe, Arizona, USA May 4- 8, 2019.*

Smith, H. J., Dinev, T., and Xu, H. (2011), "INFORMATION PRIVACY RESEARCH: AN INTERDISCIPLINARY REVIEW", *Mis Quarterly*, 35(4), 989–1015.

Solove, D. J. (2002), Conceptualizing Privacy. California Law Review, 90(4), 1087–1155. http://doi.org/10.2307/3481326?ref=no-x-route:b2978ad7e6a023a38f6a0148804669e1

Spiekermann, S., and Cranor, L. F. (2009), "Engineering Privacy", *IEEE Transactions on Software Engineering*, 35(1), 67–82. http://doi.org/10.1109/tse.2008.88.

Sprenger, P. (1999), "Sun on privacy: 'Get over it'", *Wired*, available at: http://www.wired.com/politics/law/news/1999/01/17538 (accessed 14 February 2019),

Stanaland, A. J. S., and Lwin, M. O. (2013), ONLINE PRIVACY PRACTICES: ADVANCES IN CHINA. *Journal of International Business Research*, 12(2), 1–146.

Wang, Z. and Yu, Q. (2015), "Privacy trust crisis of personal data in China in the era of Big Data: The survey and countermeasures", *Computer Law and Security Review*, 31(6), 782–792. http://doi.org/10.1016/j.clsr.2015.08.006.

Warren, S.D. and Brandeis, L. D. (1890), "The Right to Privacy", 4 HARV. L REV. 193.

Westin, A. F. (2003), "Social and Political Dimensions of Privacy", Journal of Social Issues, 59(2), 431–453. http://doi.org/10.1111/1540-4560.00072.

Young, E. (2015), "Educational privacy in the online classroom: FERPA, MOOCs, and the big data conundrum", *Harvard Journal of Law Technology*, 28(2).

Zuboff, S. (2019), “Surveillance Capitalism and the Challenge of Collective Action”, *New Labor Forum*, 28(1), 10–29. http://doi.org/10.1177/1095796018819461.

Zuboff, S. (2015), “Big other: surveillance capitalism and the prospects of an information civilization”, *Journal of Information Technology*, 30(1), 75–89. http://doi.org/10.1057/jit.2015.5 7/jit.2015.5.

# IV

# PRIVACY-DRIVEN DESIGN OF LEARNING ANALYTICS APPLICATIONS: EXPLORING THE DESIGN SPACE OF SOLUTIONS FOR DATA SHARING AND INTEROPERABILITY

by

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# Privacy-Driven Design of Learning Analytics Applications: Exploring the Design Space of Solutions for Data Sharing and Interoperability

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**ABSTRACT:** Studies have shown that issues of privacy, control of data, and trust are essential to implementation of learning analytics systems. If these issues are not addressed appropriately, systems will tend to collapse due to a legitimacy crisis, or they will not be implemented in the first place due to resistance from learners, their parents, or their teachers. This paper asks what it means to give priority to privacy in terms of data exchange and application design and offers a conceptual tool, a Learning Analytics Design Space model, to ease the requirement solicitation and design for new learning analytics solutions. The paper argues the case for privacy-driven design as an essential part of learning analytics systems development. A simple model defining a solution as the intersection of an approach, a barrier, and a concern is extended with a process focusing on design justifications to allow for an incremental development of solutions. This research is exploratory in nature, and further validation is needed to prove the usefulness of the Learning Analytics Design Space model.

**Keywords**: Learning analytics, privacy, data sharing, trust, control of data, privacy by design, interoperability

## 1 INTRODUCTION

Learning analytics (LA) is developing rapidly in higher education, and it is beginning to gain traction in schools, according to many foresight analysts (Johnson et al., 2016; Johnson, Adams Becker, Estrada, & Freeman, 2014a; Johnson, Adams Becker, Estrada, & Freeman, 2014b; Griffiths, Brasher, Clow, Ferguson, & Yuan, 2016). Nevertheless, market players experience severe setbacks related to lack of trust in LA systems (Singer, 2014; Drachsler et al., 2016). A main barrier for mainstream adoption of this technology revolves around concerns about privacy, control of data, and trust (Hoel, Mason, & Chen, 2015; Mason, Hoel, & Chen, in press; Griffiths, Hoel, & Cooper, 2016; Hoel & Chen, 2014, 2015; Cooper and Hoel, 2015; Scheffel, Drachsler, Stoyanov, & Specht, 2014). This paper promotes the idea that LA systems development should be based upon a "privacy by design" approach, rather than addressing privacy concerns as an unpleasant afterthought. If systems that have integrated privacy concerns in their designs were prioritized, it would help research and development to focus on viable projects instead of wasting time and money on blue-sky technologies.

Privacy may, however, be defined as beyond the scope of LA systems and LA interoperability specification development (ADL, 2013; IMS Global, 2015), as one might think that privacy issues are dealt with by front-

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end systems that provide the data exhaust for analytics. This position is flawed, both conceptually and practically. First, privacy cannot be handled only by a sign-on process or a consent form; privacy permeates all processes of the LA process cycle (Hoel, Chen, & Cho, 2016). Second, if privacy requirements are not reflected at the time of design, the developed solutions may not deliver according to law or market needs (Hoel & Chen, 2015). That said, privacy is also an equivocal concept that needs to be understood in context of emerging LA practices.

"The principles of data protection by design and data protection by default" (EC, 2012, p. 27) have recently been built into European and US policies, respectively, through the General Data Protection Regulation (Council Directive 95/46/EC) and Recommendations for Business and Policy-makers from the US Federal Trade Commission (FTC, 2012). The privacy-by-design (PbD) framework was developed within the Information and Privacy Commission of Ontario, Canada, with goals of "ensuring privacy and gaining personal control over one's information and, for organizations, gaining a sustainable competitive advantage" (Cavoukian, 2012, pp. 36–37). The PbD framework laid down by Cavoukian (2012) encompasses IT systems, accountable business practices, physical design, and networked infrastructures and follows these seven foundational principles:

1. Proactive not reactive; preventative not remedial
2. Privacy as the default setting
3. Privacy embedded into design
4. Full functionality – positive-sum, not zero-sum
5. End-to-end security – full lifecycle protection
6. Visibility and transparency – keep it open
7. Respect for user privacy – keep it user-centric (p. 37)

As long as these principles are maintained as high-level concepts left open to be defined by the organization seeking a "competitive advantage," the PbD approach will have difficulties in leaving any footprint on a particular domain. The principles need to be applied in context, both in terms of domain (in our case learning), and design (i.e., systems engineering) activities. This paper aims to develop a design process model that will make it easier to create privacy-aware designs for learning analytics.

The paper is organized as follows: Section 2 offers a literature review that looks at how privacy has been the focus of research and discourse within the LA community in the last few years. Contexts and context integrity are identified as an important backdrop for understanding privacy. Based the authors' previous work, an LA Design Space concept is developed and a model offered as a useful discourse artefact for achieving privacy-driven design of LA (Section 3). In Section 4, the current state of the art related to data sharing is described in the case used in Section 5 to construct a Problem Space, a Solution Space, and, based on these constructs, a Design Space analysis of viable solutions for dealing with privacy in LA. The result is discussed in Section 6, and Section 7 concludes with ideas for further work.

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## 2 RELATED WORK

Is privacy recognized as an issue in current LA research? The yearly international conferences on Learning Analytics and Knowledge (LAK) are a representative outlet for LA research. Looking at the main conference proceedings of LAK '14 and LAK '15, one may say that privacy is recognized, but only superficially so. However, from 2014 to 2015, we see signs of a new approach that not only identifies privacy as a concern but points to privacy solutions at different levels. At LAK '14, 12 of 57 papers mentioned privacy, three of them describing how data was anonymized to protect privacy. The rest of the papers were concerned with privacy as a barrier (Ferguson, De Liddo, Whitelock, de Laat, & Buckingham Shum, 2014a); as a restriction for data tracking (Drachsler, Dietze, Herder, d'Aquin, & Taibi, 2014b); and as a cluster of stakeholder concerns revolving around risks (Drachsler, Stoyanov, & Specht, 2014a). However, privacy is clearly an obstacle that should be overcome in order to reap the benefits of LA since "Learners need to be convinced that [LA systems] are reliable and will improve their learning without intruding into their privacy" (Ferguson et al., 2014b, p. 251). "Many myths surrounding the use of data, privacy infringement and ownership of data need to be dispelled and can be properly modulated once the values of learning analytics are realized" (Arnold et al., 2014, p. 259). Some authors reminded the audience that one should be mindful (of privacy) when designing user interfaces (Aguilar, 2014). In doing so, another paper pointed out that while ethics and privacy are features of educational data sciences, public entities are required to adhere to FERPA and other such regulations, whereas "in the private sector there are fewer restrictions and less regulations regarding data collection and use" (Piety et al., 2014, p. 198). One paper called for ethical literacy by LA knowledge practitioners, "maintaining an ethical viewpoint and fully incorporating ethics into theory, research, and practice of the LAK discipline" (Swenson, 2014, p. 250).

One year later, at LAK '15, privacy was still not a major theme (mentioned in 10 out of 82 papers), but the issue was put on the agenda by researchers active in European projects in a panel discussion (Ferguson et al., 2015) and a workshop dedicated to ethics and privacy[1] (Drachsler et al., 2015a). The main conference papers of LAK '15 still looked at privacy as a search term (Sekiya, Matsuda, & Yamaguchi, 2015), a course subject (Vogelsang & Ruppertz, 2015), or an abstract concern (Scheffel, Drachsler, & Specht, 2015), which could limit access to data (Wang, Heffernan, & Heffernan, 2015; Drachsler et al., 2015b), or one that must "be addressed given the larger scale of the tools usage compared with pilot studies" when "testing the tool in-the-wild" (Martinez-Maldonado et al., 2015, p. 6).

However, two papers advocated that institutions "must engage more proactively with students, to inform and more directly involve them in the ways in which both individual and aggregated data is being used" (Prinsloo & Slade, 2015, p. 8). Prinsloo and Slade (2015) explored the concept of student *privacy self-management* and issues around consent and the seemingly simple choice to allow students to opt-in or opt-out of having their data tracked. They concluded that the way forward cannot simply be to introduce a choice between opt-in or opt-out as "Only by increasing the transparency around learning analytics

[1] A majority of the contributions to this special issue of JLA (Vol. 3, No. 1) are based on input to this LAK '15 workshop.

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activities will HEIs gain the trust and fuller co-operation of students" (2015, p. 8).

Kitto, Cross, Waters, & Lupton (2015), the authors of the second paper, discussed privacy vs. data ownership and proposed a technical solution, the Connected Learning Analytics Toolkit, as a radically different solution to current systems in the market since "Many of the ethical problems that arise from within the privacy perspective evaporate when students are given full access to their data" (p. 5). Kitto et al. (2015) referenced a work by Pardo and Siemens (2014) that advocates a contextual approach with respect to information privacy; sometimes we want our information to be public, sometimes not.

No doubt, the upcoming LAK '16 conference will move the research frontier on ethics and privacy for LA; so will outputs from the European LACE project, which has published a Review Report on current issues and their solutions (Drachsler et al., 2016a), as well as this special issue of the *Journal of Learning Analytics*. A preprint of a LAK '16 paper by Drachsler and Greller (2016) promotes a checklist approach to trusted learning analytics building on a number of catch phrases (determination, explain, legitimate, involve, consent, anonymize, technical, external) making up the DELICATE checklist. "[W]e would like to encourage the Learning Analytics community to turn the privacy burden into a privacy quality label," Drachsler and Greller state, seeing the challenges as "a 'soft' issue, rooted in human factors, such as angst, scepticism, misunderstandings, and critical concerns" (p. 5). Referencing the authors of this paper (Hoel and Chen), Drachsler and Greller spell out that they "would refrain from solving a weakness in a new learning technology by proposing technical fixes or technological solutions, such as standardization approaches" (2016, p. 5).

In choosing between soft checklists and hard technical fixes, there is a need for a conceptual tool that could help us move from barriers and concerns to well-argued solutions. The aim of this paper is to develop such a conceptual framework. However, before doing so there is still a need to unpack privacy as a socio-cultural concept to bring it more to the centre of LA application design.

### 2.1 A Contextual Approach to Privacy

Privacy in LA is related to how data are used, stored, and exchanged. When data contain information that can be linked to a specific person, we talk about "personal data." We also talk about "private data" that are part of a person's privacy. The boundaries put around personal and private data are social agreements that depend on who the person is and in what social settings the data are created and shared. A key question revolves around who is the owner of the data. The answer certainly involves the person at hand, but to leave the control to this person alone is often too simple a solution.

Heath (2014), discussing contemporary privacy theory contributions to LA found that the "debate regarding privacy has swung between arguments for and against a particular approach with the limitation theory and control theory dominating" (p. 142). Control theory focuses on allowing individuals to control their personal information, while limitation theory is concerned with the limitations set on those who

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could gain access to personal information. Heath puts more confidence, however, in theories that highlight contexts as the organizing concept, one of the contexts being LA. At an international workshop on the future of privacy, Dartiguepeyrou concluded that there will be an increased acceptance of sharing data for common good, increased social and public value, with a following likely evolution of the notion of privacy from the "'ability to control one's personal information' (collection, disclosure, use) to 'a dynamic process of negotiating personal boundaries in intersubjective relations'" (2014, p. 13). Thus, a good understanding of the meaning of "context" is needed.

Helen Nissenbaum (2014) has moved the privacy debate beyond "control" and "limitation," promoting respect for context as a benchmark for privacy online. Her theory of contextual integrity is a theory of privacy regarding personal information "because it posits that informational norms model privacy expectations; it asserts that when we find people reacting with surprise, annoyance, indignation, and protest that their privacy has been compromised, we will find that informational norms have been contravened, that contextual integrity has been violated" (Nissenbaum, 2014, p. 25). Context is, however, an elusive concept that needs to be defined. Nissenbaum has studied the contexts that shape privacy policy, i.e., context as technology system or platform; context as business model or business practice; context as sector or industry; and context as social domain. In the discourse on LA and interoperability, it is natural to focus on technical characteristics as the context, e.g., properties defined by respective media, systems, or platforms that shape the character of our activities, transactions, and interactions. "If contexts are understood as defined by properties of technical systems and platforms, then respecting contexts will mean adapting policies to these defining properties" (Nissenbaum, 2014, p. 14). However, Nissenbaum does not think the best solution is to develop privacy context rules for Twitter, Facebook, specific learning applications, etc. She aspires to promote respect for contexts, understood as respect for social domains, as it "offers a better chance than the other three [technology system, business model, or industry sector] for the Principle of Respect for Context to generate positive momentum for meaningful progress in privacy policy and law" (Nissenbaum, 2014, p. 25).

Willis, Campbell, and Pistilli (2013) seem to be well aligned with Nissenbaum's contextual integrity theory in their paper exploring the institutional norms related to using big data in higher education, particularly for predictive analytics. They concluded, "the institution is responsible for developing, refining, and using the massive amount of data it collects to improve student success and retention." Furthermore, "the institution is responsible for providing a campus climate that is both attractive and engaging and that enhances the likelihood that students will connect with faculty and other students" (Willis et al., 2013, p. 6). Recent development of codes of ethics by higher educational institutions shows that the educational systems are responding to the challenges to improve the contextual integrity of their students (Sclater, 2016).

From a contextual integrity perspective, the institution may not have violated the informational norm if the roles of the actors involved — e.g., students, teachers, administrators — are acknowledged, the agreed information types were used, and the agreed data flow terms and conditions were followed.

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Actors, information types, and transmission principles are the three key parameters offered by Nissenbaum for describing a context in terms of integrity and informational norms. By looking at education as a social domain instantiated in a number of specific contexts, the tools provided by Nissenbaum's privacy theory are well suited to analyze the design space for LA applications, providing privacy is chosen as a key foundation for application development.

## 3 FROM PROBLEMS TO SOLUTIONS: CONSTRUCTING A LEARNING ANALYTICS DESIGN SPACE (LADS) MODEL

This paper will carry out a first development and tentative validation of the LADS model. This research is positioned in the first Relevance Cycle of the three research cycles of Design Science Research (DSR) (Hevner, March, Park, & Ram, 2004; Hevner, 2007), addressing requirements and field-testing. The purpose is to come up with a model that will make the ideas of PbD more relevant for LA solutions promoting data sharing and interoperability. However, the scope of the LADS model is not limited to issues of privacy, control of data and trust. This initial cycle of DSR process focuses on "generating design alternatives and evaluating the alternatives against requirements until a satisfactory design is achieved" (Hevner, 2007, p. 90). In this paper, we do the first design and testing of the LADS model against requirements solicited through community exchange and analysis of cases derived from LA practices. In order to prove the usefulness of the model, rigorous evaluation needs to be done. Some ideas on how this future research could be done are presented in Section 7.

In looking for the low-hanging fruits of LA Interoperability, Hoel and Chen (2014) built on Interoperability and Enterprise Architecture theories and came up with a concept of a solution space. These theories are concerned with how organizations are able to solve problems by communicating and exchanging information, using the information exchanged, and getting access to the functionality of a third system (Chen & Daclin, 2006). The solution space is conceived as a three-dimensional model, describing concerns, barriers, and solutions (Figure 1).

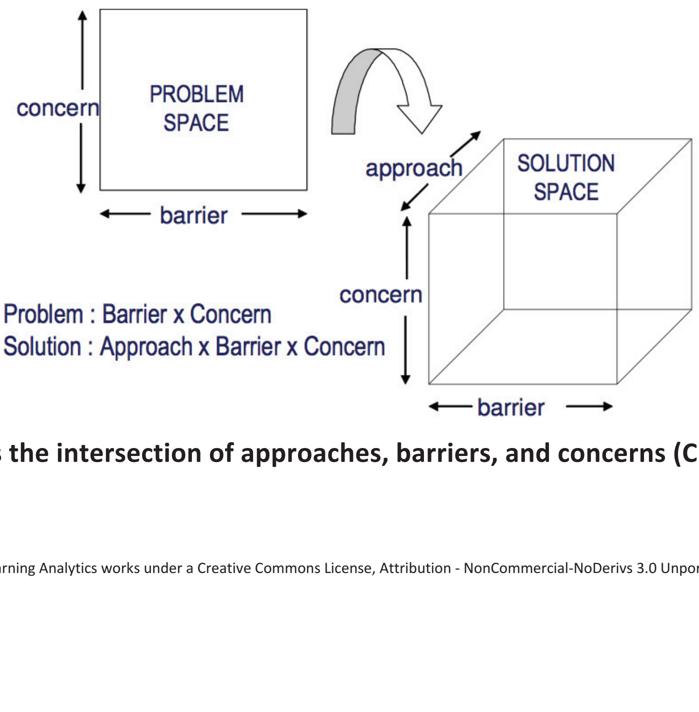


**Figure 1: Solutions as the intersection of approaches, barriers, and concerns (Chen & Daclin, 2006).**

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In this paper, this concept of a solution space is further developed into a LA design space (LADS). It is understood as a range of potential designs that could solve identified LA problems, e.g., those related to privacy, control of data, and trust. These designs are justified according to a design space analysis. MacLean, Yong, Bellotti, and Moran (1991) presented design space analysis as an approach to represent design rationale, focusing on three aspects: questions, options, and criteria. Questions are key issues for structuring the space of alternatives, options are possible alternative answers to the questions, and criteria are the basis for evaluating and choosing among the options.

The LA Design Space model (Figure 2) is based on a three-step process, identifying concerns, barriers, and design solutions. The following walk through the three steps will explain the LADS model.

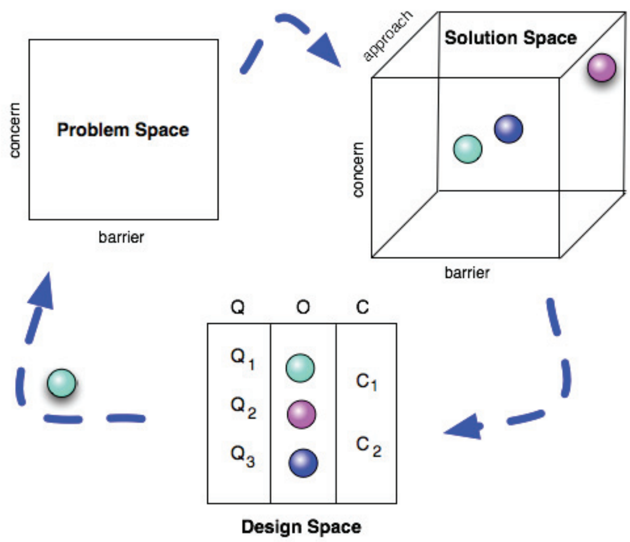


**Figure 2: The Learning Analytics Design Space Model.**

**1. Constructing the problem space:** For this paper, the *concerns* are related to data sharing and interoperability, which revolve around issues of privacy, control of one's own data, and trust in applications and service providers (Hoel & Chen, 2014). The *barriers* related to data sharing and interoperability are part of the challenge of scaling up LA. As Ferguson et al. (2014b) observe, few reports currently exist in the LA literature regarding deployment of scale. Moving from research and pilot environments to large-scale applications could prove difficult due to lack of data for learning analytics (Cooper & Hoel, 2015; Griffiths, Hoel, & Cooper, 2016). For the purpose of this paper we have explored how LA data could be collected (Section 4) to identify barriers and propose solutions.

**2. Constructing the solution space:** Solutions should be developed along many dimensions, (e.g., technical, organizational, legal, or political), trying out both "soft" and "hard" approaches (see Figure 2 where the solutions are represented by coloured dots.)

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**3. Constructing the design space and selecting a first solution:** In the last step, the questions derived from the Problem Space analysis are used to analyze the candidate solutions (in Figure 2, see Option column "O" in Design Space), and criteria (C1 and C2) derived through moving from problem to solution to design. These will be used to select one or more solutions (green dots) for further analysis in a continuous development cycle. For the sake of argument, one solution might be that a "technical fix," e.g., a data-sharing consent dashboard needs to be developed, and that codes of practice and organizational policies were not enough to provide solutions to the identified problems.

In the following section, we will select some data as input for a first demonstration of the viability of the model.

## 4 CASES OF DATA SHARING: ISSUES TO BE ANALYZED USING THE LADS MODEL

In order to conduct a first run through of the model, we will identify concerns and barriers selected from a few cases we have built for this paper exploring which data could be available for learning analytics. After examining different aspects of data sharing in this section, in Section 5 we will use the results as input to see if the LADS model is a viable instrument for analysis.

LA begins and ends with data. Data are generated from learner actions and the contexts of learning; then the analytics produces new data, which is used by follow-up actions and interaction with the learner, which in turn produce new data to feed into the next LA cycle. The data are stored in standardized formats of sorts, and are subject to data clearance procedures following national, institutional, or company rules and regulations.

A study of the data elements of the US Common Education Data (CEDS, 2014) concludes that much of the data residing in Student Management Systems or Learning Activity Record Stores are not imbued with privacy issues raised by the introduction of new LA practices. Of course, there are sensitive issues related to the identification of a person; and the aggregation of disparate data about a person can always be felt as a threat, especially if one loses trust in the system itself. However, these data have been around in education for decades without causing too much concern. It is the learning process data, sitting in the intersection between organizations, people, and learning resources that now have become so much more important.

Process data are, as observed in new LA applications, captured in formats defined in activity stream specifications, e.g., ADL Experience API,[2] Tin-Can,[3] IMS Caliper[4] (Griffiths, Brasher, Clow, Ferguson, & Yuan,

[2] www.adlnet.gov/tla/experience-api
[3] tincanapi.com
[4] www.imsglobal.org/caliper

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2016). These specifications establish a core language to describe activities by providing information on subject, verb, object, context, etc. On top of these core specifications, community profiles provide specialized vocabularies for educational settings like schools, higher education, workplace training, etc. With a powerful and extensible core language one is, in principle, able to describe any activity, which opens up the question of what LA practitioners want to describe.

Ferguson and Buckingham Shum (2012) introduced five categories of analytics that make use of five partly overlapping classes of data:

- **Social network** (analyzes relationships using data about identifiable persons and their activities, e.g., publishing papers, participating in social platforms, etc.)
- **Discourse** (analyzes language as a tool for knowledge negotiation and construction using full-text data from discussion fora, talk, and other written text sources)
- **Content** (analyzes user-generated content using data from Web 2.0 applications)
- **Disposition** (analyzes intrinsic motivations to learn using a range of activity data, in principle generated by all the tools used by the learner)
- **Context** (considers formal and informal learning based on data describing the contexts within which learning happens, e.g., use of tools, educational setting, groups, etc.)

Most of the different types of analytics described by Ferguson and Buckingham Shum (2012) would not be possible without data from social software, also called Web 2.0 applications. With mobile devices now in nearly every student's pocket, use of social media is part of everyday life, including on campus or in the classroom. Even when institutional policies try to restrict their use in formal education settings, social media still pervades the educational space.

Garaizar and Guenaga (2014) explored how HTML5 browser APIs could shed some light on how the use of Web apps in mobile environments has the potential to enhance learning. The APIs allow web pages to make use of data collected by different sensors, e.g., sensors embedded in wearable computers (mobile phones, wristbands, watches, etc.). This opens up a range of new data sources. Table 1 lists the data types used by HTML5 APIs and derives questions as to what pedagogical or learning analytics uses these data types could potentially have.

**Table 1: Data types in HTML5 APIs and their potential use for LA.**

| Data type | Information provided | Potential questions |
|---|---|---|
| Geolocation | Latitude / longitude changes | Is the learner at school or at home? Is she commuting? Where does the learning take place? |
| 3-D Orientation | Acceleration changes | Is the context suitable for learning? |

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| **Data type** | **Information provided** | **Potential questions** |
|---|---|---|
| Battery | Status of battery, charging | Does the battery status affect the learning context? How? |
| Network information | Cost of network access | Does the cost of network access disrupt the learning scenario? How? |
| Offline and online events | Connectivity status | Which problems are caused by the lack of continuity in connectivity? |
| DOM storage: file, indexed database | Local storage | What did the learner do when she was offline? Did it affect the learning process? |
| Ambient light | Light surrounding the learner | Is the learning environment suitable for learning or more suitable for relaxation? |
| Temperature | Temperature around the learner | Is the learning environment suitable for learning? |
| Atmospheric pressure | Height above ground | Is the context suitable for learning? |
| Proximity of objects | | Are learning aids accessible to the learner during work with a particular app? |
| Gestures | Swipe, pinch, twist, etc. | What is the learner focused on? |
| Blood pressure | | What is the physical state of the learner during learning events? |
| Heart beat | | What is the physical state of the learner during learning events? |
| Perspiration | | Is the learner nervous? |
| getUserMedia | Native access to audio and video devices | What is the learner looking at? What is she listening to? How is the learning context in terms of space, luminosity, noise, etc.? |
| WebRTC | Send and receive multimedia between browsers | How can the multimedia streams be collected, stored, analyzed, and enriched in real time? |
| WebVVT | Subtitles and audio descriptions | What is the impact of adding supplementary textual information to multimedia streams? |
| Animations (CSS, SMIL, rAF, SVG, Canvas 2D, WebGL) | Declarative and procedural animations | What is the impact of adding supplementary visual information to multimedia streams? |

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| Data type | Information provided | Potential questions |
|---|---|---|
| Timers (high resolution, user, resource, navigation) | Timestamps per millisecond | How long does it take to perform an action (download a learning activity, render a web app, etc.)? Is the learner multitasking? Is she bored? Is she cheating via automatic responses? |
| DOM 4 mutation observes, drag and drop events, focus | Fine-grained user interactions | Which web controls are easy or hard to use? Which gestures and/or complex interactions are preferred by learners? |
| Page visibility, full screen, pointer lock | Single task / multitask scenarios | Is the learner multitasking? How? When? Do single task / multitask activities enhance learning? |
| History | History of web session | Is the workflow of the learning app appropriate? |

Following the data trail, literally speaking, from the headmaster's filing cabinet to the pocket of the learner has moved our focus of analysis away from the data elements and their potential privacy issues to data in context. Privacy is not a unidimensional concept describing the relationship between the data element and the person about whom this element holds information. By bringing in the context dimension, we see that data belong to more than the person described; it is the characteristics of the setting (context) that impact the privacy concerns.

Exploring these cases of data available for learning analytics, we have shown that the context of formal study or teaching is essential, as it establishes the boundary for what is within or outside the scope of data available for learning analytics. From an institutional perspective, if this boundary is crossed — e.g., by introducing social software services run by a third party — this can only happen by individual consent on a case-by-case basis. From an individual or a third-party perspective, this boundary may be less definitive, which leads to tensions among different stakeholders in the use of LA to support learning. However, the boundaries between formal and informal learning are far from clear, as Malcolm, Hodkinson, and Colley (2003) have demonstrated. They found (*before* social media took off in learning) "a complete lack of agreement in the literature about what informal, non-formal and formal learning are, or what the boundaries between them might be" (Malcolm et al., 2003, p. 313).

The input for constructing the Problem Space is concerns and barriers. The first workshop on LA at ICCE 2014 expanded on the privacy, control, and trust cluster of issues referred to above (Hoel & Chen, 2014), and mapped concerns (Mason, Hoel, & Chen, in press). Some concerns point in the direction of restrictive sharing of data and putting a cap on services that interoperate. However, there are also concerns about not being able to reap all the benefits of LA, understanding and optimizing learning (Duval, 2011). These benefits are directly in the interest of the learner who wishes to be in control of her data. Since we have multiple stakeholders with legitimate interests, the eventual solutions must balance the interests of all parties.

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Concerning barriers, the Educause Center for Applied Research identified four major challenges to achieving success with analytics in higher education: affordability, data, culture, and expertise (Bichsel, 2012). From an institutional perspective, cost is the main obstacle; however, factors like misuse of data, regulations requiring the use of data, inaccurate data, and individual privacy rights are barriers that higher education leaders worry about since they are collecting more data than ever before (Bichsel, 2012).

Hoel, Mason, and Chen (2015) analyzed a corpus of more than 200 questions gathered by the Learning Analytics Community Exchange[5] and found that the discussion on data sharing and big data for education is still in an early stage. Conceptual issues dominate and there is still a long way to go in moving towards solutions for technical development and implementation.

## 5 A FIRST DEMONSTRATION OF THE LEARNING ANALYTICS DESIGN SPACE MODEL

Based on the concerns and barriers derived from the selected cases in Section 4, we construct a Problem Space for LA data sharing. This Problem Space leads to an exploration of solutions, which in turn will be selected as candidates for design.

### 5.1 Building the Problem Space

From a learner's perspective, two concerns are pulling the "data sharing slider" in opposite directions: prioritizing privacy and individual control of data tends to limit data sharing, while wanting to take advantage of the latest personal learning app on the market is an invitation to tick a number of "give-access-to" boxes.

The barriers are related to the concept of a "user in context." Informal and individual learning leaves the decisions of giving access to personal data to the user, and is a matter of the appreciation of benefits, feeling of control, trust in applications, companies, institutions, and so on. In the current situation, individuals seem to be more willing to take risks and go for new and innovative solutions (Xu, Luo, Carroll, & Rosson, 2011). While formal learning is led by institutions wanting to have *ethical use of student data policies* in place, they tend to stay with institutional learning platforms that use only a limited set of data sources for LA. For the institutions, lack of privacy frameworks is a major barrier to data sharing and using sensitive data sources that otherwise are only available to commercial LA providers.

The barriers seem to be more socio-cultural or organizational than technical or legal, to use the European interoperability framework dimensions (IDABC, 2004); however, the solutions will need to address all these interoperability challenges.

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[5] www.laceproject.eu

 

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## 5.2 Building the Solution Space

Solutions are found by addressing the concerns and breaking down the barriers, which in our case we define as being of a technical, socio-cultural, and legal nature. Going for a "radical" alternative, using a variety of data sources and a high degree of data sharing, we can see these tentative solutions based on requirements from the cases discussed in Section 4:

- **Technical:** design a specification allowing users to express detailed conditions for data sharing when signing up for LA applications, with opt-out possibilities
- **Socio-cultural:** boost trust in LA systems, development of privacy declarations, industry labels guaranteeing adherence to privacy standards, and other means of supporting customer dialogue about privacy
- **Legal:** strengthen ownership and control of data from learning activities in national and international law

The next step is to choose one or more of these alternative solutions for design.

## 5.3 Design Space Analysis

Which solution should be focused on? The design space analysis starts with questioning the rationale of a project as a refinement of the problem space analysis. For our purpose, we maintain the ambitious goal of using applications supporting personalized and adaptive learning. Furthermore, we ask, is the solution safe from "losing face" through leakage of personal information? And does the solution support ubiquitous learning by allowing both formal and informal learning in the same application?

The criteria for which options to choose drive the design process based on the identified solutions. The privacy-by-design approach advocated by Nissenbaum (2014) gave priority to the social domain as the context to explore — to see if contextual integrity is maintained when data are shared. Therefore, does the proposed option pass the test of having been subject to an informed public deliberation on the benefits of LA and the consequences of data sharing for the user as well as for the institution, the service provider, and others?

In the case of the *technical solution* proposed above, the design must go beyond a quick technical fix to solve the problem and give the user absolute control. The institution (school or university) should have a say, since it is also responsible for the greater good, the class or group, the parents, and society. Technical solutions should, therefore, include an element of permanent negotiation, thus requiring simple, transparent solutions (Hoel & Chen, 2015). The *legal solution* is also an option but not the first priority. Of course, solutions must have legal backing, but the privacy concerns surrounding data sharing are not solved by legal measures alone. Our analysis points instead to the socio-cultural domain for solutions and design requirements.

A *socio-cultural design solution* must focus on the communication between user and system/service

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provider. Trust is not a "thing" that, negotiated once, lasts forever; it must be renegotiated repeatedly. Especially in a dynamic environment crowded with actors with different interests, large-scale, complex, non-transparent solutions will therefore be challenged. It will be easier to maintain context integrity with smaller solutions. Smaller LA solutions may seem a contradiction in terms, as the ideas of big data and data sharing across systems often lead to plans for large-scale solutions, perhaps with a centralized Learning Record Store or data warehouse aggregating data from a number of systems. Nevertheless, if maintaining trust is pivotal to LA systems in the current stage of development, our design space analysis concludes that the socio-cultural aspects of negotiating access to data should direct the design of technical solutions, legal frameworks, and implementation. With that result of the first design cycle of the LADS model, new concerns and barriers should be mapped in order to arrive, after several iterations, at an implementable design.

**Table 2: Summary of the first iteration of the LADS model.**

| Questions | Solutions | Criteria | Design Solution Candidate |
|---|---|---|---|
| Will student privacy self-management be maintained? | User data sharing consent tool | Promote context integrity | |
| Will privacy in different contexts be respected? | Data sharing dashboard with consent and opt-out mechanisms | Continuous negotiation between learner, institution, and third parties | |
| Will different user groups trust the solutions? | Learner/institution dialogue practices | Avoid obfuscation, promote transparency | Solution that prioritizes the socio-cultural aspects for negotiation of access to data for learning analytics |
| Will the solutions support ubiquitous learning in both formal and informal settings? | Regulation of data ownership and control through law | Harvest low-hanging fruits | |

Table 2 summarizes the first iteration of using the LADS model to form questions and design solutions. This table maps the process illustrated in Figure 2 with examples of problems, solutions, criteria, and a candidate design solution identified for the selected cases in Section 4.

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## 6 DISCUSSION

Educational institutions have always used learner behaviour and performance data to determine, visualize, and sort strengths and weaknesses of individual learners and groups. What is new with LA is the ability to process this information in real time and on demand. Furthermore, LA can go far beyond classroom assessment procedures. By doing so, LA is working with data the learner often does not know are being used (Williamson, 2015). LA can be used to compute the relationships between learners based on their interactions, to compare the commitment of a learner in a course based on time spent on the learning material, or to compare text written by students against pre-existing corpora. Thus, LA affects the privacy rights of learners in a new manner, making it necessary for the learner and the institution to negotiate the boundaries between personal and institutional spaces, between informal and formal learning, and between institutionally provided tools and technology for personal use. As Thomas has argued, "learning spaces have to be planned on the strength that different kinds of learning will only emerge once these spaces are used by students" (Thomas, 2010, p. 508). When "much, if not most, learning does not occur in formally designated learning spaces," it is time to "wrest the locus of control from the traditional conception of learning space planning as the exclusive province of architects and physical facility planners" (Thomas, 2010, pp. 503, 510). This need to re-assess where learning happens is reinforced by the introduction of LA as a support technology. LA is, however, an emerging discipline (Siemens, 2013), and most of the technological ideas are still on the drawing board. Therefore, there is a strong need to *do the right thing* from the outset, to avoid setbacks and the need to correct misconceptions and rebuild trust after privacy collapses.

This paper contributes a conceptual tool to ease the requirement solicitation and design for new LA solutions. A simple model defining a solution as the intersection of an approach, a barrier, and a concern was extended with a process focusing on design justifications to allow for the incremental development of solutions. We used privacy-by-design principles to steer the development of ideas toward solutions; however, other principles could be used to test alternative design solutions, like pedagogical principles focusing on learning efficacy, learner-centred approaches, ubiquitous learning, and so on.

## 7 CONCLUSIONS AND FUTURE RESEARCH

Privacy awareness is reported to be one of the major features of smart LA when researchers summarize their experiences "from the field" (Ebner, Taraghi, & Saranti, 2015). LA is a young field both in research and in application design. New ideas are being launched nearly every day, and there is a need for testing to see if they meet the requirements of different stakeholders. For example, Kennisnet, a Dutch governmental school agency, has chosen PbD principles as a starting point for their new design: "Next, we use the open User Managed Access (UMA) standard. The student, or parent for underage students, has a central place and is the owner of his own educational data" (Bomas, 2014). Will giving students and parents full ownership of their data using the UMA standard benefit educational goals? In order to answer this question, one must analyze how the standard is implemented and how the different concerns are

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addressed.

In this paper, we have proposed the LADS model as a tool to answer such questions. The tool allows users to map the problem space and analyze different solutions according to different criteria. The first tentative validation of the model presented in this paper shows that it has the potential to make a requirement discourse on LA applications more fruitful. However, in order to verify this conclusion, further testing is necessary. The European Learning Analytics Community Exchange (LACE) project has identified privacy and ethics as major themes for community discourse to develop the field of LA. This project will be a suitable testing ground for the LADS model.

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## REFERENCES

ADL (Advanced Distributed Learning). (2015). xAPI specification. *Produced by the Experience API Working Group in support of the Office of the Depute Assistant Secretary of Defense (Readiness) Advanced Distributed Learning Initiative.* Retrieved from https://github.com/adlnet/xAPI-Spec/blob/master/xAPI.md

Aguilar, S. (2014). Perceptions and use of an early warning system during a higher education transition program. *Proceedings of the 4th International Conference on Learning Analytics and Knowledge* (LAK '14), 390–391. http://dx.doi.org/10.1145/2567574.2567625

Arnold, K. E., Lynch, G., Huston, D., Wong, L., Jorn, L., & Olsen, C. W. (2014). Building institutional capacities and competencies for systemic learning analytics initiatives. *Proceedings of the 4th International Conference on Learning Analytics and Knowledge (LAK '14),* 257–260. http://dx.doi.org/10.1145/2567574.2567593

Bichsel, J. (2012). Analytics in higher education: Benefits, barriers, progress, and recommendations. Louisville, CO: EDUCAUSE Center for Applied Research. https://net.educause.edu/ir/library/pdf/ERS1207/ers1207.pdf

Bomas, E. (2014, 29 August). How to give students control of their data. [Web log post] Retrieved from http://www.laceproject.eu/blog/give-students-control-data/

Cavoukian, A. (2012). *Privacy by design: From rhetoric to reality*. Toronto, ON: Information and Privacy Commissioner of Ontario. Retrieved from https://www.ipc.on.ca/images/Resources/PbDBook-From-Rhetoric-to-Reality.pdf

CEDS. (2014). Common education data standards (CEDS): Version 4 data model guide. Retrieved fro https://ceds.ed.gov/

Chen, D., & Daclin, N. (2006). Framework for enterprise interoperability. In *Proceedings of the Workshops and the Doctorial Symposium of the Second IFAC/IFIP I-ESA International Conference: EI2N, WSI, IS-TSPQ.* Retrieved from http://chen33.free.fr/M2/Elearning/CIGI2009.Chen.final.pdf

Cooper, A., & Hoel, T. (2015). Data sharing requirements and roadmap. Public Deliverable D7.2 from the LACE project (European Commission Seventh Framework Programme, grant number 619424).

 

(2016). Privacy-driven design of learning analytics applications: Exploring the design space of solutions for data sharing and interoperability. *Journal of Learning Analytics*, *3*(1), 139–158. http://dx.doi.org/10.18608/jla.2016.31.9

Retrieved from http://www.laceproject.eu/deliverables/d7-2-data-sharing-roadmap/

Dartiguepeyrou, C. (Ed.). (2014). *The futures of privacy*. France: Fondation Télécom, Institut Mines-Télécom. Retrieved from https://www.fondation-telecom.org/wp-content/uploads/2016/01/2014-The-Futures-of-Privacy-.pdf

Drachsler, H., & Greller, W. (2016) Privacy and learning analytics — it's a DELICATE issue: A checklist to establish trusted learning analytics. *Proceedings of the 6th International Conference on Learning Analytics and Knowledge (LAK '16)*, 89-98. http://dx.doi.org/10.1145/2883851.2883893

Drachsler, H., Hoel, T., Greller, W., Kickmeier-Rust, M., Steiner, C., & Griffiths, D. (2016) Ethics and privacy for learning analytics: A review of current issues and their solutions. Retrieved from LACE project website http://www.laceproject.eu/

Drachsler, H., Hoel, T., Scheffel, M., Kismihók, G., Berg, A., Ferguson, R., Chen, W., Cooper, A., & Manderveld, J. (2015a). Ethical and privacy issues in the application of learning analytics. *Proceedings of the 5th International Conference on Learning Analytics and Knowledge (LAK '15),* 390–391. http://dx.doi.org/10.1145/2723576.2723642

Drachsler, H., Dietze, S., Herder, E., d'Aquin, M., Taibi, D., & Scheffel, M. (2015b) The 3rd LAK data competition. *Proceedings of the 5th International Conference on Learning Analytics and Knowledge* (LAK '15), 396–397. http://dx.doi.org/10.1145/2723576.2723641

Drachsler, H., Stoyanov, S., & Specht, M. (2014a). The impact of learning analytics on the Dutch education system. *Proceedings of the 4th International Conference on Learning Analytics and Knowledge* (LAK '14), 158–162. http://dx.doi.org/10.1145/2567574.2567617

Drachsler, H., Dietze, S., Herder, E., d'Aquin, M., & Taibi, D. (2014b). The learning analytics & knowledge (LAK) data challenge 2014. *Proceedings of the 4th International Conference on Learning Analytics and Knowledge (LAK '14),* 289–290. http://dx.doi.org/10.1145/2567574.2567630

Duval, E. (2011). Attention please!: Learning analytics for visualization and recommendation. *Proceedings of the 1st International Conference on Learning Analytics and Knowledge (LAK '11*), 9–17. http://dx.doi.org/10.1145/2090116.2090118

Ebner, M., Taraghi, B., & Saranti, A. (2015). Seven features of smart learning analytics: Lessons learned from four years of research with learning analytics. *eLearning Papers*, 40. Retrieved from http://www.openeducationeuropa.eu/en/article/Seven-features-of-smart-learning-analytics----lessons-learned-from-four-years-of-research-with-learning-analytics-

EC (European Commission). (2012). *Proposal for a Regulation of the European Parliament and of the Council on the protection of individuals with regard to the processing of personal data and on the free movement of such data (General Data Protection Regulation)* COM(2012)11 Final.

Council Directive 95/46/EC on the protection of individuals with regard to the processing of personal data and on the free movement of such data [1995] OJ L 281/31

Ferguson, R., & Buckingham Shum, S. (2012). Social learning analytics: Five approaches. *Proceedings of the 2nd International Conference on Learning Analytics and Knowledge (LAK '12),* 23–33. http://dx.doi.org/10.1145/2330601.2330616

Ferguson, R., Cooper, A., Drachsler, H., Kismihók, G., Boyer, A., Tammets, K., & Martínez Monés, A. (2015). Learning analytics: European perspectives. *Proceedings of the 5th International Conference on Learning Analytics and Knowledge (LAK '15),* 69–72. http://dx.doi.org/10.1145/2723576.2723637

Ferguson, R., De Liddo, D., Whitelock, D., de Laat, M., & Buckingham Shum, S. (2014a). DCLA14: Second international workshop on discourse-centric learning analytics. *Proceedings of the 4th International Conference on Learning Analytics and Knowledge (LAK '14),* 283–284. http://dx.doi.org/10.1145/2567574.2567631

(2016). Privacy-driven design of learning analytics applications: Exploring the design space of solutions for data sharing and interoperability. *Journal of Learning Analytics*, *3*(1), 139–158. http://dx.doi.org/10.18608/jla.2016.31.9

Ferguson, R., Clow, D., Macfadyen, L., Essa, A., Dawson, S., & Alexander, S. (2014b). Setting learning analytics in context: Overcoming the barriers to large-scale adoption. *Proceedings of the 4th International Conference on Learning Analytics and Knowledge (LAK '14*), 251–253. http://dx.doi.org/10.1145/2567574.2567592

Federal Trade Commission (FTC). (2012). *Protecting consumer privacy in an era of rapid change: Recommendations for businesses and policymakers*. Retrieved from the Federal Trade Commission website http://www.ftc.gov/reports/protecting-consumer-privacy-era-rapid-change-recommendations-businesses-policymakers

Garaizar, P., & Guenaga, M. (2014). A multimodal learning analytics view of HTML5 APIs: Technical benefits and privacy risks. *Proceedings of the 2nd International Conference on Technological Ecosystems for Enhancing Multiculturality* (TEEM '14) (pp. 275–281). New York: ACM. http://dx.doi.org/10.1145/2669711.2669911

Griffiths, D., Brasher, A., Clow, D., Ferguson, R., & Yuan, L. (2016). "Visions of the Future," Horizon Report. Public Deliverable D3.2. LACE Project. Retrieved from http://www.laceproject.eu/wp-content/uploads/2016/02/LACE_D3_2.pdf

Griffiths, D., Hoel, T., & Cooper, A. (2016). *Learning analytics interoperability: Requirements, specifications and adoption.* Public Deliverable D7.4. LACE Project (European Commission Seventh Framework Programme, grant number 619424). Retrieved from http://www.laceproject.eu/d7-4-learning-analytics-interoperability-requirements-specifications-and-adoption/

Heath, J. (2014). Contemporary privacy theory contributions to learning analytics. *Journal of Learning Analytics, 1*(1). Retrieved from https://epress.lib.uts.edu.au/journals/index.php/JLA/article/view/3339

Hevner, A. (2007). A three cycle view of design science research. *Scandinavian Journal of Information Systems, 19*(2), 87–92 (article 4).

Hevner, A., March, S. T., Park, J., & Ram, S. (2004). Design science in information systems research. *Mis Quarterly, 28*(1), 75–105.

Hoel, T., & Chen, W. (2014). Learning analytics interoperability: Looking for low-hanging fruits. In C.-C. Liu et al. (Eds.), *Proceedings of the 22nd International Conference on Computers in Education* (ICCE 2014) (pp. 253–264). Japan: Asia-Pacific Society for Computers in Education.

Hoel, T., & Chen, W. (2015). Privacy in learning analytics: Implications for system architecture. In T. Watanabe & K. Seta (Eds.), *Theory and Practice for Knowledge Management: Proceedings of the 11th International Conference on Knowledge Management* (ICKM 2015). Retrieved from http://hoel.nu/publications/Hoel_Chen_ICKM15_final_preprint.pdf

Hoel, T., Chen, W., & Cho, Y.-S. (2016). *Privacy requirements for learning analytics: From policies to technical solutions.* Paper presented at the Workshop on Ethics and Privacy for Learning Analytics at the 6th International Conference on Learning Analytics and Knowledge (LAK '16), 25 April, Edinburgh, UK.

Hoel, T., Mason, J., & Chen, W. (2015) Data sharing for learning analytics: Questioning the risks and benefits. In H. Ogata et al. (Eds.), *Proceedings of the 23rd International Conference on Computers in Education* (ICCE 2015). Asia-Pacific Society for Computers in Education. Retrieved from http://hoel.nu/publications/ICCE2015_Hoel_Mason_Chen_final.pdf

IDABC. (2004). *European interoperability framework for pan-European eGovernment services*. *Version 1.0.* Luxembourg: Office for Official Publications of the European Communities. Retrieved from http://ec.europa.eu/idabc/servlets/Docd552.pdf?id=19529

IMS Global. (2015). *Caliper Analytics™ Background*. Retrieved from the website of IMS Global Learning Consortium http://www.imsglobal.org/activity/caliperram

(2016). Privacy-driven design of learning analytics applications: Exploring the design space of solutions for data sharing and interoperability. *Journal of Learning Analytics*, *3*(1), 139–158. http://dx.doi.org/10.18608/jla.2016.31.9


Johnson, L., Adams Becker, S., Cummins, M., Estrada, V., Freeman, A., & Hall, C. (2016). *NMC Horizon Report: 2016 Higher Education Edition*. Austin, Texas: The New Media Consortium. Retrieved from http://cdn.nmc.org/media/2016-nmc-horizon-report-he-EN.pdf

Johnson, L., Adams Becker, S., Estrada, V., & Freeman, A. (2014a). *NMC Horizon Report: 2014 Higher Education Edition*. Austin, Texas: The New Media Consortium. Retrieved from http://www.nmc.org/pdf/2014-nmc-horizon-report-he-EN.pdf

Johnson, L., Adams Becker, S., Estrada, V., & Freeman, A. (2014b). *NMC Horizon Report: 2014 K–12 Edition*. Austin, Texas: The New Media Consortium. Retrieved from http://cdn.nmc.org/media/2014-nmc-horizon-report-k12-EN.pdf

Kitto, K., Cross, S., Waters, Z., & Lupton, M. (2015). Learning analytics beyond the LMS: The connected learning analytics toolkit. *Proceedings of the 5th International Conference on Learning Analytics and Knowledge* (LAK '15), 11–15. http://dx.doi.org/10.1145/2723576.2723627

MacLean, A., Yong, R. M., Bellotti, V. M. E., & Moran, T. P. (1991). Questions, options, and criteria: Elements of design space analysis. *Human–Computer Interaction, 6*, 201–250. http://dx.doi.org/10.1207/s15327051hci0603&4_2

Malcolm, J., Hodkinson, P., & Colley, H. (2003). The interrelationships between informal and formal learning. *Journal of Workplace Learning, 15*(7/8), 313–318. http://dx.doi.org/10.1108/13665620310504783

Martinez-Maldonado, R., Pardo, A., Mirriahi, N., Yacef, K., Kay, J., & Clayphan, A. (2015). The LATUX workflow: Designing and deploying awareness tools in technology-enabled learning settings. *Proceedings of the 5th International Conference on Learning Analytics and Knowledge* (LAK '15), 1–10. http://dx.doi.org/10.1145/2723576.2723583

Mason, J., Hoel, T., & Chen, W. (in press). Questions as data: Illuminating the potential of learning analytics through questioning an emergent field. Accepted for publication in *Research and Practice in Technology Enhanced Learning*.

Nissenbaum, H. (2014). Respect for context as a benchmark for privacy online: What it is and isn't. In C. Dartiguepeyrou (Ed.), *The futures of privacy* (pp. 19–30). France: Fondation Télécom, Institut Mines-Télécom. Retrieved from https://www.fondation-telecom.org/wp-content/uploads/2016/01/2014-The-Futures-of-Privacy-.pdf

Piety, P. J., Hickey, D. T., & Bishop, M. J. (2014). Educational data sciences: Framing emergent practices for analytics of learning, organizations, and systems. *Proceedings of the 4th International Conference on Learning Analytics and Knowledge* (LAK '14), 193–202. http://dx.doi.org/10.1145/2567574.2567582

Pardo, A., & Siemens, G. (2014). Ethical and privacy principles for learning analytics. *British Journal of Educational Technology*, *45*, 438–450. http://dx.doi.org/10.1111/bjet.12152

Prinsloo, P., & Slade, S. (2015). Student privacy self-management: Implications for learning analytics. *Proceedings of the 5th International Conference on Learning Analytics and Knowledge (LAK '15),* 83–92. http://dx.doi.org/10.1145/2723576.2723585

Scheffel, M., Drachsler, H., Stoyanov, S., & Specht, M. (2014). Quality indicators for learning analytics. *Educational Technology & Society, 17*(4), 117–132.

Scheffel, M., Drachsler, H., & Specht, M. (2015) Developing an evaluation framework of quality indicators for learning analytics. *Proceedings of the 5th International Conference on Learning Analytics and Knowledge (LAK '15),* 16–20. http://dx.doi.org/10.1145/2723576.2723629

Sclater, N. (2016) Developing a code of practice for learning analytics. *Journal of Learning Analytics, 3*(1), 16—42. http://dx.doi.org/10.18608/jla.2016.31.3

Singer, N. (2014, 21 April). InBloom student data repository to close. *New York Times*. Retrieved from

(2016). Privacy-driven design of learning analytics applications: Exploring the design space of solutions for data sharing and interoperability. *Journal of Learning Analytics*, *3*(1), 139–158. http://dx.doi.org/10.18608/jla.2016.31.9

http://bits.blogs.nytimes.com/2014/04/21/inbloom-student-data-repository-to-close

Sekiya, T., Matsuda, Y., & Yamaguchi, K. (2015). Curriculum analysis of CS departments based on CS2013 by simplified, supervised LDA. *Proceedings of the 5th International Conference on Learning Analytics and Knowledge (LAK '15*), 330–339. http://dx.doi.org/10.1145/2723576.2723594

Siemens, G. (2013). Learning analytics: The emergence of a discipline. *American Behavioral Scientist, 57*(10), 1380–1400. http://dx.doi.org/10.1177/0002764213498851

Swenson, J. (2014). Establishing an ethical literacy for learning analytics. *Proceedings of the 4th International Conference on Learning Analytics and Knowledge (LAK '14),* 246–250. http://dx.doi.org/10.1145/2567574.2567613

Thomas, H. (2010). Learning spaces, learning environments and the dis'placement' of learning. *British Journal of Educational Technology, 41*(3), 502–511. http://dx.doi.org/10.1111/j.1467-8535.2009.00974.x

Vogelsang, T., & Ruppertz, L. (2015). On the validity of peer grading and a cloud teaching assistant system. *Proceedings of the 5th International Conference on Learning Analytics and Knowledge (LAK '15),* 41–50. http://dx.doi.org/10.1145/2723576.2723633

Wang, Y., Heffernan, N. T., & Heffernan, C. (2015). Towards better affect detectors: Effect of missing skills, class features and common wrong answers. *Proceedings of the 5th International Conference on Learning Analytics and Knowledge (LAK '15).* 31–35. http://dx.doi.org/10.1145/2723576.2723618

Williamson, B. (2015). Digital education governance: Data visualization, predictive analytics, and "real-time" policy instruments. *Journal of Education Policy, 31*(2), 123–141. http://dx.doi.org/10.1080/02680939.2015.1035758

Willis, J. E., Campbell, J., & Pistilli, M. (2013, 6 May). Ethics, big data, and analytics: A model for application. *Educause Review*. Retrieved from http://www.educause.edu/ero/article/ethics-big-data-and-analytics-model-application

Xu, H., Luo, X. R., Carroll, J. M., & Rosson, M. B. (2011). The personalization privacy paradox: An exploratory study of decision making process for location-aware marketing. *Decision Support Systems, 51*(1), 42–52. http://dx.doi.org/10.1016/j.dss.2010.11.017

# V

# PRIVACY IN LEARNING ANALYTICS – IMPLICATIONS FOR SYSTEM ARCHITECTURE

by

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# Privacy in Learning Analytics – Implications for System Architecture

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**Abstract:** This paper explores the field of ICT standardisation related to learning analytics, a new class of technologies being introduced to schools, universities and further education as a consequence of increased access to data from learning activities. Learning analytics has implication for how the individual manages data and knowledge about herself and her learning, highlighting issues of privacy, ownership of data, and consent to share and use data, – issues that are not yet been fully discussed in the field of learning technology development in general, and standardisation of learning technologies in particular. What do these issues mean for standardisation and design of LA architectures? Based on requirements of open architecture, transparency and trust, and ownership and consent this paper proposes a search architecture for learning analytics based on open and linked data. The proposed middle layer highlights dynamic usage agreements and student agency and represents an alternative approach to the LA architectures now being developed in international standardisation fora.

**Keywords**: Learning analytics, data sharing, interoperability, privacy, data ownership and consent, standardisation

## 1. Introduction

Unveiling and contextualising information so far hidden in different educational data in order to analyse it and present it for different stakeholders, – this is the promise of learning analytics (LA) according to Greller and Drachsler (2012). LA will offer new insights for learners and improve effectiveness and efficiency for institutions. "This new kind of information can support individual learning processes but also organisational knowledge management processes" (Greller & Drachsler, 2012). Ambitious to harness the new capabilities of "big data" in education it is easy to forget that when translating education into numbers one "makes education actionable through the production and stabilization of specific kinds of views of what education and learning should be" (Williamson, 2015). Once, however, this political or normative aspect of learning analytics is out in the open teachers, parents and the learners themselves will start asking questions on what happens when they start sharing data. This will introduce new requirements for design of LA technologies.

More and more of the forces that create global change are driven by data, and based on new practices of sharing data, e.g., mobile devices, social media, big data, sensors, and location-based services (Scoble & Israel, 2013). These services are also exploited in education, and thus data mining and learning analytics are topics that start to appear on the agenda of standards organisations dealing with ICT for learning, education and training. ISO/IEC JTC 1/SC36[1] has established a new working group on learning analytics, which met for the first time in June 2015 in Rouen, France. In addition, a number of initiatives work towards defining learning analytics architectures, e.g., industry consortia like Apereo,[2] and IMS Global[3]; and government agencies like UK Jisc, Keris of Korea, or country initiatives like one found in Estonia. These architectures are ranging from high-level description of

1 www.iso.org/iso/iso_technical_committee%3Fcommid%3D45392

2 www.apereo.org

3 www.imsglobal.org

LA systems to reference implementations of running code. Till now, requirements raised by data sharing are not brought into the center of interest for LA standardisation (Cooper & Hoel, 2015)

Data sharing, understood as the release of data for use by others, i.e., other persons or organisations (Cooper & Hoel, 2015), is needed by many applications of learning analytics. Data from more than one source are needed to realise the potential of LA. For example, large-scale data is often a prerequisite for educational data mining techniques or multi-variate statistics. Alternatively, it is usually the case that the data required to undertake learning analytics resides in different software systems, and that data from a variety of different sources is vital. Although the data from an institutional learning platform or a MOOC may be considered large and varied, the scale and coverage of such datasets may be insufficient to give good analytics because of the great variety of learner and contextual attributes (Verbert et al., 2011). This challenge applies to both learning science research and to potential products and services built around data generated during learning activities. This situation motivates the idea that data sharing between organisations - potentially including public and private sector bodies - is an important enabler for effective learning analytics. Data sharing is also indicated by Cloud Computing models of service and IT provision, where expertise or technology is provided by a separate organisation to the education provider.

The requirements for data sharing set educational establishments apart from archetypical Big Data corporations like a retail store or a online shop. Work in the European LA community exchange project LACE[4] has shown that these requirements to a large extent are related to concerns about data protection, privacy and ethics, data control, and trust. These legal and organisational issues have traditionally played a minor role in international standardisation work within the field of learning technologies, where technical and semantic interoperability have dominated.

In this paper requirements of legal, organisational and semantic-technical nature are explored to see what implications they will have for design of LA architectures. The paper builds on current work within the community of LA researchers and stakeholders, particularly the work of the European coordination and support action project, LACE. Based on the legal and organisational requirements so far identified, what would be the technical-semantic design options that could be pursued for standardisation?

The rest of this paper is organised as follows: First, a review of recent research on the effects of extensive data sharing for LA is presented. Then three sets of requirements are derived and used for evaluating current LA architecture proposals and to develop a new proposition for a new middle layer bridging between data sources and LA processes. This first explorative proposal is discussed, and the paper concludes with some reflection how this work should be progressed and could contribute to current standardisation in the field of LA.

## 2. Related work

In absence of clear evidence of the benefits of learning analytics there is a growing body of research pointing to the possibility of adverse effects of extensive use of data from multiple sources for analytics. The concerns are centered around student vulnerability (Slade & Prinsloo, 2013; Prinsloo & Slade, 2013) and different aspects of privacy, data protection, and ownership to data (Hoel et al., 2015; Cooper & Hoel, 2015).

Prinsloo and Slade (2015) suggest using student vulnerability as a lens for analysis, stating that "[t]hrough the quantification practices in higher education, students' vulnerability is increased when they see themselves, their potential and their futures, as presented in the number of clicks, logins, time-on-task". Prinsloo and Slade (2105) maintain that we are more than our data, and therefore we need to take into account the contexts in which numbers are created. They want to strengthen the student agency and have suggested a framework to mitigate the student vulnerability and optimise student agency, including the duty of reciprocal care; the contextual integrity of privacy and data; the centrality of student agency and privacy self-management; the need to rethink consent and employing nudges; developing partial privacy self-management; adjusting privacy's timing and

4 www.laceproject.eu

focus; and moving toward substance over neutrality and moving from quantified selves to qualified (Prinsloo & Slade, 2015).

In focussing on vulnerability and student agency when looking at the individual, and education as a moral practice when looking at the institution (Jisc, 2015) it becomes clear that we have to go beyond binary solutions to the issues of privacy, data protection, consent to give access to data, etc. It is not about ticking a box to give consent to use or not to use one's data. It is not about privacy as having or not having control of data, or secrecy or not secrecy.

Borocas and Nissenbaum (2015) understand informed consent as a limited waiver of rights and obligations. They state "[i]t is time for the background of rights, obligations, and legitimate expectations to be explored and enriched so that notice and consent can do the work for which it is best suited" (Borocas & Nissenbaum, 2015). It is not the case that privacy is an "unsustainable constraint if we are to benefit, truly, from big data" (Borocas & Nissenbaum, 2015). However, privacy needs to be seen in the right context. "[C]onsent is not required for acceptable, expected behaviors, but only for those that departs from it. The burden on notice, therefore, is to describe clearly the violations of norms, standards, and expectations for which a waiver is being asked and not to describe everything that will be done and not done in the course of treatment or research…(…) Where, for example, anonymizing data, adopting pseudonyms, or granting or withholding consent makes no difference to outcomes for an individual, we had better be sure that the outcomes in question can be defended as morally and politically legitimate. When anonymity and consent do make a difference, we learn from the domain of scientific integrity that simply because someone is anonymous or pseudonymous or has consented does not by itself legitimate the action in question" (Borocas & Nissenbaum, 2015).

Xu (2011) has developed a privacy framework based on privacy literature, bounded rationality theory, control agency theory, and social contract theory. The goal of the framework is to provide understanding of the major drivers and impediments of information disclosure in the context of online social networks. It has been shown that individuals express privacy worries but behave in ways that contradict their statements. The phenomenon is called the privacy paradox, and is another reason why there is a need to move beyond control and access as lenses to understand privacy, and look more towards the context integrity perspective on privacy. It is noted that Xu bases his framework (Figure 1) on the dialectics between privacy as control vs privacy as restricted access. However, he applies several theoretical lenses. "[A]n individual's perceived privacy is (..) viewed as perceived control over information release and perceived ease of information access, with the considerations of optimistic bias. (…) Users may genuinely want to protect their personal data, but because of bounded rationality, rather than carefully calculating long-term risks of information disclosure, they may opt for immediate gratification instead" (Xu, 2011).

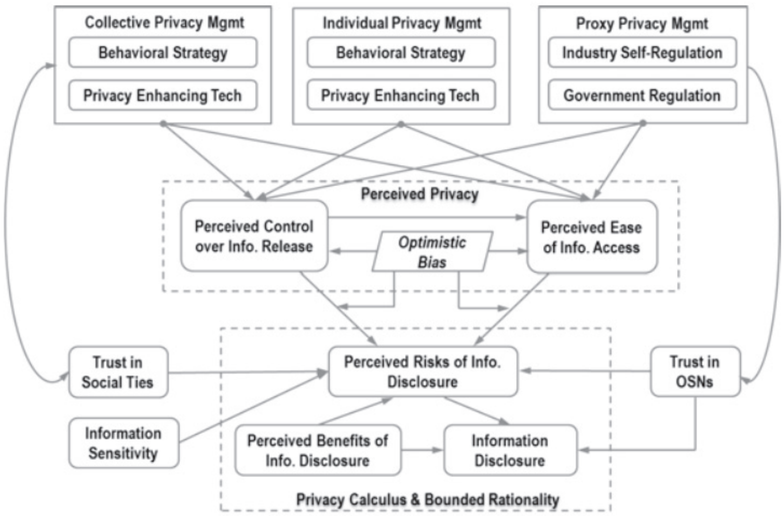


**Figure 1.** Proposed theoretical framework for Privacy 2.0 by Xu (2011)

A report on Data Sharing Requirements and Roadmap by the LACE project (Cooper & Hoel, 2015) grouped the concerns related to data sharing according to the interoperability levels defined in the European Interoperability Framework (European Commission, 2010): *Legal issues:* Lack of awareness of what is possible within the law, National differences, and Current legislation is out of date; *Organisational issues:* Privacy, and Inadequate decision-maker knowledge; *Technical and semantic issues:* Incompatible technical implementations, Inappropriate architectural assumptions, Inadequate domain-level semantic models, and Lack of adoption of existing specifications.

Based on this problem space Cooper and Hoel (2015) recommend that these activities could be undertaken: *Legal Issues:* Raise awareness of what is possible within the law; *Organisational issues:* Anonymisation and statistical disclosure control, Analytics models as shared data, Remote access analytics, Trusted data analysis, User-managed access, Common codes of practice and standardised data agreements, and Develop understanding and consensus around risk-based approaches to privacy protection; *Technical and semantic issues:* Shared open architectures and common frameworks, Code-bashes (plugfests) - addressing mid-level practical interoperability, and Practice-oriented pre-standardisation at the domain-level.

The roadmap of activities towards solutions developed by Cooper and Hoel (2015) is very high level and gives limited directions for design. Furthermore, it is not clear how legal and organisational concerns are turned into requirements for technical-semantic design. It is therefore useful to look further into the case studies Cooper and Hoel used to come up with these recommendations, in order to see if more concrete requirements could be derived from their data.

Through community engagement supported by LACE project and other actors a great number of questions and concerns related to LA are collected (Cooper & Hoel, 2015). Hoel et al. (2015) analysed 220 questions to see how the captured concerns could be understood in terms of propositions for solutions. They found that "Technical requirements were not explicitly stated in any of the 220 questions, and the need for technical alignment was only indirectly present (…) Most clearly, technical solutions are needed for exchange of information about ownership to data. Also the idea of learning as a risk-based activity offers technical design challenges" (Hoel et al., 2015).

Ownership and control of data, – a complex set of issues that relate data used for analytics to the individual is identified by Hoel et al. (2015) as the most prominent challenge to solve, also for technical-semantic design.

One idea for technical solutions could be gleaned from a case study in this LACE report (Cooper & Hoel, 2015), which describes a Norwegian pilot of a cross-sector service platform brokering between services and systems that have information about users and a range of specialised educational services, some of which could be dealing with learning analytics. The service providers connect to and retrieve information through standardised APIs, while the end users of the services are authenticated through a national identity management service.

### *2.1. Research Questions refined*

At the current state of development of LA solutions, issues of legal, organisational and technical-semantic nature seem to be interwoven, justifying actions on all levels of interoperability. Traditionally, the LET standards community has been grappling with questions of systems interoperability, content repositories and learning objects. Data-driven education where data about learning activities are a learning resource in its own right makes it pressing to solve issues on legal and organisational levels. The technical-semantic challenges, however, remain. This paper explores what it means for technical-semantic interoperability within the field of LA when privacy requirements, or more widely, legal and organizational challenges, are translated into technical solutions.

Methodologically, this research is positioned in the first Relevance Cycle of the three research cycles of Design Science (Hevner, 2004; 2007), addressing requirements and field testing. The purpose is to come up with candidate concepts that describe the problems and opportunities in the application domain from a people, organisational systems, and technical systems perspective.

## 3. Requirements

Community exchange among stakeholders of LA technologies gives a clear indication that the interoperability issues that need to be tackled first are not of technical nature but related to legal and organisational challenges. Alignments of legal practices and codes of ethics may seem abstract and bound to cultural, legal and organisational systems; however, alignment processes involve exchange of information, which offers challenges of technical and architectural nature. It is important to specify these technical systems considering the full range of requirements, as recent history has shown that ill designed systems could prove fatal for the success of new LA approaches (Cooper & Hoel, 2015, section 3.8).

The following requirements are derived from issues identified through desk research and LA community exchange:

**Open architecture:** Learning analytics components may be developed as proprietary or open source, however, the architecture itself should be developed using open standards and open solutions. There are several technical and economic reasons for this, like making it easier to achieve a critical mass of multiple products fitting the architecture; flexibility for institutions in selecting components without having to invest in a single large monolithic system, etc. However, one should also acknowledge that an open architecture would make it easier to achieve data sharing and develop trust between different stakeholders based on transparency, another main requirement highlighted in this study.

**Transparency and Trust:** This cluster of requirements is supported by a wide range of non-technical features like codes of practice; competency development; open research practices sharing research results and data, publishing predictive models; etc. However, quite a few of these measures can and should be supported by technical solutions being an integral part of LA systems.

**Ownership and consent:** Even if data could be harvested through institutional practices assuming implicit consent to data sharing as the learners sign up for courses and enroll in a study, in the end, the question of access to data always comes back to the individual and her willingness to share. These requirements build on the 'context integrity' perspective on privacy developed by Nissenbaum (2009). From this perspective questions of ownership and consent are not to be dealt with once and for all when students register to a course; it is a matter of maintaining a continuous conversation on privacy issues making sure that the student actively and at all times agrees to share data for different types of analytics, and that the institution is able to justify its learning analytics research and interventions. Most ICT systems have some kind of identity management solutions, however, their scope is often only simple authentication and authorisation. There is a need to rethink how ownership and consent features could be embedded in these solutions.

## 4. Towards Design Propositions

Several architectures have been proposed for learning analytics. In 2011 an Open Learning Analytics Architecture (OLA) was proposed by Siemens et al. (2011). The Apereo Learning Analytics Initiative has developed a set of interlocking pieces of open source learning analytics software described in their LA Dimond model (Figure 2). However, a mature conceptual framework supported by a fully functional end-to-end reference implementation has yet to fully emerge (Sclater et al., 2015).

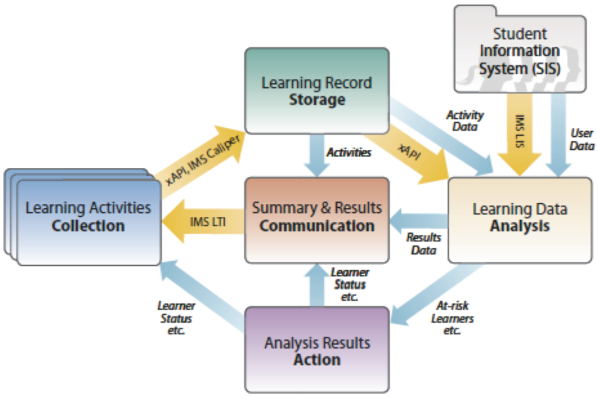


**Figure 2**. Apereo diamond model of an open learning analytics architecture (Siemens et al., 2011)

Jisc, a UK based public body, has attempted to conceptualise an end-to-end basic learning analytics system, which is now procured for higher education. Data comes primarily from the student record system, the virtual learning environment (VLE or learning management system) and a variety of library systems. Institutions are also beginning to use data from other systems such as attendance monitoring and assessment systems (Cooper & Hoel, 2015).

While the Apereo model (Figure 2) is silent about student ownership of data and consent to share it is interesting to observe that the Jisc model has defined a Consent Platform with a Student Consent Service, logging self-declared data (Sclater et al., 2015). This part of the Jisc system has still to be designed. It is also interesting to note that when Jisc in beginning of 2015 tried to procure the development of this service no suppliers came forward, and the Student Consent Service therefore will be developed in-house (Sclater, 2015).

In the architectures described in Figure 2 and by Jisc the data end up in a Learning Records Store hosted locally or most probably in the cloud as Software as a Service. Access to this Learning Records Warehouse is provided though an Authentication and Authorisation service giving access to the Access API or direct access through queries. It is natural to think of access policies as a function of being member of groups, e.g., class, course, educational role, etc., not as a function of a more dynamic negotiation about the purpose of the analysis and the pedagogical and cultural context of the learning taking place. In order to foreground both student and institutional agencies, and to put emphasis on contextual and temporal aspects of data access this paper suggests to explore a linked and open data approach to learning analytics systems, lifting the access negotiation into a search middle layer. This middle layer will dynamically give access to search capabilities depending on a number of rule sets developed by the key stakeholders of learning analytics.

The architecture described in Figure 3 is based on open and linked data being exposed by institutions, vendors, local authorities and other players (also individual students) with access to data relevant for learning analytics. These actors may have their own fully functional LA systems, but also having interest in getting access to richer datasets by taking part in a data exchange system based on open data. Therefore, they publish parts of their data as open and linked data, making sure that different approaches to anonymisation are followed. Anonymisation is not a panacea, and as the risk of re-identification is growing the more datasets are combined it is necessary to introduce some access control also to search of the 'open data' being exposed in this architecture. The organisations (and individuals) contributing data and stakeholders representing users, vendors and other parties using the LA system enter Usage Agreements regulating who has access to the Search Process and how this process is to be carried out. The Search Process Rules govern who gets access to the Ontologies that enable meaningful search. The Search Process also fires off post-search actions defined in the Search Process Rules, which aim is to enhance and maintain the legitimacy of the data sharing and search process.

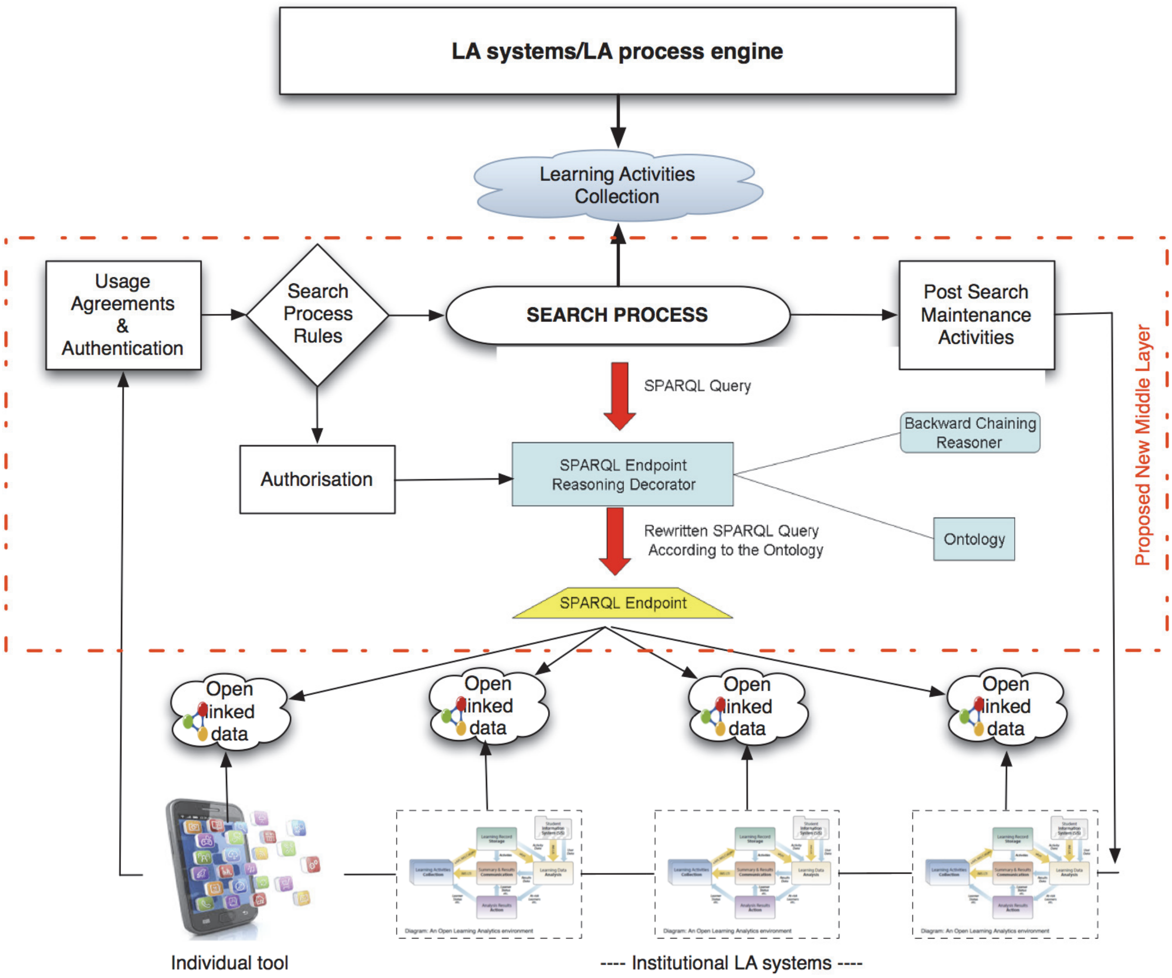


**Figure 3.** Search architecture for learning analytics based on open and linked data

The result of the search is sent to a Learning Activities Collection that feeds the processes of learning analysis, communication and intervention described in Figure 2 or similar architectures. However, this paper does not describe how the Search process defined in this middle layer, is used by learners, teachers, and institutions for analytics. The model should be further specified in order to show how different end-users initiate search.

The main contribution of this proposal is the design of a Usage Agreements and Post Search Maintenance Activities. Both constructs need to be further developed, based on these and other ideas:

- The middle layer described in Figure 3 is dynamic, i.e., Post Search Activities will feed back to Usage Agreements and Search Process Rules through active stakeholder participation.
- The end users of learning analytics, primarily students and teachers are (also) initiating search, and therefore taking part in the search process improvement loop.
- Usage agreements should be built through interaction with the data subjects.
- Learners and teachers should through Post Search Activities be able to learn more about how the data are shared and used so they can contribute to improved privacy and data protection.

## 5. Discussion

The aim of the proposed LA Search Architecture is to strengthen student agency and institutional dialogue related to data sharing for learning analytics. The architecture is built on top of existing and more monolithic systems, and it is up to each data store manager to expose their data as open and linked data, and to be part in a LA Search Agreement. The student should also be able to share from social media, mobile apps and other tools if found useful for learning. In preparation for exposure of one's data as open and linked data the data owner will have to revisit the data structure of the different data sets in order to select which data fields to expose, which anonymisation technology to use, and how to supplement the datasets with a shared ontology to enable intelligent search. (If the data owner is a student using an app or a small enterprise with a new LA solution it is clear that this process is complicated and will need both organisational support and tools.) It is these authors' hypothesis that this preparation for data sharing together with an emphasis on privacy and ownership of data in the Usage Agreements and Post Search Activities will lead to more targeted and pedagogically motivated data sharing, perhaps with a more local scope and limited time range. A focus on consent for use and clear purpose for use will counteract the tendency to keep all activity data from most systems in store for an indefinite period of time, just because it is possible to do so of technological and economical reasons.

The idea of exposing learning activity data as open data is interesting because it will lead to a much needed discourse on what types of data it is advisable to share within the educational domain. When the access rules are separated from the data warehousing it creates a pressure on the data owners to select data sources with care. Furthermore, more open data on learning activities might boost innovation in learning analytics as more actors would be able to join the data sharing community.

Usage Agreements needs to be set up through negotiations that are balanced in terms of who controls access to data. Even if one recognises "the centrality of student agency and privacy self-management" (Prinsloo & Slade, 2015) one has to leave space for the institution to follow its business interests and be able to use the data that is solicited to support learning and teaching. The only way to get the balance right is through open negotiations, accountability and transparency. If one sees this as a negotiated balance it is clear that the tipping point can change over time. The proposed architecture allows for re-negotiations through the feedback loop and the Post Search Activities.

The main purpose of LA systems is to answer questions about learning progress, to adapt the learning process, to support course design, and in other ways to improve education. Data management is a support activity, which should not by design be distractive. Therefore, the Post Search Activities, taking input form both the Search process and the learning analytics activities (out of scope of the model in Figure 3), should be designed as a non-intrusive part of the LA system. Sometimes, for example when privacy concerns are in the news, or when the LA interventions are surprising or questionable, or for other reasons, the end user should be able to ask questions about the data, which the analysis builds on. What data are used? How did the system capture data about my activities? Who has given permission to use my data? For how long are the data available for analysis? etc. Such questions are never asked and answered when you sign up for a system. In embedding such a process that ensures accountability and transparency about data sharing in the system itself, it becomes a quality improvement process that contributes to the sustainability of the LA system as a whole.

## 6. Conclusions

Data sharing, i.e., the release of data for use by others is a precondition for effective learning analytics. This paper has chosen as a premise for design of architectures for learning analytics that data sharing, often taken for granted by some of the high level LA system architectures, is a non-trivial issue. As the issues often are of a non-technical nature, this paper has focussed on interoperability challenges related to legal and organisational – one may even say pedagogical and political – levels in order to solicit conditions that could be turned into technical and semantic requirements.

Prinsloo and Slade (2015) espouse a move from quantified to qualified selves in designing LA solutions. This means to give more priority to design features that promote student agency and make sure that numbers do not speak for themselves, but through continuous negotiations of meaning through interactions with both systems and their stewards. When the standards community now is challenged with the task of defining architectures for learning analytics it is important that they see the whole picture and recognise both soft and hard requirements. LA architectures are not only about data exchange between system components. Learning could be seen as a conversational activity (Laurillard, 2013), and therefore, any LA system that does not support conversations about the achievements of learning is missing the target.

This paper explores an approach to LA system architecture that differs from the systems design being discussed till now. The proposal is based on search in open and linked data taking place in a middle layer between data sources (both institutional and individual) and learning analytics process engines. The approach is explorative and conceptual, and the proposal is far from thought through. The aim of this exploration is to show that being serious about issues like privacy, data ownership, barriers to data sharing, and student vulnerability would take the design of LA architectures in a different direction from what is proposed in the LA system designs that have been discussed till now in standardisation groups like IMS Global and ISO/IEC JTC 1/SC36.

The next steps of this first design cycle should be to further specify the Usage Agreement process, the Search Rules service, and the Post Search Maintenance process (Figure 3) in order to solicit feedback form the main stakeholders before commencing on a new design cycle. A weak aspect of the proposed solution might be to apply access rules to open and linked data endpoints. This needs to be further researched to see if privacy requirements are met through restricting the access to the search ontology and through other means of anonymisation.

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## References

Barocas, S. & Nissenbaum, H. (2015) Big Data's End Run around Anonymity and Consent. In J. Lane, V. Stodden, S. Bender & H. Nissenbaum (eds.), Privacy, big data, and the public good, (pp. 44-75). New York, NY: Cambridge University Press.

Cooper, A. & Hoel, T. (2015) Data Sharing Requirements and Roadmap. Deliverable 7.2 from LACE project, online at http://www.laceproject.eu/deliverables/d7-2-data-sharing-roadmap.pdf

European Commission (2010). Annex 2 to the Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of Regions 'Towards interoperability for European public services', COM(2010) 744 final. Available from http://ec.europa.eu/isa/documents/isa_annex_ii_eif_en.pdf, accessed 29 June 2015

Greller, W., & Drachsler, H. (2012). Translating learning into numbers: A generic framework for learning analytics. International Journal of Educational Technology & Society., 15(3), 42–57.

Hevner, A. (2007). A Three Cycle View of Design Science Research. Scandinavian Journal of Information Systems, 2007, 19(2):87-92, 1–6.

Hevner, A., March, S. T., Park, J., & Ram, S. (2004). Design science in information systems research. Mis Quarterly, 28(1), 75–105.

Hoel, T., Mason, J. & Chen, W. (2015) Data Sharing for Learning Analytics – Questioning the Risks and Benefits. In Ogata, H. et al. (Eds.) (2015). Proceedings of the 23rd International Conference on Computers in Education. China: Asia-Pacific Society for Computers in Education

Jisc (2015): Code of practice for learning analytics, online at http://www.jisc.ac.uk/guides/code-of-practice-for-learning-analytics, accessed 29 June 2015

Laurillard, D. (2013). Rethinking university teaching: A conversational framework for the effective use of learning technologies. Routledge.

Nissenbaum, H. (2009). Privacy in Context. Technology, Policy, and the Integrity of Social Life. Standford University Press

Prinsloo, P. & Slade, S. (2015). Student vulnerability and agency in networked, digital learning. In Proceedings of the European Distance and E-Learning Network 2015 Annual Conference Barcelona, 9-12 June, 2015. ISBN 978-615-5511-04-2

Reigeluth, T. 2014. Why data is not enough: Digital traces as control of self and self-control. Surveillance & Society 12(2): 243-354. http://www.surveillance-and-society.org | ISSN: 1477-7487

Sclater, N. (2015). Jisc's Learning Analytics Architecture – who's involved, what are the products and when will it be available? Blog post of June 15th, 2015, available online at http://analytics.jiscinvolve.org/wp/2015/06/15/jiscs-learning-analytics-architecture-whos-involved-what-are-the-products-and-when-will-it-be-available/, accessed August 7th, 2015

Sclater, N., Berg, A., & Webb, M. (2015) Developing an open architecture for learning analytics. Paper presented at EUNIS 15, Dundee, UK.

Scoble, R. & Israel, S. (2013). Age of Context: Mobile, Sensors, Data and the Future of Privacy. Patric Brewster Press, United States.

Siemens, G., Gasevic, D., Haythornthwaite, C., Dawson, S., Shum, S. B., & Ferguson, R. (2011). Open Learning Analytics : an integrated & modularized platform Proposal to design , implement and evaluate an open platform to integrate heterogeneous learning analytics techniques. Knowledge Creation Diffusion Utilization.

Slade, S. & Prinsloo, P. (2013). Learning analytics: ethical issues and dilemmas. In American Behavioural Scientist, 57(1), (pp. 1509–1528).

Verbert, K., Drachsler, H., Manouselis, N., Wolpers, M., Vuorikari, R., & Duval, E. (2011). Dataset- driven research for improving recommender systems for learning. In Proceedings of the 1st International Conference on Learning Analytics and Knowledge (pp. 44–53). New York, New York, USA: ACM Press. doi:10.1145/2090116.2090122

Williamson, B. 2015. Digital education governance: data visualization, predictive analytics, and 'real- time' policy instruments. Journal of Education Policy. DOI: 10.1080/02680939.2015.1035758

Xu, H. (2011). Reframing Privacy 2.0 in Online Social Network. In University of Pennsylvania, Journal of Constitutional Law, 14(4), (pp. 1077-1102).

# VI

# DATA SHARING FOR LEARNING ANALYTICS – DESIGNING CONCEPTUAL ARTEFACTS AND PROCESSES TO FOSTER INTEROPERABILITY

by

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# Data Sharing for Learning Analytics – designing conceptual artefacts and processes to foster interoperability

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**Abstract:** Learning Analytics is based on data from the digital traces left by learning activities. In the controlled environment of a research lab combining data from different sources does not pose many problems. However, when scaling up learning analytics for general use in schools and universities data sharing and interoperability become major challenges. These issues are now being addressed in standardisation settings, both internationally and nationally. A case study of a Norwegian standards project shows that there are considerable conceptual issues emerging when stakeholders representing different interests start working towards consensus on these issues. Based on the case study this paper contributes with a number of conceptual constructs and a process that will make it easier to reach consensus about different aspects related to access to and exchange of data from different sources relevant for analysis of learning and the contexts in which learning occurs.

**Keywords:** Data Sharing, Interoperability, Learning Analytics, Educational Data Mining, Standardisation

## 1. Introduction

A common definition of Learning Analytics (LA) is given by the Society for Learning Analytics Research (SOLAR): "Learning analytics is the measurement, collection, analysis and reporting of data about learners and their contexts, for purposes of understanding and optimising learning and the environments in which it occurs" (LAK11, 2011). The definition presupposes that we have a clear idea of what kinds of data are needed to optimise learning and its environments. When moving out of the research lab into the complex field of real life actors representing the vastly diverse interests we find in education we see that it is not only the access to data that represents a challenge; we also lack good concepts to describe the data we want to collect. According to the LA definition it is our understanding of what contributes to learning and optimal learning contexts that should frame our search for data. In the real world we have to do with what we have got, implying that we often start with the data coming out of our learning management systems and our learning assessment systems (Macfadyen & Dawson, 2010; Rienties, Toetenel, & Bryan, 2015; Kitto, Cross, Waters, & Lupton, 2015).

Data sharing can be defined as the release of data for use by others (Cooper & Hoel, 2015). In beginning of 2016, Standards Norway, the main standards organisation of Norway, gathered 'the others' around a table and started work on a technical report on "data sources and conditions for data sharing for learning analytics". The work is to be based on the interest of vendors, school authorities, universities, publishers, and others in the Norwegian market who want to advance the use of LA based on a richer set of data. A provisional scope has been agreed to clarify what are the most important data sources in the Norwegian market; what conditions regulate access and sharing; and to come up with ideas of methods for sharing that will give access to data across actor groups.

In the opening meeting of this project, in which both authors took part, it soon became clear that a data centric approach to data sharing was fraught with subtleties that soon could render the discussion impenetrable. As an example, the concept of a data source proved difficult to use. A data source does not tell much about what information is embedded in the data, which in turn is important to know in order to see if for example entailed personally identifiable information (PII) would make it difficult to share the data. In this meeting it was felt that there was a need for developing a new conceptual toolbox to make the exploration of different data sharing scenarios fruitful.

This paper will explore the discourse space one enters when addressing the data sharing needs for the LA community. Based on this case study we will develop a set of conceptual artefacts that can be used in further work in this particular group and hopefully beyond. The paper is organised as follows: After reviewing related work, we will present a small case study of the Norwegian standards project on data sharing. Based on the requirements identified in the case study, we will construct conceptual artefacts and a process that could be used in this context. The proposals will be discussed and the conclusions will present ideas how this work could be developed further.

## 2. Related Work

Interoperability and data sharing become issues first when we go beyond LA research and start to explore how LA will influence the agendas for schools, universities and national policy makers. LA being an emergent field of research, it is as expected that till now 'interoperability' and 'data sharing' in the context of LA have been rather absent in the research literature. The European Union LA support and coordination action, LACE, on the other hand had a work package on interoperability and data sharing. In a deliverable on 'Data Sharing Requirements and Roadmap' Cooper and Hoel (2015) reported they were struck by the extent to which the characterisation and ramifications of data sharing had not been worked on.

> The interpretation of data sharing is at present somewhat confused by common conceptions of ownership and related factors, under-developed thinking about the topic, and sometimes a failure to consider it. The increasing use of software hosted in “the cloud” - i.e. Software as a Service (SaaS) - has amplified this situation, but we have also inherited a confusion from the days when most software used in education was running on-site. This confusion relates to ownership and control, and the extent to which the educational establishment has absolute authority or acts as a custodian on behalf of the learner. While it is clear that there is some data which the educational establishment is required to keep, and some of which the learner has no right to change, there has generally been little attention to the details of ownership, control, and custodianship. (Cooper & Hoel, 2015, p. 11)

Within a research context there is a long tradition for data handling with ethical committees and a systematic approach for deposit, sharing, reuse, curation and preservation of data (van den Eynden & Bishop, 2014). Even if some of the processes and technologies are relevant for large scale LA delivery, going beyond a controlled research setting will bring into play a more complex set of actors and systems. Till now it is mainly technical factors that are driving the need for data sharing. "Increasing use of Cloud Computing models of service and IT provision, where expertise or technology is provided by a separate organisation to the education provider, has increased the extent to which data is not only distributed between different IT systems, but is also distributed among legal entities" (Cooper & Hoel, 2015, p. 9). However, as pointed out in the report from the LACE project, the situation for educational institutions is more characterised by Small Data than Big Data, – "you can easily fit your data in a spreadsheet on your laptop computer!" (Cooper & Hoel, 2015, p. 9). While a spreadsheet may be inadequate for captured activity data, it remains true that for most of the potential applications of learning analytics in education and training practice, the useful data will be of a scale well below that of Big Data.

For the practical work the Norwegian standards group sets out to do on data sharing and interoperability Cooper and Hoel (2015) give limited help. They observe that the variety of data that is relevant to learning analytics is indeed potentially very great; however, the LACE report limited the interest primarily to concern data about people and their activity in a learning-related situation. Other data sources, e.g., national and international classification schemas for subject matter of courses or learning resources lack many of the complications of person-related data, and they are undertaken as Open Data initiatives and other projects (Cooper & Hoel, 2015, p. 7). However, as the initial meeting in the standards group showed, these other data sources are often the point of interest, from where the stakeholders start to explore LA data sharing and interoperability. Therefore, it seems to be a gap – not addressed by the current LA research literature – how to bridge between person-related activity data and the other data sources well established in the education community.

One way of proceeding is to actually see what kinds of data are used for LA. In 2012, Chatti, Dyckhoff, Schroeder, and Thüs did a review of recent literature related to LA and related fields and found that centralized web-based learning systems (e.g. Intelligent Tutoring Systems (ITS), and Learning Management Systems (LMS)) represent the most widely used data source for LA. They further found that most of the current LA applications were oriented toward intelligent tutors or researchers/system designers; the most commonly applied objectives were adaptation and monitoring/analysis; and the most frequently used LA techniques were classification and prediction (Chatti et al., 2012). This pattern, however, they thought would change,

> "as the focus of LA will shift toward more open, networked, personalized and lifelong learning environments. LA further requires key stakeholders to address a number of challenges, including questions about handling increasing data volume, heterogeneity, fragmentation, system interoperability, integration, performance, scalability, extensibility, real-time operation, reliability, usability, finding meaningful indicators/metrics and appropriate information visualization, supporting mixed-method approaches (quantitative and qualitative), data privacy, stewardship, ethics, and integration of LA into everyday practice. These challenges will need to be addressed as the understanding of the technical and pedagogical issues surrounding LA evolves" (Chatti et al., 2012).

Not surprisingly, what the study of Chatti et al. (2012) shows is that educational practitioners start with the data they have. In universities one have LMS and some experimentation with ITS. This, however, does not give the full picture of what LA promises to deliver. Only for Social Learning Analytics, what Ferguson and Buckingham Shum (2012) propose as a subset of LA, five distinct approaches are identified: network analytics, discourse analytics, content analytics, dispositions analytics and context analytics. Each of these approaches has its own justification and typical set of data. When we are looking for data interoperability and the possibility to share and merge data sets in a future perspective, we need to look at the different types of LA approaches and see what data sources they build on.

### *2.1 Focus of this study*

The review of related work has established a research gap related to the conceptualisation of data sharing for LA. The perspective in this paper is pragmatic, in the sense we want to facilitate the process of coming up with consensus of data sharing and interoperability for LA within a national context. We see that there is a need for a more concrete discussion of the aims for data sharing than outlined in the LACE report discussed above. Cooper and Hoel (2015) pointed towards "more useful analysis through combination of data from different sources", "sufficient scale of data to determine relevance and quality of ed[ucational] resources", "critical mass of data for learning science research, reproducibility and transparency in LA research", "cross-institutional strategy comparison", "research on the effect of education policy", "social learning informal settings", and "learner data as a teaching and learning resource" as aims for learning analytics data sharing (p. 8). None of these rationales would advance the discussion around the table in the standardisation group under study.

After a short case study into the dynamics of the group, the authors of this paper will design a first draft of a discourse toolbox, which will be tested in the coming meetings in the group. This research is positioned in the first Relevance Cycle of the three research cycles of Design Science (Hevner, 2004; 2007), addressing requirements and field testing. The purpose is to come up with candidate concepts that describe the problems and opportunities in the application domain from a people, organisational systems, and technical systems perspective.

## 3. Case study of the initial phase of a consensus process

The kickoff of the standard project on data sharing May 2016 was preceded with an invitation to think about the issues from a bird's eye view and to contribute use cases led by four simple questions: Who does you represent? What data sources do you use? What data sources would you like to get? Do you have comments on conditions for sharing? Both activities were carried out as a collaborative writing effort using Google Docs.

From a work group facilitator's point of view, the preparatory work was a disappointment. The high level reflection on data sharing for LA opened up a Pandora's box of everything related to data in education. One contributions argued why open data is important and therefore supported by government policies. Another reported ongoing work to create a data architecture for higher education in Norway mapping the activities of all service providers in the sector. Just a quick look at the draft document would prove that this attempt to get a high level grasp of challenges would lead nowhere.

Four stakeholders contributed to the first round of use cases: a big vendor, a local school authority, a school agency, and a publisher. Even with the same set of questions and access to each others' contributions the answers vary a lot in scope. We have a list of services and data providers, with a number of concerns and issues related to technical architecture, ownership, sharing culture, what type of data are collected, etc.

The school authority gave an overview of their central databases on curricula and learning goals and official statistics from national authorities. They were also pointing out that they had access to student information data on users, LMS data and user-generated data from a number of applications for digital learning resources. What they wanted to get hold of were roster data, competency information related to learning activities, and local learning goals related to the curriculum.

The school agency was concerned with the availability of the vast datasets managed by The Norwegian Directorate for Education and Training and the Norwegian Centre for Research Data. The data are essential for assessing the quality of education in Norway; however, the datasets are not easily accessible, and provided examples of exchange with these data authorities prove that substantial negotiations are necessary to make these datasets an active open source for learning analytics.

The publisher presented their solution for ebooks, explaining that they stored detailed information on usage patterns of each learning resource (e.g., right and wrong answers to quizzes, did the user check for right answer, how does the learning resource relate to curriculum, etc.).

The kickoff meeting, gathering 22 experts representing all the relevant stakeholders for this work in Norway discussed rationale, scope, output of work and agreed on working procedures before embarking upon technical work. As expected, the initial discussion was dominated by framing activities, positioning the actors (Hoel & Pawlowski, 2012), making sense of the scope of work (Hoel & Mason, 2012), and exploring the stakeholder interests (Hoel & Hollins, 2011). The appointed technical lead tried to drive discussion towards getting a grasp of what data the stakeholders were interested in exchanging, but struggled to get beyond principled views of open access and sweeping reference to categories of data and the data sources mentioned in the shared document.

Much as the facilitator repeatedly referred to use cases as a useful instrument to map concrete and relevant stakeholder interests the discussion never came to the point where for example a publisher would declare: We have these data, which makes this application work today; however, if we get those data form that source we could make a much better learning resource. Participant observation of the discussion made it visible that the group lacked a common conceptual understanding of data sharing and LA. To discuss use cases did not make any sense for the group. Along the LA spectrum from person-related, activity-focussed analytics to more traditional academic analytics (Baepler & Murdoch, 2010) different concepts of data come into play. The group lacked the necessary conceptual common base to engage in a solution oriented discourse.

To create a common ground one needs to reach out – to find a new position. However, the discourse in this start-up meeting also highlighted another prerequisite for moving towards consensus: willingness to be explicit about one's own position and interests. Conceptual tools are not enough; one also need motivation.

Two comments were noticed as pointing towards a common ground on which to build consensus about ways forward. The representative for the data protection authorities said the legal boundaries were not that difficult to map providing one was able to identify *what information* to be exchanged. It was not enough to just to focus on sources of data without knowing what information was represented. The other comment was from a publisher who said: We have only been discussing what data we would want to have. As a publisher we have data *to give*, *or sell*, but we don't know how this could be done.

### *3.1 Requirements for design*

This short case study of the setting up of a standards project highlights the need for conceptual clarification and the design of a process that will deliver consensus on principles that will level the playing field for the Norwegian LA actors. Also the case study demonstrates the need to bridge the gap identified in the review of related work (Section 2) between person-related activity data and other types of education data.

In the initial phase of the project a survey of available data sources is foreseen. The challenge, however, is to ensure that this survey identifies the relevant data sources that will be part of actual negotiations between actors in the market who want to extend their existing data sets or make more data available for analysis. In doing so, we need a description of the data attributes that are stumbling blocks for exchange.

It is also clear from this case study that the objective of LA needs to be made explicit in order to focus the search for fitting data. LA is still an ill-defined field of interest. The different stakeholders focus on different data types, e.g., along the range from person-related data to aggregated high-level data on different groups' learning results. If a stakeholder's aim with the LA is not stated, it may be easy to define a data source out of scope because it does not fit a dominant stakeholder interest.

## 4. Design of conceptual artefacts and process

The aim of this design is to better facilitate a standards development process. The process is set up to arrive at a common and negotiated understanding of what data should be shared in the Norwegian market, giving the different stakeholders increased opportunities to develop LA services for all sectors of education by also pointing towards how it could be achieved.

Therefore, the developed artefacts are designed to make the stakeholders sitting around the table willing and able to share enough information so that they can work out what data in the Norwegian educational market could be made available for exchange between actors, on what conditions. Standardisation is a consensus process, and the intended output, a technical report (ISO 5966:1982), should pave the road for practical progress within the community in question. The test of success is whether new data sources are released for use by others as a result of the consensus documented in the technical report.

### *4.1 Concepts*

The conceptual artefacts we propose are designed to answer specific questions.

**I) How to declare specific stakeholder's interest in data sharing?**

Stakeholder's position is often given by business interests. Many actors are reluctant to discuss their business models, and therefore, in standardisation settings we often see specific business interests hidden behind more general high-level market concerns. One way of making it easier to discuss business drivers for data sharing is to ask stakeholders to position themselves in the LA landscape. The following instruments are proposed:

1. How do you characterise your interest in LA (referring to the definition of LA given by SOLAR) – are you mainly working to improve *learning* or the *contexts*, in which learning occurs?

If you do not want to choose one or the other, think of one or more typical scenario(s) where you are 1) working directly on providing feedback to the learner, or 2) working on different learning contexts (learning resources, learning design, learning tools provision, physical infrastructure, etc) where the learner is more indirectly influenced.

2. In case of *alternative 1 learning*, Figure 1 gives a simple model of the LA cycle, focussing on data and metrics informing learner interventions.

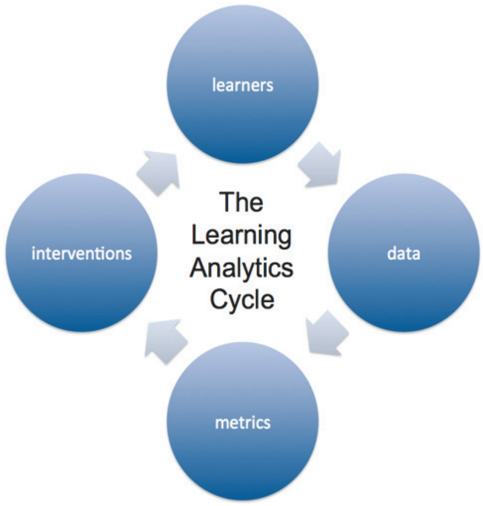


Figure 1. The Learning Analytics Cycle (Clow, 2012)

Starting with *metrics* or analytics, what insight are you looking for in the specific LA use case or scenario? Think of the visualisations, dashboards, or lists coming out of the analytics and note potential insights into learning behaviour, navigation through learning resources, students 'at risk', assessment results, motivation, etc.

Given you have a pretty good idea of your metrics – what you are looking for – a) what data are you using or envisioning use of now; and b) what data would strengthen your analytics if you would be able to collect them?

List data sources of a) and b) in a table and add a column of Ownership/Control. Some of the data, you, e.g., as a vendor or institution, will be in control of. Other data sources have to be released from an external legal body. Categorise your data sources; sort the list; add a third column *Sharing Issues*, and identify issues that could contribute to or block your sharing (of the data you control yourself) or your access (to external data).

3. In the case of *alternative 2 contexts*, Figure 2 gives a template model of learning and its contexts. Revise the model to suit your LA scenario(s): What context do you want to improve?

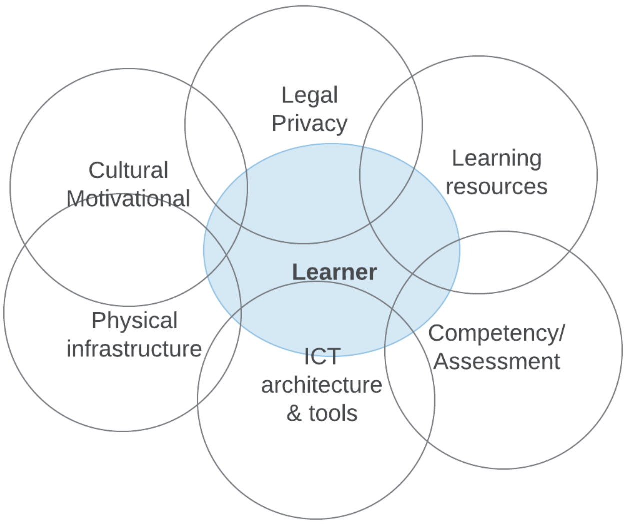


Figure 2. Learning Contexts (template model)

There are a number of data schemas describing learning contexts. E.g., there are metadata standards for describing learning resources and competency structures. Often these standards overlap or interchange, e.g., a learning resource is targeting a specific learning objective.

First, list all data schemas relevant to your chosen learning context. In particular, look for connection points. E.g., in a description of a textbook there is information about class level, which hooks up to a specification of class structure in schools, which in turn is related to descriptions of curricula for each level, which are broken down in specific learning objectives, and so on.

Second, when you have an idea of which data schemas that are relevant for describing your learning context, create a table with the 2nd column stating who populates the data schemas. Some of the data will be produced in your organization; some will be external. And some of the external data will be more static, e.g., the Norwegian Directorate for Education and Training has a curriculum service that is available for queries via a defined API.

Third, add a column to your table registering sources of *dynamic information* about the learning context, information, which you find crucial for establishing the quality of the context. Look at the interchange points (described as 'hooks' above) for clues; e.g., a data stream that relates activity data coming from a tools log to learning objectives; to a physical installation or artefact; or to a assessment register could provide information that are useful to understand how the learning context performs in supporting learning. In carrying out this third step, you will be challenged to come up with hypothesis about the improvement potentials of the learning context in question.

Fourth, add another column to your table for your ideas on who are the data controllers for the dynamic information you have identified as crucial for your project. Reflect also on the issues that could contribute to or block sharing and access to this data.

**II ) What are the barriers for access to and sharing of crucial data identified using instrument I?**

Use the information gathered in the previous step to list barriers for access to and sharing of the data you find important. Each barrier should be evaluated in terms of how it is related to PII issues. Is it necessary to gather information on persons, e.g., because you would like to merge datasets? Or could you do with sets of aggregated data?

Barriers could be described at different levels, e.g., technical, semantic, organisational, political or legal. Use this classification as a scaffold in creating your list of barriers.

**III) What are the enablers for access to and sharing of crucial data identified using instrument I and II?**

Based on the information gathered in the previous steps, what are your ideas for solutions? The task at hand is to make different actors interoperate, directly or indirectly in order to improve learning and its contexts. The solutions are found at different levels, the same as for the barriers (e.g., technical, semantic, organisational, political or legal). This classification could also be used to scaffold the brainstorming of enablers. However, it is also useful to think about the broader stakeholder picture for this endeavour. In most societies education is shared responsibility, with actors that take on different tasks. For example, national authorities may be challenged to build 'trust architectures' that could make it easier for actors A and B to share data.

### *4.1 Process*

In preparing the standards work described in the case study (Section 3), a simplified use case approach was chosen. A use case driven approach has the advantage that it helps to cope with the complexity of the requirement analysis process; however, the disadvantage is the lack of synthesis (Regnell, Kimler, & Wesslén, 1995). The standardisation group needs to manage the complexity of different data, diverging data description schemas, data governance, etc.; and synthesis is not that important in the beginning of a standardisation process. What makes us put less emphasis on gathering use cases in the initial stage of this work is the issue of motivation. There is a need to make sure that different stakeholders want to extend their perspective beyond current business models and are willing to expose their future visioning to other stakeholders.

We have identified the challenge of sticking to and developing one's own stakeholder perspective, and the challenge to go to the core of learning analytics (the improvement of learning and its contexts) as the main obstacles for a successful consensus process and output. Therefore, in designing the process (Figure 3) we have made sure these challenges are addressed.

The process model describes a spiral process, starting with mapping stakeholder interests. For the initial round, the model proposes to form two separate subgroups for mapping of stakeholder interest, one with more focus on adaptive learning (vendors, developers, and publishers), and one with a more academic analytics perspective (school agencies, local authorities and universities). For the second round we suggest that the whole group meets together to compare notes and maintain perspectives and interests throughout the range of LA practices.

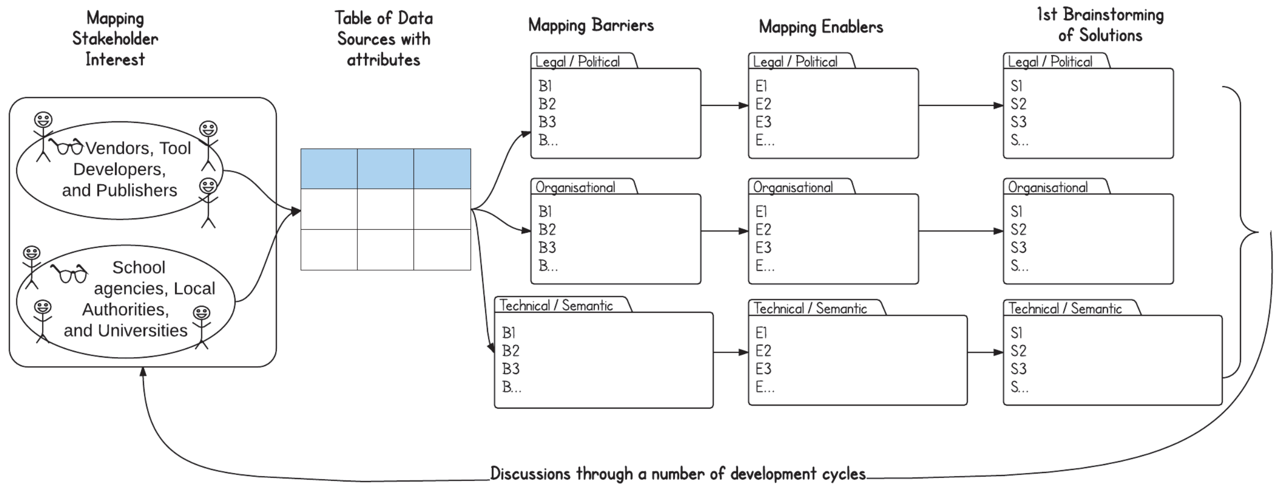


Figure 3. Draft process model of standardisation work related data sharing for LA

The discourse is captured in a shared table, and the joint group proceeds to map barriers and enablers (instrument II and III above). The last subprocess before going back to checking stakeholder interests and the potential for new data sources is the first brainstorming of data sharing solutions. Also for solutions it is suggested that the discussion should be structured according to the different interoperability levels used in the previous discussions.

## 5. Discussion

Cargill (2011) described standardisation as a poorly understood discipline in practice. "While there are excellent studies of standardization as an economic phenomenon, or as technical a phenomenon, or as a policy initiative, most of these are ex post facto and written from a dispassionate academic view. They are of little help to practitioners who actually are using and creating standards" (Cargill, 2011).

This study is written with the persons actually creating the standard in mind, "working in an area of imperfect knowledge, high economic incentives, changing relationships, and often, short--range planning (Cargill, 2011). At the start of the process much energy is used to get the right stakeholders on board, and agreeing upon rationale and scope. It is the authors' experience from many years of participation in national standardisation that it is unexpectedly hard to move beyond the initial phase of general knowledge sharing into actual technical work based on real stakeholder positions. Often the subject field is complex, and there are lots of technologies in the market waiting to be explored and better understood. With a heterogeneous group of participants it is easy to get stuck in seminar style meetings, where it is undemanding to agree upon trends, but arduous to create consensus on new technical specifications. In the case of this LA technical report it also seems to be an issue that this new field of interest needs to be justified vis-à-vis top management, new customers, and others.

Scoping is key to a successful standardisation process (Hoel & Mason, 2012). If arguing *why* a technology is useful is included in the scope, the scope is clearly to wide. The process should be more focussed on questions of *what* and *how*. Nevertheless, there is a need to know why, at least to keep the participants motivated to move beyond mere knowledge sharing. Therefore, in the process designed in this paper we have defined questions of metrics and analytical outcome to precede the questions of what data could be collected. It is crucial that we are able to base the work on actual needs for analytics originating from each actors' core business.

The scope of the project in our case study includes also *conditions and solutions for data sharing*. In the process we have designed the discussion of solutions to come as a brainstorming exercise at the end of the process cycle. At the initial stage of this specification work we would like to downplay the role of sharing solutions and conditions till we have a good grasp of what data sources are available. We see in the discussion that some data sources are described as *not available* simply because there are no solutions developed that would make sharing possible. In such cases it is useful to have a short brainstorming about solutions in order to put the source on a roadmap for data sharing. We also see that some data sources are taken for granted, while it would be easy to come up with scenarios that would scatter that impression (e.g., related to re-identification of anonymised data). A brainstorming of solutions would also help in this discussion. The main purpose of the process described in Figure 3 is to identify data sources and start the next phase of mapping sharing conditions and requirements for sharing solutions.

For barriers, enablers and solutions we propose to use the interoperability levels from the European interoperability framework (IDABC, 2004) as a scaffold for the discussion. The framework reminds us that interoperability is not only a technical question; it is also about agreeing upon using the same concepts, harmonising business cultures, agreeing upon common policies, and developing rules of law in order to level the playing ground for a well functioning market.

## 6. Conclusions and further work

This study has designed conceptual artefacts and a process to support the initial discourse of a standardisation group organised to draft a technical report on data sharing and interoperability for learning analytics. The case study informing the design is set in a Norwegian context; however, both the challenges addressed and the contributions of this research are international in scope. It is one of the paradoxes when big data comes to school that without work on data models and interoperability there are only small data available for learning analytics, "the data [will] remain isolated in self-referencing islands" (Cope & Kalantzis, 2016).

As the field of LA is maturing we will move from big data to meaningful data, where the LA community becomes "more focused on broad research from many data sources and targeting many nuanced questions about what it can deliver" (Merceron, Blikstein, & Siemens, 2015). The challenge for a local market with a mixed stakeholder group, ranging from advanced tool developers looking for an international market for their cutting edge technologies to school authorities wanting to evidence-base their assessment policies, is to agree on what questions to ask. Knowing that it is the questions that lead to fruitful data sources, we need to design a consensus process that pick the low-hanging fruits without losing sight of the big promises of learning analytics.

The developed conceptual artefacts and the process will be tested in the Norwegian standardisation project. Already now we see the need for further development, and we will point to two obvious cases: one related to our understanding of data that are difficult to share, and one related to the use of existing technical infrastructure in Norway.

A data source (or we might use the more precise term data catalogue) contains a number of datasets. Not all of these datasets are problematic in terms of data sharing. But some are, and how do we pinpoint these aspects so that we can start to design solutions for easier access? It is clear to us that a group of these problematic aspects relates to personally identifiable information (PII). However, we would suggest there is a need for a LA specific conceptual model of this phenomenon. We cannot see that this model exists, and we think such a model would have helped the current work on data sharing and interoperability for LA.

Looking ahead to solutions that could support data sharing, we see that Norway have a good technical infrastructure for education that could be used. We have a identity management system now being expanded to include a API gateway[1] connecting data sources and end-user applications. This infrastructure could be used to solve privacy and data protection issues allowing market actors to exchange data without compromising PII (Hoel & Chen, In press; 2016; 2015).

## References

[1] www.uninett.no/en/service-platform-dataporten

Baepler, P., & Murdoch, C. J. (2010). Academic Analytics and Data Mining in Higher Education. International Journal for the Scholarship of Teaching and Learning,

Cargill, C. F. (2011). Why Standardization Efforts Fail. The Journal of Electronic Publishing, 14(1). http://doi.org/10.3998/3336451.0014.103

Chatti, M. A., Dyckhoff, A. L., & Schroeder, U. (2012). A reference model for learning analytics. International Journal of Technology Enhanced Learning (IJTEL), Vol. 4, No. 5/6 http://doi.org/10.1504/IJTEL.2012.051815

Clow, Doug. (2012). The Learning Analytics Cycle: Closing the Loop Effectively. In

Proceedings of the 2nd International Conference on Learning Analytics and Knowledge (LAK12), Vancouver, BC, Canada, April 29 May 02, 2012, edited by Simon Buckingham

Cooper, A. & Hoel, T. (2015) Data Sharing Requirements and Roadmap. Deliverable 7.2 from LACE project, online at http://www.laceproject.eu/deliverables/d7-2-data-sharing-roadmap.pdf

Cope, B., & Kalantzis, M. (2016). Big Data Comes to School: Implications for Learning, Assessment, and Research. AERA Open, 2(2), 1–20. http://doi.org/10.1177/2332858416641907

Ferguson, R., & Shum, S. B. (2012). Social learning analytics: five approaches. the 2nd International Conference (pp. 23–33). New York, New York, USA: ACM. http://doi.org/10.1145/2330601.2330616

Hevner, A. (2007). A Three Cycle View of Design Science Research. Scandinavian Journal of Information Systems, 2007, 19(2):87-92, 1–6.

Hevner, A., March, S. T., Park, J., & Ram, S. (2004). Design science in information systems research. Mis Quarterly, 28(1), 75–105.

Hoel, T., & Chen, W. (In press) Privacy and Data Protection in Learning Analytics – Suggestions for Systems Design

Hoel, T., & Chen, W. (2016). Privacy-driven design of learning analytics applications: Exploring the design space of solutions for data sharing and interoperability. Journal of Learning Analytics, 3(1), 139–158. http://dx.doi.org/10.18608/jla.2016.31.9

Hoel, T. & Chen, W. (2015). Privacy in Learning Analytics – Implications for System Architecture — In Watanabe, T. and Seta, K. (Eds.) (2015). Proceedings of the 11th International Conference on Knowledge Management. ISBN 978-4-9908620-0-8

Hoel, T., & Mason, J. (2012). Deficiencies of scope statements in ITLET standardization. In G. Biswas et al. (Eds.) (2012). Proceedings of the 20th International Conference on Computers in Education. Singapore: Asia-Pacific Society for Computers in Education

Hoel, T. & Pawlowski, J.M. (2012). Managing standards development in emergent fields of technology innovation – a proposed model of key processes in ICT standardisation, in Enterprise Interoperability - Proceedings of the Workshops of the Sixth International Conference I-ESA '12, ISTE Ltd, London.

Hoel, T., & Hollins, P. A. (2011). Standards for Learning, Education and Training – a proposal for an improved process (pp. 1–3). Presented at the ICALT 2011. http://doi.org/10.1109/ICALT.2011.146

IDABC. (2004). European interoperability framework for pan-European eGovernment services. Version 1.0. Luxembourg: Office for Official Publications of the European Communities. Retrieved from http://ec.europa.eu/idabc/servlets/Docd552.pdf?id=19529

ISO 5966:1982 Documentation -- Presentation of scientific and technical reports. http://www.iso.org/iso/catalogue_detail.htm?csnumber=12160

Kitto, K., Cross, S., Waters, Z., & Lupton, M. (2015). Learning analytics beyond the LMS (pp. 11–15). Presented at the the Fifth International Conference, New York, New York, USA: ACM Press. http://doi.org/10.1145/2723576.2723627

LAK11 (2011). Call for Papers. 1st International Conference on Learning Analytics and Knowledge. Online at https://tekri.athabascau.ca/analytics/call-papers

Macfadyen, L. P., & Dawson, S. (2010). Mining LMS data to develop an "early warning system" for educators: A proof of concept. Computers and Education, 54(2), 588–599. http://doi.org/10.1016/j.compedu.2009.09.008

Merceron, A., Blikstein, P., & Siemens, G. (2015). Learning analytics: From big data to meaningful data. Journal of Learning Analytics, 2(3), 4–8. http://doi.org/10.18608/jla.2015.23.2

Regnell, B., Kimbler, K., & Wesslen, A. (1995). Improving the use case driven approach to requirements engineering. Presented at the RE '95: Proceedings of the Second IEEE International Symposium on Requirements Engineering, IEEE Computer Society.

Rienties, B., Toetenel, L., & Bryan, A. (2015). "Scaling up" learning design: impact of learning design activities on LMS behavior and performance (pp. 315–319). Presented at the LAK '15: Proceedings of the Fifth International Conference on Learning Analytics And Knowledge, ACM. http://doi.org/10.1145/2723576.2723600

Van den Eynden, V., and Bishop, L. (2014). Incentives and motivations for sharing research data. A Knowledge Exchange Report. Retrieved from: knowledge-exchange.info/Default. aspx?ID=733

# VII

# INTERACTION BETWEEN STANDARDISATION AND RESEARCH – A CASE STUDY

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# Interaction Between Standardisation and Research:
## A Case Study

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## ABSTRACT

Standards-making is a design practice that relies on input from research and end-users, involving experts that represent diverse stakeholders spread all over the globe. However, the standards-setting culture and formal rules are sometimes at odds with the culture and practice of research. Based on previous research identifying the lack of openness and transparency, and a suboptimal interaction with academic research as issues that could explain a lack of success in a European setting, this article studies how an ongoing international standards project on privacy and data protection policies for learning analytics has interacted with an international academic research community. The results of this study show that establishing feedback loops between standardisation, research, and development is essential in order to produce results. However, the study also shows that in individual projects, internal processes and culture in the standard setting group could be of crucial importance for the outcome.

## KEYWORDS

Data Protection, Design Practice, Interoperability, Learning Analytics, Learning Analytics Systems Design, Privacy, Standardisation

## 1. INTRODUCTION

Standards' key role in encouraging innovation, improving markets and creating competitive opportunities are strong selling points when explaining the benefits of interfacing with standard bodies (Copras, 2007a, Blind, 2013). In Europe, the launch of the new version of the European Interoperability Framework (EC, 2017c) has connected standards work even stronger to laudable activities like designing and delivering "seamless European public services", "promoting interoperability", and contributing to the "establishment of the Digital Single Market" (EC, 2017d). With the importance assigned to standards one would expect that a lot of resources and manpower were allocated to standards-making. This is not always the case. Many potential standards experts experience barriers to participation, e.g., lack of time, travel budgets, and other resources (Blind, 2006); lack of support from their employers (Blind, 2013), distrust in the process (Hoel, 2014a, 2014b), etc. Lack of participation, however, is only part of the problem, as we do not fully know what contributes to the quality of a standard (Hollins & Hoel, 2010; Sherif, Jakobs, & Egyedi, 2007), and how standards are related to innovation (Blind, 2013).

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This paper focuses on a particular challenge of the standards-setting process, namely how interaction between the research and the standardisation communities could be facilitated in order to solicit necessary requirements and ideas for design. This challenge is not new. In 2004 - 2007 the European Commission funded the COPRAS (Co-Operation Platform for Research and Standards) project with the objective to improve the interface between research and standards. The project, run by the major standardisation organisations in Europe (CEN, CENELEC, ETSI, W3C, and The Open Group) found that research projects do not start thinking about standardisation until they are in the final stages of their activities, and then they discover they do not have sufficient resources and time to pass their output through standardisation. On the other side, it was found that the standards bodies do not have mechanisms for addressing the output of research projects (Brusse, 2005). One of the outputs of the COPRAS project was suggestions for guidelines how Information Society Technology (IST) research project should interface with ICT standards organisations, explaining the benefits of standards and standardisation (Copras, 2007a).

The COPRAS research had an organisational perspective, exploring how research and standardisation could work better together through identifying possibilities for cooperation. This paper, on the other side, is written from the perspective of a standards group, with the focus on processes for enhancing quality of the standardisation work by seeking contributions from research and searching for means to make them an active part of design in standard-setting in particular domain. This study adds to the body of knowledge on the interface between research and standardisation in other domains, e.g., see Blind and Gauch's study (2009) of technology transfer in nanotechnology.

Let us first briefly introduce the standards project used as a case in this study before we explain the methods used to explore where new understanding of interaction between research and standardisation is needed in this domain. The project is under the auspices of the sub-committee 36 of the Joint Technical Committee 1 of ISO/IEC (SC36), which in Working Group 8 is developing standards for learning analytics interoperability (LAI). Learning analytics (LA) is a new domain of applications and practices driven by the easy access to data provided by mobile devices and an increasing number of sensors. The aim is to achieve actionable insights from data derived from the full spectrum of learning and teaching activities. By sourcing analytics with data from both within and outside of formal institutional settings, LA has the potential to boost system integration in learning, education and training (LET), bringing both institutions and vendors together. LAI standards are needed to make sure that data can be integrated from different sources and used in a consistent, safe and purposeful way by different systems and stakeholders.

LA is an emerging field with few solutions in full-scale production. LA is part of a dynamic development of Big Data and so-called smart learning environments. Hoel & Mason (forthcoming) have observed that the more these environments use educational big data and technologies that could be classified as smart, the less is to be found in terms of relevant standards or even conceptualisations of standardisation challenges. This gives an incitement to study the relationship between research and standardisation in this field; and it gives standards experts a need to interface extensively with research to gather requirements for their standards work that is inherently anticipatory of nature (Umapathy, Purao, & Bagby, 2011).

The guiding questions for this study are derived from participant concern of being able to develop a standard that not only represents the consensus of the national bodies taking part in the project, but also represents state-of-the-art in research:

- How can a high quality and research-based draft specification be developed within the current formal and informal rules of an ISO standards group?
- What are the areas of concern that need further research in order to come up with suggestions for improvement of the standardisation process in the LET domain?

The paper is organised as follows: First, in section 2, we will establish a backdrop on which the embedded case study (Yin, 2009) in section 4 will be projected. The backdrop will establish the context and challenges for the domain, raising questions related to how to optimise the standards development process by interfacing with academic research and the users of standards. In section 3 a model of standards-setting is described. The model is used in the foreground study in section 4 to show how challenges are met in a particular project. In section 5 this projected case is analysed from the perspective of the highly structured and formalised process defined in the ISO directives, triangulating the data included in the foreground and background studies (Yin, 2009, p. 116). In section 6 research gaps are identified, and section 7 summarises the study and outlines ideas for further work.

In this study, standardisation is unpacked through analysing data made available through one of the authors' yearlong participation in European and international standards groups and other open data sources. The particular set of events chosen for this study falls under what Stake (2008) describes as an instrumental case study designed mainly to provide insight into an issue: "The case is of secondary interest, it plays a supportive role, and it facilitates our understanding of something else" (Stake, 2008, p.123). This *something else* is the aim to identify knowledge gaps and challenges that need to be addressed to allow high quality development of anticipatory standards. The case is from standardisation in the domain of learning technologies; however, the results of this study will also have implications for other domains. The case study approach allows us to deal with a full variety of evidence - documents, artefacts (e.g., specifications), interviews, and observations - beyond what might be available in a conventional historical study (Yin, 2009). Table 1 gives an overview of units of analysis, focus and data used in this study.

## 2. BACKDROP: ICT STANDARDISATION FOR LEARNING, EDUCATION AND TRAINING

ICT for LET (ITLET) is an emerging field of technology, and we have seen a proliferation of standards and specifications addressing different needs (Hoel, Hollins, & Pawlowski, 2010). The inherent need for stable standards is difficult to reconcile with the aim to develop state-of-the-art standards, and to combine standardisation with innovation. Standards' dynamics (Egyedi & Sherif, 2008), especially in the field of anticipatory standardisation, imply that specifications and technologies co-evolve, something that requires a well-coordinated interaction between the standards community and the R&D community.

Blind and Gauch (2009) used a simple technology transfer model to study transfer of relevant codified and tacit scientific and technological knowledge in the field of nanotechnologies. They also analysed how different types of standards, i.e., semantic, measurement and testing, interface, and compatibility standards, played specific roles in the various phases of the research and innovation process. Jakobs (2009, 2000) has focussed more closely on the work of standards groups, exploring how different stakeholder agendas, and individual factors like external forces,

**Table 1. Units of analysis, study focus and data sources**

| Unit of analysis | Focus | Data |
|---|---|---|
| LET domain | Characteristics of domain | Documents, Research literature, Participant observations |
| Standards group | Background & cultural composition, Standardisation process | Documents, Participant observations |
| Editorial group | Group dynamics related to production of draft specification, Standardisation domain knowledge | Documents, Participant observations |

individual major stakeholders' preferences, and the context within which working groups works impact on the final standards.

In this study, however, we will point to another factor, differences in organisational cultures, that has not been fully addressed in the previous studies on the interface between research and standardisation. We have found that for the domain we are studying, the ways the two communities organise their work are different, and that to a degree that potentially leads to conflicts. In this section, we will give examples of tensions that impact standards development. We will describe the tensions at group level (ITLET researchers taking part in standardisation), and from a system level (European ITLET standardisation).

## Openness, Confidentiality and Handling of IPR

The majority of the experts engaged in ITLET standardisation have some kind of relationship to education and academic research. The academic research community is used to confidentiality and strict governance of IPR. General design ideas and opinions, however, are shared openly among researchers who know that openness fosters innovation (Bolin, 2003). In the requirement phase of standards development one does not expect to find confidential or business sensitive information and researchers therefore expect an open process with free sharing of documents. When the same researchers meet in the role of standards experts they may experience a different culture, where the norm is secrecy and uncertainty whether non-controversial information may be shared (Hoel, 2014b).

How the directives of the standards organisation influences work will be discussed in section 5. Here we note that Hoel (2014a) concluded that the document-for-profit model of formal standards bodies drives a wedge between the standards community and the research community. When the sustainability of the standardisation system rests on sale of documents open distribution of drafts for input and comments becomes a threat to the standards organisation. In the case of European ITLET standardisation, this position has had detrimental effects on the practice as a whole.

## European ITLET Standardisation on Hold

Each year the European Union publishes a Rolling Plan for ICT Standardisation, viewed as "a unique bridge between EU policies and standardisation" (EC, 2017a). This plan is followed up with a work programme for European standardisation (EC, 2017b). The plan sets out e-skills and e-learning as one of the societal challenges on par with e-health and active and healthy ageing, web accessibility and accessibility, emergency communication and ecall, and egovernment (EC, 2017a, p. 6). Compared with the proposed actions in the other fields, however, the challenge of e-skills and e-learning is modestly specified with only one target within e-skills: "to develop standards for a comprehensive European framework for the ICT profession". Knowing that this work has been going on for years in European standardisation, and noting that the EU Rolling plan is aware of the needs for standards development in e-learning, this low level of activity is striking. The reason is hinted to in the rolling plan's overview of ongoing European and international standards development: "CEN/TC 353 Information and Communication Technologies for learning, education and training. *It has been dormant for a while*" (EC, 2017b, p. 64, authors' italic).

Why European information technology for LET (ITLET) standardisation in this domain is sleeping (as the EC puts it) despite extensive and documented needs for new standards has been researched for years by one of the authors of this paper (Hoel, 2014a, 2014b). In 2015, European Committee for Standardization (CEN) Technical Committee 353 was put on hold due to lack of new projects. In principle, TC 353 could be brought to life at any time if new projects should emerge. However, this does not seem to happen, and the reason for this is a situation where no ITLET anticipatory standardisation work is taking place. In 2014 the Workshop on Learning Technologies was disbanded by CEN Technical Board after years of conflict about working process and procedures with the workshop's own experts. The outputs of the Workshop were the basis for standards development in the CEN TC 353.

Between the lines, EC policy documents seem to realise that there is a discrepancy between needs and ongoing projects within ITLET standardisation. Analysis of the history of CEN activities in this field points to factors that could explain the predicament. Disagreements between the LET research community and the standards community about how design activities should be carried out may be one factor. The question is whether the work should be done in an open way according to academic norms, or in a closed way according to a strict interpretation of standardisation directives. Another factor is the relationship between anticipatory standardisation (as done in the CEN Workshop) and de jure standardisation (as done in the TC). In an emergent field as ITLET it seems that more lightweight consensus documents typically developed in a workshop setting is a precondition for more formal standards work to initiated in a technical committee. This could be explained with the different nature of participation in a workshop and TC. In a workshop, you will find experts with an identity as researchers representing themselves and the field of interest they identify with. In a TC, on the other hand, you will find mainly standardisation bureaucrats representing the national standardisation bodies. In the case of TC 353 it has been proven that for work to progress there is a need for preparatory work in a workshop setting, unless one builds on mature documents developed by a national body or other standards groups.

## 3. TOWARDS AN IDEAL MODEL OF STANDARDS-SETTING

Openness and transparency are identified as important factors in the above cases. What does this mean for organising new projects, e.g., in the field of LAI, which we will focus on in our foreground case study in the next section of this paper? Clearly openness and transparency highlights the exchange between stakeholders playing different roles in standards-setting and use of the outputs, i.e., (1) the research community, (2) the standards practitioners, and (3) the users of standards. Low output and even low technical quality (Hoel & Mason, 2011) could be attributed to insufficient input from research and development, and insufficient testing and feedback from the implementers of standards. How could this process be improved?

Standardisation is a design practice. Methods and organisation of work should reflect the task at hand, and therefore it would be worthwhile to look at design science research methodology to learn more about how to design processes for knowledgeable outputs. We will conclude this background study with construction of a framework for standards-setting based on Design Science Research (DSR) methodology. The framework will be used to analyse the foreground case presented in this paper.

According to Gregor and Hevner (2013, p. 345) DSR activities are positioned in one of four quadrants in the cross-section of application domain maturity and solution maturity (Figure 1).

The definition of LA[1] most used in the field today was given in 2010 in a call for papers to the first learning analytics and knowledge (LAK) conference (Long & Siemens, 2011). The field of LA is quite immature, both in terms of conceptual understanding and access to applications. Therefore, the solution maturity is low, which positions the design activities as invention of new solutions for new problems, contributing to knowledge creation and exploration of research opportunities. While DSR contributes to both descriptive and prescriptive knowledge creation (Gregor & Hevner, 2013, p. 344), the main objective of standardisation will always be to harness prescriptive knowledge. Action Design Research, a near-standing field to DSR, is defined by Sein, Henfridsson, Purao, Rossi, and Lindgren (2011, p 40) as "a research method for generating prescriptive design knowledge through building and evaluating ensemble IT artifacts in an organizational setting". Figure 2 is an adaptation of Sein et al.'s generic schema for IT-dominant Building of the IT artefact, Intervention in the organisation, and Evaluation (BIE) (ibid., p. 42).

In this section we have analysed the LET standardisation practice with regard to interaction between standards practitioners, academic researchers, and users of standards. The model in Figure 2 assumes that a project initiated in a standards group actively seeks input from research, tests the

**Figure 1. Design science research knowledge contribution framework (adapted from Gregor & Hevner, 2013)**

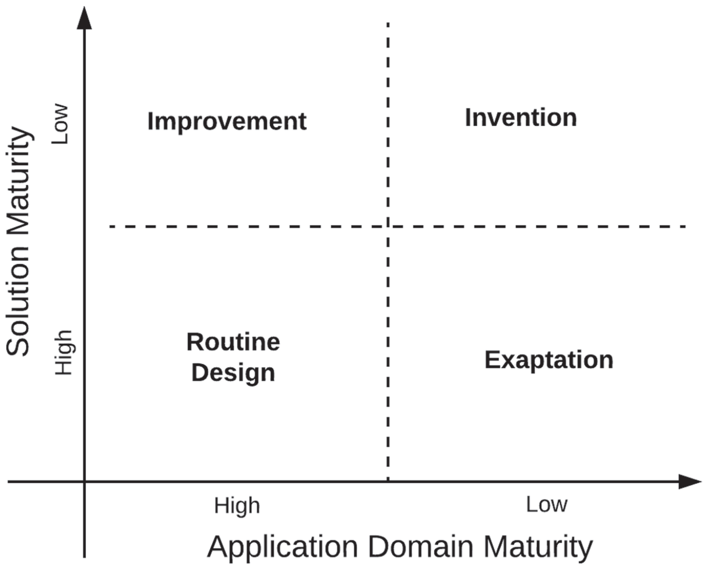
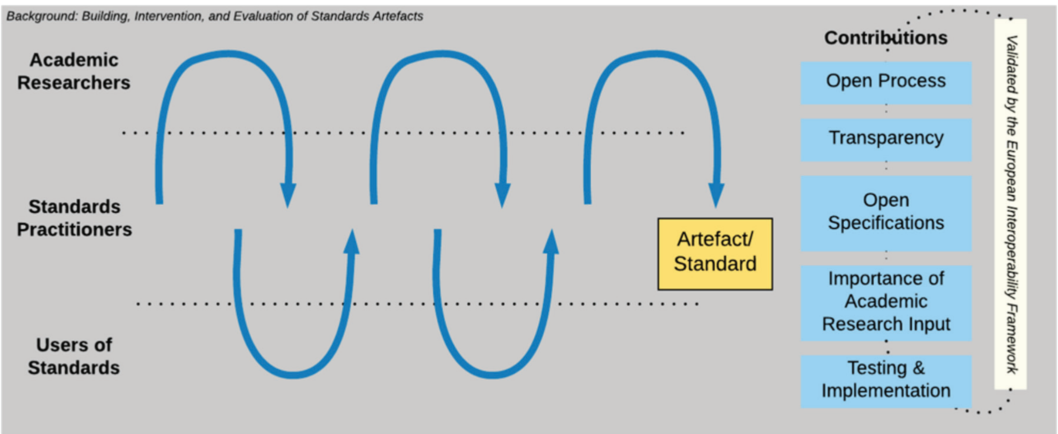



**Figure 2. An ideal model of standards-setting coming out of the background research contribution (adaptation of Sein et al., 2011)**




developed draft concepts and design ideas with the implementers community through several iterations, before finally agreeing to go for a final design, e.g., setting a standard.

The output of the BIE process is a contribution to the knowledge base. In Figure 2 we have included the output from the background research, i.e., the importance of academic input, openness and transparency, and open standards for testing and implementation in the adoption community. These contributions, we would claim, are supported by general policy recommendations in the newly published revision of the European Interoperability Framework (EC, 2017c). (This is further elaborated in the Discussion section of this paper.)

Superimposing the DSR process model on standardisation as done in the model in Figure 2 gives us a new lens to analyse anticipatory standards projects, as the one to be presented in the next section. However, if this model were to be proposed as a new and ideal model for standards-setting it would raise a number of questions related to how standardisation is justified and how participation in the process i regulated. The scope of this research is merely to explore how standards-setting in a particular domain can take place when the field of knowledge is emergent and the knowledge development is in the Invention quadrant of knowledge contribution model described in Figure 1.

## 4. FOREGROUND: LAUNCHING AN ISO PROJECT ON LA PRIVACY AND DATA PROTECTION POLICIES

In the following case study, we present the SC36 project "20748-4" with the title "Information technology – Learning, education, and training – Part 4: Privacy and data protection policies". Formally, this project developing a technical specification was established end of 2017. However, the project has been prepared in SC36 WG8 for more than one year as a natural offshoot of a multipart standard project on LAI. Though several meetings editors had prepared a lengthy draft that was submitted as a base document for the new work item proposal.

The following is a participatory observation account of how the lead editor of 20748-4 has experienced preparing the first draft of this part of the multipart standard.

### Preliminaries

The project on privacy and data protection policies originates from the reference model of LAI (ISO/IEC TR 20748-1, 2016). The model identifies six main processes of LA, i.e., selection of learning activity, data collection, storing and processing of data, analysis, visualisation, and feedback actions. In developing this model, it became clear that each and every process had issues related to privacy and data protection. Participants in the Part 1 project (20748-1) had struggled to make sure these issues were represented in the model, as privacy had not yet surfaced as an important issue related to LA in some constituencies, and in some standards-setting consortia privacy was beyond the scope of LA systems (Hoel & Chen, 2016). By identifying privacy and data protection policies as a cross-cutting concern affecting all LA processes a consensus formed in WG8 on the need for a separate part on privacy for LA.

When the drafting work of the new part started in 2015 it became clear that one was specifying a moving target. In Europe, the EU General Data Protection Regulation was passed 14 April 2016 after more than four years of negotiations, to become active 25 May 2018 (European Commission, 2016). Also, in Asia, privacy was discussed. Japan's update of their privacy laws took effect in mid-2017 (Lovells, 2017). An analysis of the privacy frameworks of OECD, APEC, and EU showed that there was a lot of common ground in how privacy was conceptualised (Hoel, Griffiths, & Chen, 2017). However, privacy is also a contextual concept; when putting a data collection scenario to the test of contextual integrity[2] (Nissenbaum, 2014) the responses of Korean stakeholders and Norwegian stakeholders may differ considerably. The former may value the benefits for the group and go along with collection as long as there is no breach of confidentiality; while the latter may value the active consent of the individual and block collection until an affirmative action is registered. The new standard has an international reach, which means an ambition to reconcile very different expectations. In WG8 some participants expect an implementable specification that ensures privacy and data protection through technical means. Others may think such a solution would narrow the scope too much and expect a specification that also addresses the organisational and political levels of interoperability (EC, 2017c). While requirements for the one or the other solution are gathered LAI practices are formed and reflected upon in research. As an example, in supporting LA implementations UK Jisc has limited the scope of consent as a justification for data collection based on research by Cormack (2016a, 2016b). Jisc now stresses "a more dynamic idea of consent: consent as an organic, ongoing and actively managed choice, and not simply a one-off compliance box to tick and file away" (Cormack, 2017).

In summary, the setting up of a new project proved that the task was both complex and dynamic. Just keeping up to date with the new development in the field would be a challenge in a standardisation setting.

### Standards Committee Context

International standardisation is done according to directives regulating how to establish projects, develop drafts, building consensus, etc. Formal standardisation on national, regional and international level tend to follow similar rules as found in the ISO directives (ISO/IEC, 2016). Technical work is done in technical committees or working groups. Quality assurance and publishing is done by the standard body's management organisation, which is represented in the standards group by a secretary that makes sure the document centric process is followed by carefully archiving written records of progression of work.

Technical work should be done be according to the directives, both in spirit and letter; however, sometimes the two are not easily consolidated. Standards experts want to find solutions to wicked technical problems; the standards bureaucracy wants adherence to rules. For example, if appointment by a national body is necessary to take a seat at a working group (WG) table, one cannot just invite a domain expert out of the blue because of possible valuable input. Or, maybe there are ways to combine innovative specification with strict formality?

### Working Group Context

WG8, the working group in question, is the latest WG to be established in SC36, with participation from a wide range of countries, e.g., Australia, Canada, China, France, Japan, Korea, Norway, and UK. Traditionally, editorial roles have been allocated between participants with representativeness in mind, even if the number of active editors has not always matched the nominal number. For the new project, editors from Norway, Canada, Korea and Japan were approved (joined by a second Korean editor at a later stage).

### Drafting Process

The key to a good drafting process is a well-defined scope (Hoel & Mason, 2012; 2011). The proposed scope of 20748-4 is to specify attributes and requirements for privacy and data protection with the purpose to inform design of LA systems development and LA practices. In delivering on this scope, it is a challenge to solicit requirements and other input, knowing that formal standardisation of this type does have a major problem in engaging with stakeholders that walk the talk (Hoel, 2013).

Another challenge is related to the drafting and consensus process itself. The process is document centric, with emphasis on version tracking and storing in a dedicated repository. Once the document is circulated as a working draft at the preparatory stage, experience from participation in SC36 working groups shows that it is very difficult to suggest restructuring of the text or adding new perspectives. When formal commenting is initiated, – with each national body entering comments into a spreadsheet, detailing the issue related to specific text fragments, and suggesting replacement text –, the drafting changes mode and takes the form of wordsmithing. Therefore, it is essential to present a draft that is as coherent and finished as possible, before it is being discussed in the working group (and even in the editorial group when it consists of several persons). In some projects, this challenge is addressed by initiating a study period, which could end up with ideas for a draft text. However, in the case of 20748-4 the editorial group was supposed to develop the first working draft from scratch.

### Standards Drafting as Part of Research

Even though there was a formal call for contributions, the lead editor of 20748-4 knew that the necessary input solicitation and testing of ideas had to take place outside the standardisation process as such. With the European debacle of the CEN working group fresh in mind (see section 2), it was clear that all activities involving sharing ideas and documents, inviting comments and inputs, etc., had to be balanced against the formal statues of ISO. In practical terms that meant keeping a paper trail, feeding the document registry and organise announced meetings.

Within the research community there is a growing interest in privacy issues related to LA due to the fear that ethics and privacy might pose a *show-stopper* to large-scale implementation (Griffiths et al., 2016). In 2016 the Journal of Learning analytics published a special issue on ethics and privacy in LA. A number of workshops on the issue were organised as part of academic conferences. These academic contributions were valuable input to the 20748-4 project, and research papers that discussed and tested ideas and perspectives were contributed as experts' contributions and filed in the ISO document store. In addition were WG8 meetings co-located with academic conferences and meetings; and national experts that later would have formal roles in the standard-setting group were engaged to discuss privacy and data protection issues at workshops. Overall, the editors of this project have felt that the research community is more than willing to share their work and comment on issues on privacy and data protection for LA.

### Consensus Process

Without knowing the final result of the project under study, we can only report on the processes that we have observed so far. By establishing conduits between a research community with an ongoing conversation about issues of ethics and privacy for LA, and the standards community we have created an influx of viewpoints and perspectives that also is reflected in the draft project document. When co-editors step up to representing national positions we will see how draft text will be evaluated against different conceptions that could take the document in different directions.

The normative basis for privacy varies considerably among the experts taking part in this work, and one would expect that this will play a role in further development of the project. Figure 3 describes balancing interest data controllers will do collecting data for LA, depending on legislative regimen (Hoel & Chen, 2017).

In education there are both legitimate interests of the institution to collect data (without asking for consent) and an ethical obligation of the educator to see the individual as self-asserting person (with the right to consent). Where one would put the emphasis could depend on how the culture value the individual versus the collective as described in Figure 4.

In addition to different normative perspectives a potential conflict may arise from different expectations to what a technical specification should encompass. Should it be limited to a technical system view, or should also organisational and policy guidelines be included?

## 5. ATTEMPTING INNOVATION WHILE ADHERING TO THE RULES

Projecting the 20748-4 case onto the idealised model of standards-setting coming out of our background research (Figure 2), we see that there is only a partial fit. The interaction between academic researchers and the standard group participants was established in the project; however, the interaction with the users of standards seems to be missing. One might say that user perspectives were communicated through workshops organised as part of academic conferences. But there is no systematic testing of

**Figure 3. Balancing of interests, asking for consent to process personal data. (Hoel & Chen, 2017)**

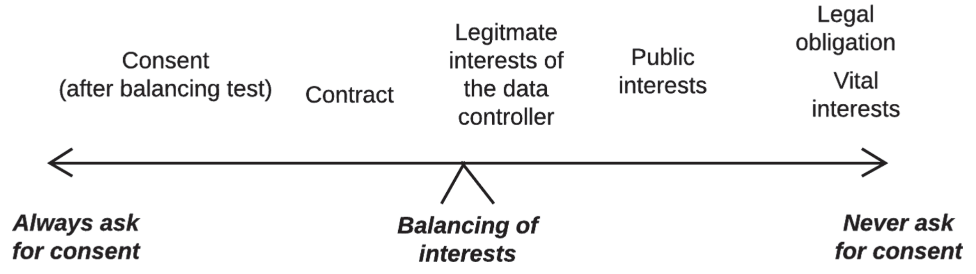
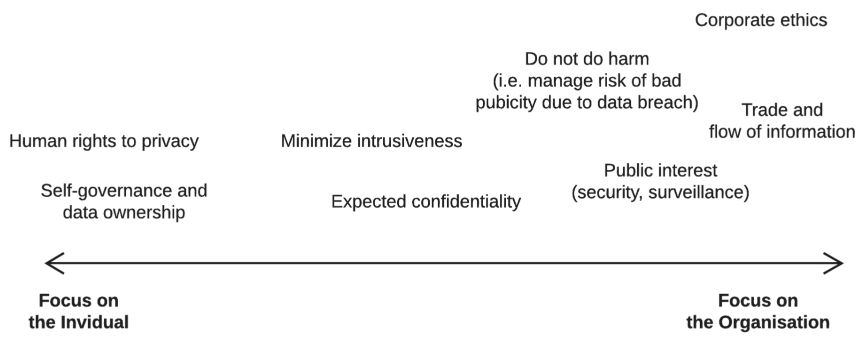


**Figure 4. Normative basis for privacy policies (Hoel & Chen, 2017)**

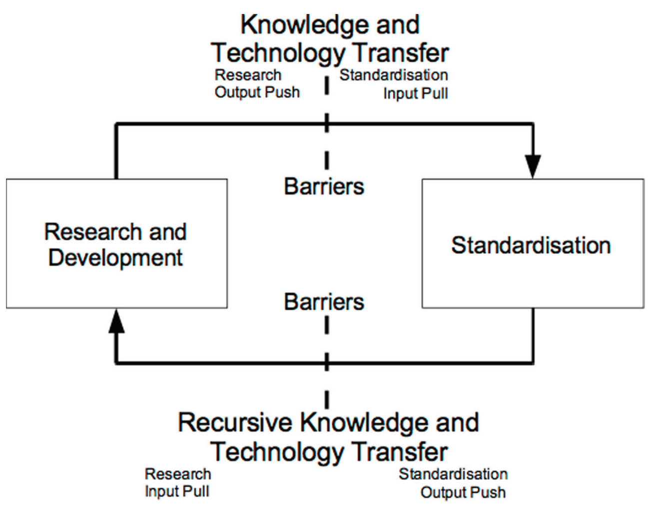



design concepts that are part of the 20748-4 project. However, this is a weakness that is inherent in anticipatory standardisation, where there is no clearly defined need when projects are initiated, and where the stakeholders are busy inventing new technologies, with no time for applying standards to level the playing field (Baskin, Krechmer, & Sherif, 1998; Jakobs, 2003; Umapathy, Purao, & Bagby, 2011). How the technical report on privacy and data protection policies for LAI will be received by vendors and educational stakeholders will only be known after publication. However, it is clear from the start that standards of this nature need to go through several development cycles to be able to serve its purpose.

Another observation comparing the 20748-4 case with the model in Figure 2 is that, in practice, there is an overlap between the roles of academic researchers and standards practitioners. In Action Design Research, teams are built where researchers work together with practitioners to design and test artefacts. In research on how Research and Development (R&D) interact with standardisation one has focused on how the different institutional contexts interact, and which barriers there are for effective knowledge and technology transfer (Figure 5) (Interest, 2007).

In the case we have reported, the role as researcher and the role as standards practitioner are often maintained by the same person. However, the acting out of the particular role is heavily influenced by the setting. In SC36, some participants fill roles as professors at national universities, and when observed in their own cultural context they act, as expected, very strongly and vociferously. In the

**Figure 5. The relation between research and standardisation (Source: Interest, 2007, p.4)**



setting of an international standards meeting, however, many of the same persons are hardly uttering a word and are very reluctant to expose their obvious mastery of the subjects in question. In order to establish the necessary basis for any design to take place, this pattern of acting out established roles needs to be broken. The work culture and directives of the formal standards organisation serve, as we have shown, as a considerable barrier against taking on multiple roles, switching between representing one's country or a stakeholder group, and entering a more open brainstorming and creative role. Therefore, in standards-making of the type described in this paper, there is a need to establish a repertoire of instruments to be used to soften the barriers against crossing role barriers.

What instruments do standards experts have in their toolbox to increase the knowledge base, on which anticipatory specification work builds? Are the rules intended to protect intellectual property and the standardisation organisation's business interest barriers to knowledge exchange?

In the case of sub-committees like SC36, the influence of the central ISO Technical Management Board (TMB) is mostly felt when projects are marked red because the deadlines are exceeded. How information is exchanged and the experts communicate are not interfered with from ISO TMB, providing they find a paper trail and the committee as such is not under special observation because of mismanagement or conflicts. If the experts want to do expansive knowledge seeking and exchange, not much could prevent them from doing so. The barriers are mostly cultural. Formalities are invoked only if there are disagreements, as long as the minimum level ISO document management process is followed.

It shall be noted, however, that the flexibility is quickly diminished as soon as the document is moved beyond the preparatory stage. In Table 1 we have summarised some instruments that are available to enhance knowledge and technology transfer in anticipatory standardisation and listed who could act at different stages of the standardisation process. The table is constructed by contrasting the provisions in the ISO directives with observations made in the context of SC36 work. Table 2 provides a summary of settings.

Standardisation is a carefully staged process, where the window of opportunity for new and alternative perspectives closes early. Standardisation as an activity is as much about consensus-making as about design. Of course, without any design, there is nothing to consent about. But one will be surprised how easy it is for a consensus process to 'dumb down' a technical proposition. As the 20748-4 case study showed, it is critical to get the preparatory stage right, as one does not get a new chance to bring in new content and perspectives when the committee stage is entered.

## 6. DISCUSSION – IDENTIFYING RESEARCH GAPS

Standardisation work typically involves conceptual, technical, and political activities that together are focused on achieving consensus among a group of stakeholders. The outcome – a standard – is essentially just a document that represents a stable reference point and sometimes includes detailed technical specifications. How this document is viewed, however, both by the stakeholders and the standard-makers may differ considerably (Ecke et al., 2008). In some countries, standards are seen as vehicles for execution of national or regional government policies. China may here serve as a case in point. While in other countries more driven by market economy, like in Europe and USA, standards are mainly recommendations that is up to the market to embrace. We would therefore claim that to understand the process and outcome of a particular standardisation process, one need to understand the national policy context of the national experts taking part in the project. This is an area where little research is done till now.

Standardisation is also a design activity that has much in common with innovation processes, both in the technical, organisational and political fields. In this paper we have pointed to the importance of relating to methods and approached from the academic research field, where for example openness and transparency play important roles in promoting innovation.

**Table 2. Summary of settings that could be used as border crossing instruments in design of anticipatory standards**

| Stage (as described in ISO Directives) | Design-setting Actor | Instruments to improve design input & testing |
|---|---|---|
| Preliminary stage (➔ proposing new work item) | Standards Committee (SC)<br>Research Community<br>End-Users | SC should avoid multipart standards projects to ensure new work item (NWI) proposal procedures with proposals for justifications and scope.<br>Research should acknowledge standardisation as knowledge creation activity and plan for interaction through targeted input.<br>End-user requirements should be solicited through Action Design Research projects. |
| Proposal stage (➔ new work item) | National Standards Bodies (NSB)<br>Standards WG | More rigorous examination of NWI justifications and scope.<br>Selection of editor(s) based on technical qualifications, as well as relationship to research and stakeholder groups.<br>Active planning of drafting process (allowing co-location with academic research events). |
| Preparatory stage (➔ working draft) | Research<br>Editors WG | Organise and coordinate research events and encourage publishing of workshop papers based on standard projects.<br>Organise academic fringe events that pickup themes of active standards projects. |
| Committee stage (➔ committee draft) | SC | Strict enforcement of deadlines; cancellation of dubious projects rather than resuscitation. |
| Enquiry stage (➔ enquiry draft) | NSB | In doubt, NSBs should vote no (instead of abstaining) to projects they don't see the value of.<br>Ballot commenting should be used to either improve or block standards (no automatic sanctioning because "standards are inherently good"). |
| Approval stage (➔ final draft international standard) | NSB WG / SC | At this stage it is the vote of the NSBs that matters, however, WG/SC should start planning supplementary documents supporting implementation. |
| Publication stage (➔ international standard) | NSB | NSBs should have an implementation strategy that solicits feedback from end-users that are fed into the revision loops. |

Interestingly, when the European Commission in 2017 published a new and updated version of the European Interoperability Framework (EIF) these principles got a prominent role (EC, 2017c). In the new version openness is an underlying principle that is defined in terms of a preference for open data (Recommendation 2), open source (Rec. 3), and open specifications (Rec. 4). The new version of EIF also underlines the principle of transparency. In the EIF context, transparency refers to enabling visibility ("allowing other public administrations, citizens and businesses to view and understand administrative rules, processes, data, services and decision-making"); ensuring availability of interfaces with internal information systems; and securing the right to the protection of personal data. Under which conditions in a standardisation setting will innovation thrive, and what roles do the academic research principles like openness and transparency play for the process of standards-making and quality of specifications? This is another under-researched field we have identified in this paper.

Standardisation processes are also about group dynamics, often in a multi-cultural setting. It is important to understand how particular groups deal with the different processes of standards-making, described in Fomin, Keil, and Lyytinen (2003) as Design, Sense-making, and Negotiation. Hoel and

Pawlowski (2011) expanded on that model and constructed the new concept of Key Knowledge Sharing Point focusing on the intersection of Key Knowledge, Key Sharing Point, and Key Timing (Figure 6).

*Key Knowledge Sharing Points are described as transition points moving from one sub-process to another. At these points one should question if key knowledge is shared with relevant actors. Interventions are embedded processes that make use of dedicated tools, e.g., conceptual modelling, study period, request for comments, etc. (Hoel & Pawlowski, 2012)*

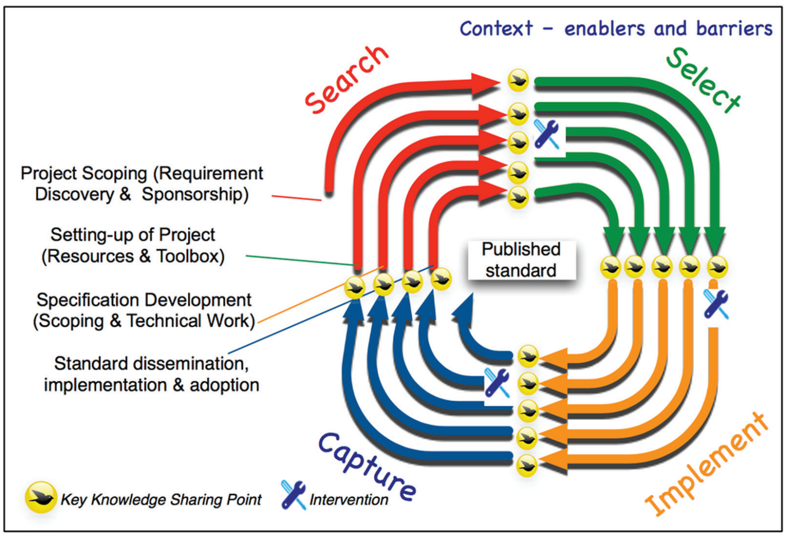
The third research gap identified in this paper is to find a better understanding of when exchange of key knowledge is necessary to support a process that both results in good design and consensus.

This paper has contributed to the understanding of how standards-making is situated in a multi-cultural, working group specific, and domain specific context. However, we would claim there is more research needed to fully understand how to design a process that will give an optimal result embarking upon a new work item in ICT standardisation for learning technologies.

## 7. CONCLUSION AND FURTHER WORK

This paper is part of an ongoing reflection on our own practice in the field of design for learning technologies, in particular through international standardisation. We have established a background of what we would understand as best practices related to the management of standardisation processes that would support innovation, especially in creating anticipatory standards. On this background, we have carried out a case study of an ongoing project in the field of privacy and data protection for learning analytics. Based on this case study we have reflected on the relationship between the academic research community, the standards community and the adopters of standards. The case study has contributed to identifying several gaps in current knowledge about the processes in question. However, as with any case study, we should acknowledge its limitations when it comes to generalise about standard-setting in other domains. Addressing the identified gaps in the work of SC36 and reflecting upon further research related to international standards development in the domain of learning technologies, this paper concludes with some ideas to pursue:

**Figure 6. A model of Standard Development Processes and Stages (Hoel & Pawlowski, 2012)**



### Regarding the Multi-Cultural Aspect of International Standardisation and the Need to Understand National Policy Contexts

Current conception and organisation of work build on the idea that requirements flow from national stakeholders via national, regional and international standard bodies to the standards group. And when the work is done, the new design flows back and is welcomed by eager stakeholders who have waited for their problems to be solved. What if both perceptions are wrong? We would suggest the selection of a small number of projects being worked on by international standards groups, see who is active as experts, and then go back to their countries to see what are the national context for the standards work items. It might be that for a particular country the experts only needed the project to be accepted (not finalised), and having a role as editor to be qualified for national funding of related research. Or in another country, the might be no national interest for a new standard, only interest for experts to travel and be part of a community. These are speculative results that might come out of national case studies. It is easy to see that such data would enrich studies of internal standards group processes.

### Regarding Academic Research Principles and Standardisation Procedures

It is more than a decade since the Copras project finished, identifying barriers against cooperation between research and standards, "such as confidentiality, IPR or membership of a standards organization, mapping research activities with standards work, or finding the standards and standards organizations most relevant to a project, and contacting them" (Copras, 2007b). We have in the Discussion section of this paper shown that the new EIF promotes transparency and openness in an unprecedented way related to interoperability projects. The last decade open access, open educational resources, open data, and open research have become the focus of most research communities around the world. Therefore, we would suggest there is scope to revisit some of the Copras project's research questions to get an updated view on how the two communities cooperate.

### Regarding Better Understanding of the Design Process

The process of drafting a standard does not usually involve many design cycles as prescribed by DSR. Therefore, the process will suffer from premature designs that are not tested and re-conceptualised before final publishing. We will suggest comparative research, exploring how standards development processes could be improved using some of the techniques from for example computer science design.

## REFERENCES

Baskin, E., Krechmer, K., & Sherif, M. H. (1998). *The six dimensions of standards: Contribution towards a theory of standardization. In Management of Technology, Sustainable Development and Eco-Efficiency* (pp. 53–62). Oxford, UK: Elsevier.

Blind, K., & Gauch, S. (2009). Research and standardisation in nanotechnology: Evidence from Germany. *The Journal of Technology Transfer*, *34*(3), 320–342. doi:10.1007/s10961-008-9089-8

Bolin, S. (2003). *Innovation and legislation: standardization in conflict.* Retrieved from http://www.thebolingroup.com/Dynamic_Tension_Conference_writeup.pdf

Brusse, B. (2005). Improving the interface between IST research and standardization. *Presentation at INTEREST workshop*, November 16.

Copras. (2007a). *Standardization Guidelines for IST research project interfacing with ICT standards organizations.* Copras consortium partners. Retrieved from https://www.w3.org/2004/copras/docu/D27.pdf

Copras. (2007b). *Final report*. Retrieved from https://www.w3.org/2004/copras/docu/D29.pdf

Cormack, A. (2016a). A data protection framework for learning analytics. *Journal of Learning Analytics*, 91–106. doi:10.18608/jla.2016.31.6

Cormack, A. (2017). GDPR: *A new kind of consent.* Retrieved from https://community.jisc.ac.uk/blogs/regulatory-developments/article/gdpr-new-kind-consent

Cormack, A. N. (2016b). *Downstream Consent: A Better Legal Framework for Big Data.* Journal of Information Rights. *Policy & Practice*, *1*(1). doi:10.21039/irpandp.v1i1.9

EC. (2017a). *Rolling plan for ICT Standardisation.* Retrieved from http://ec.europa.eu/growth/content/2017-rolling-plan-ict-standardisation-released_en

EC. (2017b). *The annual Union work programme for European standardisation for 2017.* Retrieved from http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52016DC0357&from=EN

EC. (2017c). *European Interoperability Framework – Implementation Strategy.* European Commission. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. Com(2017) 134 Final Online: https://Ec.Europa.Eu/Isa2/Eif_En

Egyedi, T. M., & Sherif, M. H. (2008). Standards' dynamics through an innovation lens: Next generation ethernet networks. In *Innovations in NGN: Future Network and Services, 2008. K-INGN 2008. First ITU-T Kaleidoscope Academic Conference* (pp. 127–134). doi:10.1109/KINGN.2008.4542258

European Commission. (2016). *REGULATION (EU) 2016/679 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 27 April 2016* on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC (General Data Protection Regulation).

Fomin, V., Keil, T., & Lyytinen, K. (2003). Theorizing about Standardization: Integrating Fragments of Process Theory. In *Light of Telecommunication Standardization Wars. Sprouts: Working Papers on Information Environments*.

Gregor, S., & Hevner, A. R. (2013). Positioning and Presenting Design Science Research for Maximum Impact. *Management Information Systems Quarterly*, *37*(2), 337–355. doi:10.25300/MISQ/2013/37.2.01

Griffiths, D., Drachsler, H., Kickmeier-Rust, M., Steiner, C., Hoel, T., & Greller, W. (2016). Is Privacy a Show-stopper for Learning Analytics? A Review of Current Issues and Solutions. *Learning Analytics Review, 6.* Retrieved from http://www.laceproject.eu/learning-analytics- review/privacy-show-stopper

Hoel, T. (2014a). Lack of openness as a potential failure in standardisation management – lessons learnt from setbacks in European learning technology standardisation. *Presented 2014-03-24 at I-ESA Workshop on Standards Management workshop*. Retrieved from http://hoel.nu/publications

Hoel, T. (2014b). Standards as enablers for innovation in education – the breakdown of European pre-standardisation. *Proceedings 2014 - Kaleidoscope 2014 - Living in a converged world - Impossible without standards?* Retrieved from http://handle.itu.int/11.1002/pub/80a5593d-en

Hoel, T., & Chen, W. (2016). Privacy-driven design of learning analytics applications: Exploring the design space of solutions for data sharing and interoperability. *Journal of Learning Analytics*, *3*(1), 139–158. doi:10.18608/jla.2016.31.9

Hoel, T., & Chen, W. (2017). Towards Developing an Educational Maxim for Privacy and Data Protection in Learning Analytics. *Presented at EC-TEL Workshop on Ethics and Privacy for Learning Analytics*, Tallinn, Estonia, September 12. Retrieved from http://hoel.nu/files/EC-TEL_EthicsPrivacy_workshop_paper_2017-09-12.pdf

Hoel, T., Griffiths, D., & Chen, W. (2017). The influence of data protection and privacy frameworks on the design of learning analytics systems. In *Proceedings of the Seventh International Learning Analytics & Knowledge Conference* (pp. 243–252), New York, NY: ACM Press. doi:10.1145/3027385.3027414

Hoel, T., Hollins, P. A., & Pawlowski, J. M. (2010). On the Status of Learning Technology Specifications and Standards. *International Journal of IT Standards and Standardization Research*, *8*(2).

Hoel, T., & Mason, J. (2011). Expanding the Scope of Metadata and the Issue of Quality. In T. Hirashima et al. (Eds.), *Proceedings of the 19th International Conference on Computers in Education*. Chiang Mai, Thailand: Asia-Pacific Society for Computers in Education.

Hoel, T., & Mason, J. (2018). *Standards for Smart Education - towards a development framework*. In *Smart Learning Environments.* Springer Open.

Hoel, T., & Pawlowski, J. M. (2011). Key Knowledge Sharing Points: Exploring a new Concept for Studying Crossroads in Global Innovation Projects. In *Proceedings of the European Conference on Knowledge Management*, University of Passau, Germany, September 1-2.

Hoel, T., & Pawlowski, J. M. (2012). Managing standards development in emergent fields of technology innovation – a proposed model of key processes in ICT standardisation. In *Enterprise Interoperability - Proceedings of the Workshops of the Sixth International Conference I-ESA '12*. London, UK: ISTE Ltd.

Interest. (2007). *INTERST Integrating Research and Standardisation. Final Report*. Retrieved from http://cordis.europa.eu/docs/publications/1248/124857051-6_en.pdf

ISO/IEC. (2016). *Directives, Part 1. Consolidated ISO Supplement – Procedures specific to ISO. Seventh edition, 2016*. Retrieved from http://www.iso.org/sites/directives/2016/consolidated/index.xhtml

ISO/IEC TR 20748-1:2016. *Information technology for learning, education and training -- Learning analytics interoperability -- Part 1: Reference model.* Retrieved from https://www.iso.org/standard/68976.html

Jakobs, K. (2000). *Standardisation Processes in IT. Impact, Problems and Benefits of User Participation*. Springer Verlag.

Jakobs, K. (2003). Information Technology Standards, Standards Setting and Standards Research. *Paper presented at Stanhope Center's Roundtable on Systematic Barriers to the Inclusion of a Public Interest Voice in the Design of Information and Communications Technologies* (pp. 1–21).

Jakobs, K. (2009). *A Fly on the Wall at Standards Bodies' Working Groups.* Lecture Notes In Informatics. Gesellschaft für Informatik. Retrieved from http://cs.emis.de/LNI/Proceedings/Proceedings154/gi-proc-154-229.pdf

Long, P., & Siemens, G. (2011). *Proceedings of the 1st International Conference on Learning Analytics and Knowledge*. Retrieved from https://dl.acm.org/citation.cfm?id=2090116

Lovells, H. (2017). *Changes in Japan Privacy Law to Take Effect in Mid-2017; Key Regulator Provides Compliance Insights*. Retrieved from https://www.lexology.com/library/detail.aspx?g=efa0a2b0-b73e-456c-b4fa-26a268e9e751

Nissenbaum, H. (2014). *Respect for Context as a Benchmark for Privacy.* Online: What It Is and Isn't. In "The Future of Privacy", Foundation Télécom, Institute Mines-Télécom. Retrieved from http://cvpip.wp.mines-telecom.fr/files/2014/02/14-02-The-futur-of-privacy-cahier-de-prospective.pdf

Sein, M. K., Henfridsson, O., Purao, S., Rossi, M., & Lindgren, R. (2011). Action Design Research. *Management Information Systems Quarterly*, *35*(1), 1–20. doi:10.2307/23043488

Sherif, M. H., Jakobs, K., & Egyedi, T. M. (2007). Standards of quality and quality of standards for telecommunications and information technologies. *Challenges in the Management of New Technologies*, *1*, 427–447. doi:10.1142/9789812770318_0029

Umapathy, K., Purao, S., & Bagby, J. W. (2011). Empirical analysis of anticipatory standardization processes: A case study. *Information Systems and e-Business Management*, *10*(3), 325–350. doi:10.1007/s10257-011-0169-1

Yin, R. K. (2009). *Case study research: Design and methods*. Thousand Oaks, CA: Sage.

## ENDNOTES

1 Learning analytics is the measurement, collection, analysis and reporting of data about learners and their contexts, for purposes of understanding and optimising learning and the environments in which it occurs.

2 Does the appropriate information flow conform with the contextual information norms. These norms refer to the five independent parameters: data subject, sender, recipient, information type, and transmission principle.

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# VIII

# ARE NORWEGIAN ACADEMIC LIBRARIANS READY TO SHARE USAGE DATA FOR LEARNING ANALYTICS?

by

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# Are Norwegian academic Librarians ready to share Usage Data for Learning Analytics?

***Peer Reviewed***

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**Abstract**

University libraries offer services that generate data about how students and faculty use knowledge sources and engage with teaching and learning. In an era of Big Data there is mounting pressure to use these data, something that challenges the professional ethics of librarians. This paper explores how Norwegian librarians position themselves in relation to the new phenomenon of learning analytics, which would like to process library data to help improve learning and its contexts. A literature review shows that librarians in general are highly skeptical to let any information that is not anonymised out of their hands to be used by other professions. However, library data is increasingly being shared with third parties as part of development of library systems and practices. In a survey presented in this paper Norwegian librarians were asked about their willingness to take part in analytics and data sharing. The findings show that even if librarians in general do not want to share data that reveals personal information, their resistance will depend on the consent of the students, and to which degree librarians themselves are involved in processing and analysis of the data. This study identifies learning analytics as a field the library community should engage with, and the authors give their advice on what should be focused to sustain librarians' professional ethics related to use of library data.

**Keywords:** library data, learning analytics, data sharing, privacy, data protection

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## Introduction

Smart use of data to give new insights for students and employees; this is a key point in the "strategy for digital transformation" of the new Oslo Metropolitan University (2018). The use of the word *transformation* indicates expectations of deep change that involves all departments of the university, also the library. This notion of *data* (Big Data) as the force behind substantial future change in the public sector has caught momentum in the last few years (Vivento, 2015). Tay (2016) has identified four trends that will make librarians more engaged in data and analytics. First, there is a rising interest in Big Data, data science and artificial intelligence in general. Second, library systems are becoming more open and more capable at analytics. A case in point is the 2015 - 2016 update of library systems in more than hundred Norwegian higher education institutions from a national solution to the multi-national Alma system from the Israeli Ex Libris company. Third, assessment and increasing demand to show value of libraries is a hot trend. And, as the fourth trend, Tay (2016) lists the rising interest in learning analytics.

Learning analytics (LA) is the measurement, collection, analysis and reporting of data about learners and their contexts, for purposes of understanding and optimising learning and the environments in which it occurs (Long & Siemens, 2011). Since the 1st International Conference on Learning Analytics and Knowledge was organised in 2012, LA has emerged as a research field now influencing educational policy development worldwide. However, at an early stage, privacy was identified as a stumbling block for large-scale implementation (Griffith et al., 2015; Hoel & Chen, 2016a; Hoel, Griffiths, & Chen, 2017). Traditionally, librarians have been the most astute champions of data privacy among all public sector professionals (Library Freedom Project, n.d.). Item 10 of the ethical guidelines of Norwegian Library Association states: "Librarians shall make sure that the users' needs for literature and information and other personal information are handled with confidentiality". To ensure this principle is understood the guidelines reiterate, "if other persons or institutions ask for information about the users' needs for information and literature it shall not be given" (Norsk Bibliotekforening, n.d. Authors' translation). With the advent of Big Data, library analytics, and now learning analytics this principled position of no data sharing may be more difficult to hold. Librarians have always worked on statistics, analysing library loans, usage of their collections, etc. What is new is that the data generated in the libraries are assets that are wanted and exchanged across systems and groups of stakeholders, and that these assets carry values also for other groups than library users, who are the primary beneficiaries in the ethical guidelines of the library association.

It is interesting to note that Tay (2016) suggested that LA would have the strongest impact on analytics use in libraries. He suggested a list of activities "in increasing level of capability and perhaps impact":

> Level 1 - Any analysis done is library function specific. Typically, ad-hoc analytics but there might be dashboard systems created for only one specific area (e.g collection dashboard for Alma or web dashboard for Google analytics)
> Level 2 - A centralised library wide dashboard is created covering most functional areas in the library
> Level 3 - Library "shows value" runs correlation studies etc
> Level 4 - Library ventures into predictive analytics or learning analytics (Tay, 2016)

Not many academic libraries are at level 3 or 4 (Oakleaf, Whyte, Lynema, & Brown, 2017). Moving up the ladder silos get broken and collaboration with other professional groups increase. We also see that there are forces outside of the library that approach library data. In a blog post from the UK Jisc LA architecture initiative it is explained, “we started off with VLEs [another term for LMS - learning management system], moved on to student records, but we’re now looking to extend our xAPI VLE approach to library data” (Baylis, 2016). The ICT departments and the teachers who promote online learning in education are turning to the libraries to get data on students’ use of the library.

However, there a few studies that show how librarians will meet the demand for library data and collaboration with professionals that pursue a LA agenda. There are no studies giving voice to Norwegian librarians. Internationally, we see that librarians now raise questions, e.g., the journal *Library Trends* put out a call for papers to a special issue on LA and the academic library (publication scheduled to March 2019), indicating a rather strident position:

> This issue will invite authors to explore and push back against statements that learning analytics will somehow improve academic libraries by addressing questions around political positions and value conflicts inherent to learning analytics, coded in related information systems, and embedded in emerging data infrastructures. (Library Trends, n.d.)

An extensive search of literature, both from the library and the LA related communities, makes us conclude that there is very little research on both political, legal, organisational and technical aspects of exchange of usage data between libraries and other parts of educational institutions for use in LA. This represents a research gap that this paper identifies, and to a small extent starts to address.

In this paper, we explore how Norwegian libraries and librarians are prepared and willing to share library data for use in analytics. The guiding research questions are:

*1.* Are the library systems used in higher education in Norway prepared for sharing data for use in LA?

*2.* The traditional position of Norwegian librarians is, what takes place between the librarian and the library user stays between the two. Are the librarians willing to leave this position to engage in LA with stakeholders outside their own profession?

We will proceed this paper with reviewing national and international literature to see if these issues are addressed in library and other research. Based on our research questions and the identified research gaps we have designed an mixed method approach of document studies and a survey. This approach is further described in the Methodology section of this paper.

## Related work

Data analytics is a new field of research and practice, both for library and learning sciences. So when the library community enters into discussion with learning scientists, computer scientists, university administrators and others it is to be expected that this is from the normative position of protecting patron privacy (Johns, & Lawson, 2005; Bowers, 2006; Hess, LaPorte-Fiori, & Engwall, 2015; Ferguson, Thornley, & Gibb, 2016; Hegna, 2016). We start this review of related work by exploring how this normative position i reflected in recent Norwegian and international discourse.

In Norway, there is no tradition to share library usage data outside of the library, with other departments of the university, or with third parties. The historical roots to this tradition, and why Norwegian librarians value privacy so strongly, can be traced back to the near political history. As Lynch (2017) points out, "[t]here is a long and ugly history of efforts by various authorities to monitor and control what people read". Librarians know about the McCarthy era in USA, but there are examples closer to home. In 1979 in Denmark, a court ordered a library to give police information about the loans of a person (Hegna, 2016). In Norway, many librarians along with other citizens asked for their surveillance files from the tumultuous 1970s, vividly described by Jon Michelet (2013), in his book "Mappa mi (en beretning om ulovlig politisk overvåking)". The authors of this paper do not know if there were examples of information leaking out of libraries; however, the interest of the Norwegian police in the reading habits of the citizens could be compared to McCarthy's, judged from what one of the authors of this paper found in his files. These experiences do not invite librarians to handle exchange of library data lightly. However, these incidents were before the Internet era. Now, there are other concerns, as new library systems, new online practices and new business models will put the tradition of confidentiality and data privacy under pressure.

Hegna (2016) claims that by outsourcing collections, systems and services the libraries abandon their role as an "anonymising broker" between the user and the sources of knowledge, not being able to guarantee privacy any more. When downloading papers the local users are registered by the publisher or distributor, not by the library – and the usage is no longer anonymised. The distributors analyse usage patterns of books. The library systems are hosted on servers outside of Norway. These are only some of Hegna's examples of how the control of the libraries of personal data relating to library use is eroding. When discussing what could be done to counter these trends Hegna touches also upon analytics:

> Data limitation. The library should ask which user data it needs to carry out its tasks. (…) Under no circumstances must the library share personal information about its services to others, whatever good intentions they might have. *This applies for example to requirements for library data to study reading patterns related to learning analytics.* (Hegna, 2016, p. 17. Authors' translation and italics).

Thinking back on 30 - 40 years of technological development, Hegna describes himself as an ambassador for "moving as many library services as possible out to the desktop of the users. Completely without any thought of this development ripping the libraries of their role as anonymising brokers" (p. 6. Authors' translation). In the Norwegian library community, Hegna has been an opinion leader for decades. Now he wants to put on the brakes and guide the libraries back to their core functions to save their professional values, and he wants librarians to have nothing to do with LA.

How do these views resonate with international library discourse? In the aftermath of the 9/11 attacks in 2001, US librarians have discussed how "library records are fair game for governmental agencies (…) the library patron will never have the opportunity to know that their library records have been examined" (Bowers, 2006, p. 381). Johns and Lawson (2005) also pointed to concerns among library users about online privacy due to the increased ability new technologies give to capture and retrieve data about library usage patterns and users. Ferguson, Thornley, and Gibb (2016) suggest that librarians' code of ethics are satisfactory on traditional library issues of access and confidentiality, "but do not address the ethical challenges of current and potential digital environments" (p. 550). They want the professional associations to communicate more with their members to provide tools that are more useful in the workplace.

This is in line with Hess, LaPorte-Fiori and Engwall (2015) who discuss how preserving patron privacy in the 21st century academic library is a balancing act, complying with professional ethics while adhering to federal-, state- and institution-level policies regarding student privacy and information security.

When it comes to the specific challenges facing libraries involved in LA initiatives, Jones and Salo (forthcoming) notes that little has yet been written. They point to Showers' (2015) book "Library Analytics and Metrics" as a notable exception. Showers (2015) claims that the boundaries of privacy are redrawn; while libraries traditionally played the role as 'heaven of privacy', now they are, without giving much thought to it, compromising privacy through for example encouraging the use of social-media widgets and sharing buttons. "The difficulty for libraries and cultural heritage institutions is that protecting the privacy of users is no longer responding against a clear and well defined threat. Indeed, it may even be perceived as an improved service or better user experience" (Showers, 2015, p. 154).

Showers' concern is that libraries may be "undermining some of the values they have traditionally held so dear" (Showers, 2015, p. 154). For Jones and Salo (forthcoming) these values, codified in The American Library Association (ALA) Code of Ethics, are the starting point for a strong warning that LA might jeopardise professional ethics. They find LA is at odds with librarians' professional commitments to promote intellectual freedom; protect patron privacy and confidentiality; and balance intellectual property interests between library users, their institution, and content creators and vendors (p. 4). To justify this position, Jones and Salo place LA as a type of Big Data practice, which is driven by an ethos of developing "boundless datasets", "taking an 'n=all' approach" (p. 4), with data scientists conducting "fishing expeditions" to look for patterns (p. 5). LA is understood as a business intelligence strategy; Jones and Salo do not believe the actionable insights of "datafying the learning experience" (p. 6) will help the students themselves. "To date, the level of access a student has to data and analytics about herself is still low, but access by institutional actors is high" (p. 9).

Jones and Salo hold the ALA Code of Ethics as a "fine-tuned code that can directly address issues with LA" (forthcoming, p. 15), and LA is in conflict, they argue, with especially three principles:

> II. We uphold the principles of intellectual freedom and resist all efforts to censor library resources.
> III. We protect each library user's right to privacy and confidentiality with respect to information sought or received and resources consulted, borrowed, acquired or transmitted.
> IV. We respect intellectual property rights and advocate balance between the interests of information users and rights holders. (American Library Association, 2008).

Regarding the 2nd ALA principle, Jones and Salo claim LA compromises intellectual freedom "when institutional actors, system designers, and algorithms limit opportunities to engage in the creation and consumption of intellectual material" (p. 16). It is the "nudging" techniques they have in mind, connecting learning environments to intellectual freedom – "the ability of an instructor to assess and penalise students for *not* responding to the nudge.

Regarding the 3rd principle, privacy and confidentiality, the two authors state that "LA naturally invokes privacy issues and concerns about confidentiality of personal information". They further note that "[s]tudent use of materials (e.g. books, articles, etc.) may be recorded, analyzed, shared with a variety of actors, and used to intervene in student learning and life choices". On this premise, Jones and Salo interestingly conclude: "These practices in turn damage intellectual freedom" (p.19).

Regarding the 4th principle on intellectual property, it is how informational and algorithmic products derived from student data could become trade secrets or marketable products (p. 22) that gives Jones and Salo the reason to fear LA.

In summary, Jones and Salo find that the library profession face an ethical crossroads, as "LA practices present significant conflicts with the ALA's Code of Ethics" (p. 26). For them, the only answer for librarians, they conclude, is to respond by "strategically embedding their values in LA through actively participating in conversations, governance structures, and policies" (p. 27). Comparing the arguments and sentiment conveyed in the papers by Hegna, and Jones and Salo we find a similarity in the description of LA and associated practices and the position and role of the library profession. The new digital practices are a distraction from the laudable core activities of an academic library defending intellectual freedom. And the librarians armed with their professional ethics should take a moral high ground embedding their values in conversations with other professions in the university.

Big Data and LA may accentuate the challenges of the information age; however, librarians have over the years developed their values. In the early years, ethical issues dealt primarily with librarians' responsibility to the employer or patron. "The focus later shifted to questions of professional identity, organisational environment, and social responsibilities" (Dole, Hurych, & Koehler, 2000). However, international examination of ethical values of information and library professional does not leave any doubt that even if previously accepted values are being challenged, there are some core values that will keep giving strong guidance. "On the whole, library professionals maintain, in the main, similar ethical values. These are, in order of values most frequently classed by professionals: service to the patron, intellectual freedom, preservation of the record, and equality of access" (p. 13). The service to the client or patron is the most important of the values, Koehler, Hurych, Dole, and Wall (2000) observers, identified "without doubt and almost without exception, [by] librarians of all kinds, in all positions, in all regions, and of both genders" (p. 19). Differences in the order of importance of values are on the second and third level, and "[w]here difference occur among library professions, these are probably a function of the different information roles and responsibilities of these information professionals" Koehler et al. (p. 19) assume.

This review of related work points to professional ethics and values as the framing of a the discourse that will come as a result of more focus on data sharing for LA within education. The works of Koehler (2006), Koehler et al. (2000), Dole, Hurych, and Koehler (2000), and Koehler and Pemberton (2000) explore how ethical values and codes of ethics both influence and are influenced by a changing technological landscape. Ayre (2017) underlines that both vendors, libraries, and patrons have a role to play in protecting patron privacy. No doubt the pressure on libraries to share data will mount, and we have to get more knowledge on how academic librarians are prepared for this development (ref our first research question). Related to the expected introduction of LA, this leads to the need to research what role the librarians will play in influencing the conditions under which the sharing of library data with other professions, departments and third parties, and what positions they have to questions on handling of data. This is the purpose of the empirical part of this research.

## Methodology

This study is based on literature review, document studies and an online questionnaire using Google forms. Initially, we wanted the questionnaire to target librarians in Norwegian higher education institutions. However, this group did no longer have a public e-mail list of their own, as they had joined the bibliteknorge@www.nb.no list that covers all 'Library Norway'. By using using this list for a convenience and snowball sampling we got 90 respondents, 72% of them from higher education, 11% from school libraries, and 11% from public libraries. 8% did not work in library. Analysis of the data showed that the different groups of librarians did not differ significantly in their responses.

The sampling method used in this study and the use of descriptive statistics have clear limitations. We are not able describe trends or infer anything about interaction between concerns. Nevertheless, we should be able to glean some information about current opinions and positions among Norwegian librarians related to access to and sharing of library data. We acknowledge that we are approaching a new field of enquiry. "Rapid technological change and the advent of the information age are forcing the library profession to rethink its mission and responsibilities" (Dole et al., 2000, p. 285). The questions were designed based on existing research on privacy and ethics in library and LA (Hoel & Chen, 2016; Mason, Chen, & Hoel, 2016). We particularly wanted to probe librarians' attitudes to sharing and analysis of different library data sources asking the respondents to specify their level of agreement using a Likert scale. We wanted to survey opinions on capture, storage and analysis of library usage patterns, both loans and literature search. We also wanted to know how librarians looked upon sharing data with other departments of the institution and with third parties. Our methods are well chosen for an exploratory study, where the aim is to describe the current state of affairs, identify tensions between current and potential new practices and to inspire further research on how HE libraries will meet the expectations of the sector's 'digital transformation'.

## Results

The first question was designed to probe the respondents' attitude to current practices embedded in the Alma library system in use in academic libraries in Norway. Today, the system does not store historic data about loans; when the material is returned to the library the log is deleted. The background is the regulations in the Data protection act (§8a) about user consent (Personopplysningsloven, 2000). Because Alma does not have a possibility of storing loans history based on an active choice of the users such records are not kept. Neither data logs on searches nor hit lists are stored in the current implementation of the Ex Libris system in Norway.

When asked if today's practice of not storing historic data on loans is necessary due to data protection reasons 60% of the respondents agreed, 22.2% disagreed, and 17.8% were neutral (Table 1). The law gives the users the last word about storage of their library loans data, and this is something that the librarians in our survey agree to. When asked if the students themselves should be able to choose if loans history should be made available for analysis, and for how long, a majority agrees. 72.2% agree, while 20% disagree (of them 13.3% strongly), and 7.8% are neutral. When probing into the details of loans history data it becomes clear that there are limits to how far the librarians in our sample are willing to go in letting the users decide. 45% agree that data about what is borrowed from the library (e.g., what paper or book) should not be stored by the system for later analysis. 25.8% were neutral, and 29.2% agreed that the data could be stored for later analysis.

Table 1.
*Attitudes to data sharing in libraries*

| | Disagreement | Agreement |
|---|---|---|
| **Today's practice** | 22.2% | 60% |
| **Students' choice should decide** | 20% | 72.2% |

When should logs showing loans of library materials be deleted? In our sample, 47.8% of the librarians were willing to reconsider today's practice and allow storage for as long as the course lasts or as long as the student has decided in the user profile. 35.6% would like to keep the practice of deletion after the material is handed in; 8.9% after one month; and 7.8% after 3 months.

Should a higher education institution be allowed to analyse library search history (Table 2)? 26.7% of our sample say no; 37.8% say yes, but only if the library itself does the analysis and it happens after consent from the user. 27.8% say yes, any Higher Educational (HE) department could do analysis if the users consent; while 7.8% did not have any opinion. This question gives an idea of how far the respondents in our study are willing to go in taking part in analysis with colleagues from other departments. We asked if they set as a condition for making library data more available for analysis, that the data are analysed within the confinement of the library (i.e. the data are not shared with other departments of the HE institution). 35.6% said yes, there should be such a condition; 21.1% said no; while 43.3% had no opinion. If library data should be shared with the whole institution, our respondents strongly advocates a solution where personal information is deleted and the data anonymised.

Table 2.
*Attitudes to make search history available for analytics*

| | No | Only by the library | By others with active consent |
|---|---|---|---|
| **Institution should be able to analyse students' search history** | 26.7% | 37.8% | 27.8% |

In the survey the librarians were also asked about possible data sources for LA. While around 80% of the respondents pointed to data related to the library object or to the course offering (Table 3), less, around half of the respondents, pointed to data sources related to persons. When asked what they thought about collecting data on use of key cards to library facilities, the answers were evenly distributed between the alternatives between 'wanted' and 'not wanted': 24.4% was strongly against, 8.1% against, 26.7% neutral, 19.8% for, and 20.9% strongly for such data collection.

Table 3.
*Potential data sources for learning analytics*

| Data source | Seen as important for LA |
|---|---|
| **Library loans (object, medium, distribution channel)** | 81.8% |
| **Use of library premises (person information)** | 51.1% |
| **Search history (person information)** | 47.7% |
| **Loan history (person information)** | 46.6% |
| **Loans (subject area, courses, institutes, etc.)** | 78.4% |
| **Search activity (subject area, courses, institutes, etc.)** | 79.5% |

With the debate on third party access to library data referred to in the literature review, we wanted to learn more about the librarians' thoughts about the current academic library practice. 51,6% of the respondents thought that third party organisations had little or very little access to reading patterns of HE library users. 30.3% took a middle position, and 18% thought it happened in some or large degree.

## Discussion

In the user agreement between the institutions and Bibsys, the provider of the library system Alma, it is stated, "if Alma later offers functionality for [storing logs on loans and usage history of returned items based on user profiles] such storage will be offered according to the user's choice" (Standard Norway, 2017. Authors' translation). While the library system provider is preparing for a future where more responsibility and choice are handed over to the individual our study shows that the Norwegian librarians are not there yet. However, our results could be interpreted in the direction that the librarians are willing to discuss new solutions where the students have more to say on sharing and analysing their library usage history. When asked if current practice is necessary out of data protection reasons one should expect a strong positive answer. 40 percent did not agree. And when asked if the students should have the final say if their library data should be analysed or stored a large majority agreed. This could be interpreted as an indication that Norwegian librarians have a student-centred focus with a willingness to respect the choices of the individual. We see this in the question of whether the student's search history should be available for analysis by the institution.

To analyse library search history could be seen as a much more intrusive and problematic activity than analysing loan history. The loans are actual student actions that may be traced in what the student delivers in essays, tests and conversations with teachers and fellow students. Searches represent ideas, dreams, and interests that may or may not be related to activities that the student wants to share with the institution. Nevertheless, only a quarter of the librarians in our sample said no to analysis of search history; 65.6% said yes, provided the students consented.

It seems that students' will trumps professional instincts. In our study, we do not have data to say anything about whether this willingness to let the students decide rests on a moral principle of respecting the individual's right to self-determination, or whether the librarians trust that students know what they are doing and will not be harmed. This question of trust versus the prerogatives of the role is raised again when we look at how the librarians in our sample relate to their colleagues in other departments and the institution as a whole. Yes, with consent by the users the search history could be analysed, but only by the library (37,8%). Only 27,8% were willing to give colleague from other departments access to the data.

In general, considering the data available in the library, one third of our sample would reserve the analysis to the library profession itself. The big group that did not have an opinion (43.3%) gives an indication that this is new territory for Norwegian academic libraries. For centuries, libraries have done academic analytics, using library data to manage collections, allocate resources, plan for new library space, etc. When more data becomes available, the first questions libraries seem to ask themselves are how library use links to student learning and success (Tay, 2016). As Oakleaf et al. (2018) observes, there are limitations to this approach, the key limitation being "a pattern of difficulties evolving from the limited data available to conduct this research". The solution Oalkleaf et al. offer as a way "to combat the challenges of too little, too siloed, and too imprecise data is to investigate and employ interoperability standards to enable integration of library data into institutional learning analytics systems". In Norway, learning analytics is just about to be introduced, mainly as a result of introduction of new library and learning management systems (LMS) across the HE sector (Standard Norway, 2017). Together with a newly established LA research centre in Bergen (slate.uib.no), and new national policies on digitalisation of education (Kunnskapsdepartementet, 2017) this will put issues of data sharing for LA on the agenda for academic libraries. The librarians will have to come to terms with how to collaborate with other professions in the institution, academics and administrators that value a variety of professional codes of ethics. It will certainly take more than an investigation into interoperability standards and technical challenges to achieve the integration.

The survey reported in this study could give a lead to a possible path that could make it easier to harmonise library analytics and learning analytics. The answers given to possible data sources for LA tell that librarians in our sample value the difference between data that exposes the individual versus data that refers to objects, subject areas, courses, activity types, etc. Data anonymisation is seen as a way out of this conundrum. With Big Data, however, anonymisation is an ideal that easily can be broken by re-identification made possible by combining different data sets (Hoel & Chen, 2016b). The way around this dilemma may be to put more emphasis on the users' control of their own data. The results of this study could indicate this as an approach which could appeal to librarians. We have seen that student choice and consent make it easier to accept exchange of information beyond the library user and librarian relationship. With the strong professional ethics that focuses on user agency librarians have a good position to promote a student-centred approach to analytics. It is not only the case that libraries need learning data to do library analytics; the pedagogical side of the aisle also needs library data not to be stuck in their siloed world of mainly LMS data. Kitto, Lupton, Davis, and Waters (2017) have voiced the need for a design for student-facing learning analytics.

> LA has placed surprisingly little emphasis upon providing the learner with tools that they can access to understand their own learning processes. This leads to a lack of

> learner agency and control over the data they generate while learning, which in turn may lead to privacy and ethical concerns. (Kitto et al., 2017, p. 153)

There are also other reasons for the librarian profession to engage in the question how library data are managed and shared. This research has revealed that Norwegian academic librarians do not have a unified view on how data on usage patterns of their users are available for third parties, e.g., publishers and distributors. The technical report recently published by Standards Norway (2017) gives a clear warning:

> A situation where third parties may have easier access to activity data from education than the sector's own professions is not only a library problem but a general problem that could have paradoxical effects. In a not too distant future one could foresee that a department or an institute will be offered to buy external services based on data from their own library – data they will not have access to because of the library guarantee of applying a confidential loans policy that is handled by not storing loans and search history data. (Standards Norway, 2017, p. 12. Authors' translation).

Norwegian academic libraries now implement new tools that connect their library system (Ex Libris) via APIs to other systems, e.g., the reading list system Leganto and the Learning Management System Canvas. This will most likely trigger both librarians' awareness and interest in LA as well as in privacy issues.

## Conclusions

Librarians are well-versed in library analytics, but have still to engage in the design of new strategies and practices now being introduced as a result of educational Big Data. Libraries have important data that are needed by the institutions but guarded by strong professional ethics and therefore not easily shared outside of the library. Some of the library discourse related to Big Data discussed in this paper gives an impression that the library could continue to exist as a "safe harbour" (Hegna, 2016) or a moral high ground, busy embedding their values in the more questionable practices of their colleagues (Jones & Salo, forthcoming). However, the survey reported in this paper shows that Norwegian librarians have a position that balances principled views with what is practically possible and in the self-interest of the students. This is the main research contribution of this paper.

From the very limited scholarly discourse on data sharing for analytics in a Norwegian context one could get the impression that library data has no place in institutional LA (Hegna, 2016). The sample of librarians we have studied gives, however, a rather mixed view on how library data can be used in different analytics settings. Interpreted on the background of international research on ethical values and code of ethics this finding is not surprising. Koehler (2006) found that "while most library and information professionals share similar values, as reflected in their codes of ethics, the application of those codes varies widely" (p. 83). Differences are according to Koehler a function of information roles and responsibilities. Library research has established service to the patron as the librarians' core value. If the patron's interests are maintained and served by new solutions, our research may indicate that librarians may be willing to renegotiate their traditional positions related to preservation of the library record. We have to stress, however, that the survey conducted in this study is exploratory and we should not draw too far-reaching conclusions about representative view of the Norwegian library profession. However, we also see that recent international library discourse is contrasting the common view of intellectual freedom, "to show how libraries may be able to participate in learning analytics practices while upholding intellectual freedom as a lodestar guiding practice and policy" (Jones, 2017).

The contribution of this paper is to raise questions about the role of library data in the rapidly growing field of LA aimed at understanding and optimising learning, and the environments in which it occurs (Long & Siemens, 2011). There is a need for the library community to engage. This paper has pointed to a direction for the Norwegian academic librarians to make a contribution. LA is not primarily to let institutions identify student engagement patterns or let the library prove that library use is correlated to good exam results; LA is about improving learning, in which librarians can play an integral role. If the library community in Norway would go in this direction they need to focus on the needs of the students as library users and support their learner agency and control over their data.

This paper is one of the first to focus on learning analytics and the library in a Norwegian, and even in a global, context. There is a need to expand the study to include more aspects of the challenges the libraries face in the age of Big Data, and there is a need to conduct a representative study to see if the results reported in this paper hold up to scrutiny.

## References

American Library Association. (2008). Code of ethics of the American Library Association. Retrieved from http://www.ala.org/advocacy/sites/ala.org.advocacy/files/content/proethics/codeofethics/Code%20of%20Ethics%20of%20the%20American%20Library%20Association.pdf.

Ayre, L. B. (2017) Protecting Patron Privacy: Vendors, Libraries, and Patrons Each Have a Role to Play. *Collaborative Librarianship, 9*(1), 1-5 Retrieved from http://digitalcommons.du.edu/collaborativelibrarianship/vol9/iss1/2

Bowers, S. L. (2006). Privacy and Library Records. *The Journal of Academic Librarianship, 32*(4), 377–383. http://doi.org/10.1016/j.acalib.2006.03.005

Baylis, L. (2016, June 28). A Technical Look into Learning Analytics Data and Visualisations. [Blog post] Retrieved from https://analytics.jiscinvolve.org/wp/2016/06/28/a-technical-look-into-learning-analytics-data-and-visualisations.

Dole, W. V., Hurych, J. M., & Koehler, W. C. (2000). Values for librarians in the information age: an expanded examination. *Library Management, 21*(6), 285–297. http://doi.org/10.1108/01435120010327597

Ferguson, S., Thornily, C., & Gibb, F. (2016). Beyond codes of ethics: how library and information professionals navigate ethical dilemmas in a complex and dynamic information environment. *International Journal of Information Management, 36*(4), 543–556. http://doi.org/10.1016/j.ijinfomgt.2016.02.012

Griffiths, D., Drachsler,H., Kickmeier-Rust, M., Steiner, C., Hoel, T., Greller, W. (2016) Is Privacy a Show-stopper for Learning Analytics? A Review of Current Issues and Solutions. *Learning Analytics Review, 6* Retrieved from http://www.laceproject.eu/learning-analytics-review/files/2016/04/LACE-review-6_privacy-show-stopper.pdf

Hegna, K. (2016). "Vi garanterer deg konfidensiell behandling" – Om biblioteket, forskningen og overvåkningen. Retrieved from http://folk.uio.no/knuthe/konfidensiell/lang.pdf

Hess, A. N., LaPorte-Fiori, R., & Engwall, K. (2015). Preserving Patron Privacy in the 21st Century Academic Library. *The Journal of Academic Librarianship, 41*(1), 105–114. http://doi.org/10.1016/j.acalib.2014.10.010

Hoel, T., Griffiths, D., & Chen, W. (2017). The influence of data protection and privacy frameworks on the design of learning analytics systems. *Proceedings of the Seventh International Learning Analytics & Knowledge Conference*, New York, New York, USA: ACM Press. http://doi.org/10.1145/3027385.3027414

Hoel, T., & Chen, W. (2016a). Privacy-Driven Design of Learning Analytics Applications: Exploring the Design Space of Solutions for Data sharing and Interoperability. *Journal of Learning Analytics, 3*(1), 139–158. http://dx.doi.org/10.18608/jla.2016.31.9

Hoel, T. & Chen, W. (2016b). The Principle of Data Protection by Design and Default as a lever for bringing Pedagogy into the Discourse on Learning Analytics. Workshop paper In Chen, W. et al. (Eds.) (2016). *Proceedings of the 24th International Conference on Computers in Education. India: Asia-Pacific Society for Computers in Education* Retrieved from http://www.et.iitb.ac.in/icce2016/files/proceedings/ICCE%202016%20Workshop%20Proceedings%20Part%202.pdf

Johns, S., & Lawson, K. (2005). University undergraduate students and library-related privacy issues. *Library & Information Science Research, 27*(4), 485–495. http://doi.org/10.1016/j.lisr.2005.08.006

Jones, K. M. L., & Salo, D. (forthcoming). *Learning Analytics and the Academic Library: Professional Ethics Commitments at a Crossroads*, 1–48. Retrieved from http://crl.acrl.org/index.php/crl/article/download/16603/18049.

Jones, K. (2017). Learning Analytics, the Academic Library, and Positive Intellectual Freedom. *Journal of Intellectual Freedom & Privacy*. Retrieved from https://journals.ala.org/index.php/jifp/article/view/6305

Kitto, K., Lupton, M., Davis, K., & Waters, Z. (2017). Designing for student-facing learning analytics. *Australasian Journal of Educational Technology, 33*(5), 1–17. http://doi.org/10.14742/ajet.3607

Koehler, W. (2006). National library associations as reflected in their codes of ethics: Four codes examined. *Library Management, 27*(1-2), 83-100. http://doi.org/10.1108/01435120610647974

Koehler, W. C., Hurych, J. M., Dole, W. V., & Wall, J. (2000). *Ethical Values of Information and Library Professionals — An Expanded Analysis*. The International Information & Library Review, 32(3-4), 485–507. http://doi.org/10.1006/iilr.2000.0141

Koehler, W. C., & Pemberton, J. M. (2000). *A search for core values: Towards a model code of ethics for information professionals. Journal of Information Ethics, 9*(1), 26-54

Kunnskapsdepartementet. (2017). Framtid, fornyelse og digitalisering. Digitaliseringsstrategi for grunnopplæringen 2017 - 2021. Retrieved from https://www.regjeringen.no/no/dokumenter/framtid-fornyelse-og-digitalisering/id2568347/

Library Freedom Project. (n.d.). Retrieved from https://libraryfreedomproject.org

Library Trends (n.d.). *Call for papers.* Retrieved from https://www.press.jhu.edu/journals/library-trends/call-papers-0

Long, P., & Siemens, G. (2011). Penetrating the Fog: Analytics in Learning and Education. *Educause Review, 46*(5), 31–40.

Lynch, C. (2017). The rise of reading analytics and the emerging calculus of reader privacy in the digital world. *First Monday, 22*(4), 1–21. http://doi.org/10.5210/fm.v22i4.7414

Mason, J., Chen, W., & Hoel, T. (2016). Questions as data: illuminating the potential of learning analytics through questioning an emergent field. *Research and Practice in Technology Enhanced Learning*, 1–14. http://doi.org/10.1186/s41039-016-0037-1

Michelet, J. (2013). *Mappa mi (en beretning om ulovlig politisk overvåking).* Oslo: Oktober forlag.

Norsk Bibliotekforening. (n.d.). *Veiledende etiske retningslinjer for bibliotekansatte*.

Retrieved from http://norskbibliotekforening.no/etikk/

Oakleaf, M., Whyte, A., Lynema, E., & Brown, M. (2017). Academic libraries & institutional learning analytics: One path to integration. *The Journal of Academic Librarianship, 45*(5). 454-461. https://doi.org/10.1016/j.acalib.2017.08.008

Oslo Metropolitan University. (2018). Fremtidens digitale universitet. Strategi for digital transformasjon 2018 - 2024. Retrieved from https://www.scribd.com/book/369963276/OsloMet-Strategi-for-Digital-Transformasjon

Personopplysningsloven. (2000). *Lov om behandling av personopplysninger.* Retrieved from https://lovdata.no/dokument/NL/lov/2000-04-14-31?q=Personopplysningsloven

Showers, B. (2015). Understanding and managing the risk of analytics. In Showers, B. (Ed.) *Library analytics and metrics : using data to drive decisions and services*. London: Facet Publishing.

Standard Norway. (2017). *Datakilder og betingelser for deling av data for læringsanalyse*. Teknisk Rapport SN/TR 4183:2017

Tay, A. (18-11-2016). 5 reasons why library analytics is on the rise. [Blog post]. Retrieved from http://musingsaboutlibrarianship.blogspot.no/2016/11/5-reasons-why-library-analytics-is-on.html .

Vivento. (2015). Kartlegging og vurdering av stordata i offentlig sektor. Rapport til Kommunal- og moderniseringsdepartementet. Retrieved from https://www.regjeringen.no/contentassets/7a30f56668634d8c96ad660f92ffd508/bruk_av_stordata_i_offentlig_sektor.pdf

# IX

# STANDARDS FOR SMART EDUCATION - TOWARDS A DEVELOPMENT FRAMEWORK

by

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# Standards for smart education – towards a development framework

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**Abstract**

Smart learning environments (SLEs) utilize a range of digital technologies in supporting learning, education and training; they also provide a prominent signpost for how future learning environments might be shaped. Thus, while innovation proceeds, SLEs are receiving growing attention from the research community, outputs from which are discussed in this paper. Likewise, this broad application of educational digital technologies is also the remit of standardization in an ISO committee, also discussed in this paper. These two communities share a common interest in, conceptualizing this emerging domain with the aim to identifying direction to further development. In doing so, terminology issues arise along with key questions such as, '*how is smart learning different from traditional learning?*' Presenting a bigger challenge is the question, '*how can standardization work be best scoped in today's innovation-rich, networked, cloud-based and data-driven learning environments?*' In responding, this conceptual paper seeks to identify candidate constructs and approaches that might lead to stable, coherent and exhaustive understanding of smart learning environments, thereby providing standards development for learning, education and training a needed direction. Based on reviews of pioneering work within smart learning, smart education and smart learning environments we highlight two models, a cognitive smart learning model and a smartness level model. These models are evaluated against current standardization challenges in the field of learning, education and training to form the basis for a development platform for new standards in this area.

**Keywords:** Smart learning, Smart learning environments, Standardization, Reference model, Development framework

## Introduction

The word 'smart' is now routinely used by the educational research community forming new terminology like Smart Education, Smart University, Smart Learning, Smart Classroom, Smart Learning Environment, etc. (Uskov et al., 2017; Roumen & Kovatcheva, 2017). We could see this as an expression of the dynamic nature of the contemporary educational domain, which is now also often characterised in terms of transformation (Liu et al., 2017; Bell, 2017; Walker et al., 2016: Tuomi, 2013; Baker & Wiseman, 2008). Fast changing domains need to be conceptualized in order to be understood and optimised for their stakeholders (Bell, 2017). This is one role of educational research now articulated in several journals and books and explored in this paper. In the domain of digital technology, however, innovation has its own dynamics and is not necessarily driven by research – often it is all about being 'first to market'. Thus, from a different though potentially more stabilizing position, another community of professionals try to harness the insights of research together with innovations at the frontier of change to document stable points of reference, so the domain can evolve in a progressive and sustainable way. This is the standards community, the group that does IT standardization for learning, education and training (ITLET) within the International Organization for Standardization (ISO).

In this paper, we examine outputs from the smart education research community and the ITLET standards community to identify how evolving conceptual frameworks could inform specification work stabilizing the core terminology (e.g., as in smart technologies) in order to promote innovation. Our examination is based on the understanding that the former community is struggling to map the new terrain and create adequate conceptual frameworks, while the latter community is struggling to discard old frameworks, make sense of the new dynamics, and propose new frameworks. This research is the first of its kind trying to align the outputs of smart education research and ITLET standardization.

For some of the leading exponents of the research community focused on smart learning a key objective is to optimise the operations of smart learning environments thereby ensuring a virtuous loop of innovation. Roumen and Kovatcheva (2017) point to an Educational Innovation Grid framework consisting of four quadrants made by the two axes digital technologies (existing providers vs new entrants), and learner ownership (formal learning vs informal learning). This presents four kinds of change: improving schools, supplementing schools, reinventing schools, and new paradigms (Fig. 1). The research community address all these changes and has a particular focus on how they are integrated, learning taking place in both informal and formal settings, using both new and well-established technologies.

It is significant in this context to emphasise the research community is not a homogenous group governed by requirements to achieve consensus but is ultimately driven by innovation. Standardization work, on the other hand, typically involves conceptual, technical, and political activities that together are focused on achieving consensus among a group of stakeholders. The outcome – a standard – is essentially just a document that represents a stable reference point and sometimes includes detailed

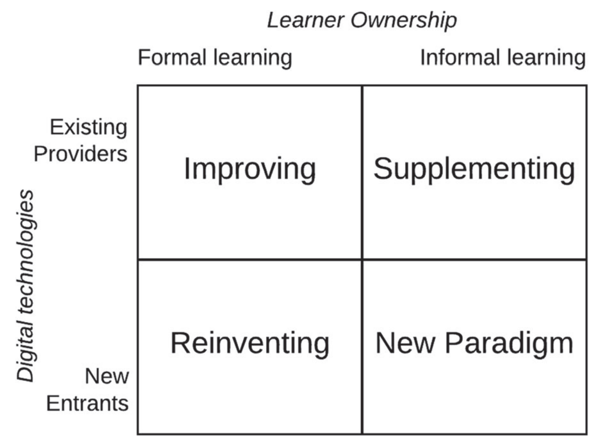


**Fig. 1** The education innovation grid (Adapted from Roumen & Kovatcheva, 2017)

technical specifications. Standardization can also be conceived as a design activity that seeks to identify and harmonize common elements from disparate inputs to support interoperability and a level playing field for further innovation and adoption of technologies. In education, standardization has played a pivotal role in promoting the principle of systems interoperability in deployment and use of learning technologies allowing the sector to move in *smarter* direction. We live in an era of change, and it is therefore a challenge to align standardization with the needs of the domain. In the technology enhanced learning domain, both the standardization community and the domain experts for some time have asked themselves what the new frameworks for development would look like.

The following discussion offers a critical examination of the *smart* in smart education, smart learning and smart learning environments (SLE) in two steps. First, we analyze a selection of papers in two key journals. Based on this analysis one paper is chosen to inform a SLE model that is discussed against requirements from the field of ITLET standardization (see section 1.1 below). This discussion results in some preliminary conclusions about veracity of the model in guiding standardization work. Next, we review the SLC to identify further conceptualizations of SLE. New perspectives are found, and this informs an additional model, which may add guidance to standardization work. This new model is discussed against a backdrop of ITLET standards framework. In the conclusion, we offer ideas for further development of a framework that could inform the development of SLEs and SLE standards.

The following discussion elaborates in further detail on the context of ITLET standards development and some prominent articles published by the research community.

### The standardization context

In this paper, we highlight Sub-Committee 36 (hereafter, SC36) of ISO/IEC Joint Technical Committee 1 as a backdrop for discussing how frameworks for Smart Learning Environments (SLE) developed by the research community could inform standards work. SC36 was initially formed in 1999 with scope to produce IT standards for Learning, Education, and Training (LET). Within SC36 the acronym ITLET (IT for Learning, Education, and Training) is commonly used. Since its inception, SC36 has produced a range of standards, some which have reflected market needs and some which do not. In 2017, the chair stated "[SC36] realize(s) that the role of technology in learning, education and training has changed, and continue(s) to change – we in SC36 need to be more agile in adapting our work processes and organization to reflect this" (Overby, 2017).

In line with all formal ISO/IEC standards development, SC36 can choose from three standardization outputs to guide its work – a Technical Report (TR), Technical Specification (TS), or full International Standard (IS). In all cases, such documents detail some degree of consensus from stakeholders. Within such outputs, it is also typical that other standards and industry specifications are normatively referenced or customised as application profiles specific for the ITLET domain. Because the development of a full IS can take many years, however, developing a TR or TS is often a practical first milestone and, given the rapid rate of innovation with digital technologies, there is an added challenge for SC36 to align its work practically.

In terms of process, all standardization activity is typically initiated by a New Work Item Proposal (NWIP) and if there is sufficient stakeholder buy-in this transitions to a formal New Work Item (NWI) – in which a clear scope statement and market need is articulated. In recent years, the trend within SC36 has been to initiate Study Groups prior to the development of an NWI so that the scoping work can be as focused as possible. Experience within SC36 has been that if scope statements are in any way ambiguous then many problems arise in progressing the work. Such Study Groups typically produce a short report which then informs the development of a Technical Report. In some cases, SC36 can also choose to adopt or adapt industry specifications as international standards that might have been developed by Liaison Organizations. Because the ITLET market is growing rapidly and innovations are constantly taking place it makes a lot of sense for SC36 to first do due diligence in identifying what industry specifications or standards might be useful rather than perform a quasi-academic research in determining market needs.

Well-defined vocabularies (terms, their associated definitions, and normative references) provide the foundation on which most standardization activities proceed – and ontologies that demand precise terminology are often important components of the digital infrastructure. This is essential for IT because terminology is what describes a domain of activity and conceptual coherence is essential. Of course, definitions of the same term vary depending on the context of application and this can sometimes be confusing to those outside the standardization process. In standards development, however, terms are defined to be fit for purpose and the definition of 'smart' as in a smart person will likely be quite different to the definition of 'smart' as in a smart phone – and, it makes no sense to appropriate a term that has high utility within English and to try and define it for all contexts. Therefore, this is where we also commence our discussion on Smart Learning Environments.

### The smart learning environment research context

In a similar way that SC36 has grappled with aligning its program and organizational structure with evolving technological development, there has been a parallel development in conceptualization resulting in establishing *smart learning* as a new field of research. The International Association of Smart Learning Environments (IASLE) has defined smart learning as: "an emerging area alongside other related emerging areas such as smart technology, smart teaching, smart education, smart-e-learning, smart classrooms, smart universities, smart society. The challenging exploitation of smart environments for learning together with new technologies and approaches such as ubiquitous learning and mobile learning could be termed smart learning" (IASLE, n.d.).

*Smart,* however, is a term that has long been associated with computers (Zuboff, 2015, 1988; Bell, 2017; Kallinikos, 2010); it also has high utility across many discourses and therefore can be problematic when defining it. Thus, IASLE explains that the "adjective 'smart' in smart learning involves some similar characteristics to the ones attributed to a person that is regarded as being 'smart'" (IASLE, n.d.). But, to proceed with any technical design activity based on the concept of smart learning there is a need to do further theoretical groundwork. In the marketplace, where smartphones have been such a success, *smart* is arguably just a term that has managed to get traction more than *intelligent* – but it certainly shares similar semantics. Perhaps the problem for *intelligent* is that it has been part of artificial intelligence (AI) for decades and for many of us that conjures up other meanings.

IASLE also points to three journals for research outputs on smart learning, *Interactive Technology and Smart Education Journal* (first volume 2004); *Smart Learning Environments* (first volume 2014); and the *International Journal of Smart Technology and Learning* (first volume 2016). While the first and oldest journal seems to have focussed more on the interactive technology and less on building theories on how these technologies are smart, the last two journals have from the very beginning tried to define the new overarching concept of smartness related to learning. For this paper, we first focus on research published in these two journals that aim at establishing a theoretical foundation for SLEs.

### Methodology

In seeking to bridge the research and standardization discourses our work is focused on conceptualisations, models, and frameworks. Prior to a New Work Item being proposed within the ISO standardization process it is typically the case for a study group to convene and to likewise undertake such work while also addressing issues such as market need. In the domain of information technology, conceptual modelling needs to be tested prior to the next stages of validation which typically involve the specification of data models and reference implementations. To produce adequate conceptual models work must first proceed on specifying the conceptual domain through identifying well-formed constructs. Likewise, academic research typically proceeds from specifying a well-formed research question. Thus, for this paper, our research question is: *What candidate constructs from contemporary research into smart learning environments might lead to a stable and coherent depiction of smart learning environments that can be progressed within the processes of international standardization?*

From the key journals identified above, we have selected five papers for analysis based on the following questions: *what papers in the inaugural issues of the two journals have the ambition to lay the conceptual groundwork for further research on SLE?* and, *what papers bring new theoretical grounding for understanding the 'smart' in SLE*?

## Defining smart

To build an understanding of the characteristics that define smart learning IASLE used the vernacular definition of smart – as in a person being smart. This follows the line of argument pursued by one of the early advocates of smart education in China, Professor Zhu Zhiting of East China Normal University, who defined *smart* in a keynote presentation to an international audience as the opposite of stupid: "If you don't quite agree [..] with the definition of smarter education, then let's first find evidences of stupid education…" (Zhu, 2014). It is easy to find examples of 'stupid education'; Professor Zhu mentions "refusing to tailor teaching approaches accordingly and denying individuality", and "solely emphasizing book-based knowledge while neglecting development of practical abilities" (Zhu, 2014). Elsewhere, smart is defined through examples of contemporary technology trends introduced by any of the players in the international market, such as IBM in its report Education for a Smarter Planet (2009). It is also inferred in national policy documents such as *Keep it Clever* by Universities Australia (2014) and an "ecology of smart learning" in South Korea consisting of self-paced e-learning, virtual classrooms, mobile learning, collaboration based learning, social learning, simulation based learning, game-based learning, etc. (Lee, 2011). This leads to a preliminary definition of smart education proposed by Zhu and Bin (2012): "the essence of smarter education is to create intelligent environments by using smart technologies, so that smart pedagogies can be facilitated as to provide personalized learning services and empower learners to develop talents of wisdom that have better value orientation, higher thinking quality, and stronger conduct ability."

In Zhu, Yu, and Riezebos, 2016 concluded "there is no clear and unified definition of smart learning so far". Besides the natural explanation that a new and multidisciplinary research field needs time to develop consensus, we suggest that a well-formed definition of smart learning requires more conceptual rigor. This is not easy for terms that already have high usage and utility in everyday conversation. Thus, in earlier work, we argued that to achieve a good scope statement one must focus on defining what is in scope, not on describing what is out of scope (Hoel & Mason, 2012). By defining A as not being B one is bound to establish a fuzzy concept of A with unclear boundaries. We have observed this line of argument in some of the attempts to define smart learning. Therefore, in exploring whether a solid theoretical base for smart learning can be discerned for the next generation of ITLET standardization activities, we examine some of the initial attempts to define the field.

While the foregoing provides some context for a growing discourse we propose that standardization processes can also provide useful guidance in how to proceed with defining terminology. For example, *ISO 704:2009 Terminology Work – Principles and methods* has been developed for this specific purpose (ISO, 2009). A key principle here is to identify the constraints of the domain in which a term is used to designate something and to specify any distinguishing characteristics. Thus, within the domain of ITLET, terms describe systems and their components. Moreover, as *ISO 704:2009* demonstrates, terms and definitions are themselves entities within concept systems in which terms and definitions are associated with concepts that have relations to other concepts. The most formal expression of such a concept system is an ontology. Thus, in reviewing the emerging discourse on smart learning, our methodology has been to check to what extent the terminology shows such characteristics. It is our expectation that for this field to mature such an ontology will need to be developed.

## Defining smart learning

The journal *Smart Learning Environments* was launched in 2014 with the aim "to help various stakeholders of smart learning environments better understand each other's role in the overall process of education and how they may support each other". In the opening article, Spector (2014) focuses on "conceptualizing the emerging field of smart learning environments" pointing to "three foundation areas that provide meaningful and convergent input for the design, development and deployment of smart learning environments: epistemology, psychology and technology". A smart learning environment, then "is one that is effective, efficient and engaging" (p. 2). To create a framework for a SLE, Spector extracts characteristics from the three foundational perspectives and classifies them according to whether they are necessary, highly desirable, or likely (see Fig. 2).

Hwang (2014) identified context-awareness; adaptiveness; and ability to adapt user interface, subject content, and report learning status as the key criteria of a SLE. Figure 3 describes the modules of Hwang's SLE system.

Zhu et al., 2016 define ten key features of a SLE: location-awareness, context-awareness, social awareness, interoperability, seamless connection, adaptability, ubiquitousness, whole record (of learning path data), natural (multimodal) interaction, and high engagement.

Zhu et al. (2016) also introduce a 'smart education framework,' identifying core elements for successful learning in a digital world (Fig. 4). The core elements identified are consistent with the Community of Inquiry (CoI) model initially outlined by Dewey and Pierce and refined for teaching in the digital era by Garrison: teacher presence, learner presence, and technology presence (Garrison et al., 2010). For Zhu, Sun, and Riezebos (2016), teacher presence is manifest in terms of instructional design, facilitating and directing instructions, and providing technology support. Technology presence provides connectivity, ubiquitous access, and personalized services; while learner presence is characterized by autonomous and collaborative learner roles and efficient technology use.

Koper (2014) defines SLEs as "physical environments that are enriched with digital, context-aware and adaptive devices, to promote better and faster learning" (p.1). According to Koper, an SLE as a technical system consists of one or more digital devices added to physical locations of the learner (p. 4). The digital devices are aware of the learners' location, context and culture; and they add learning functions to these elements, such as provision of augmented information, assessment, remote collaboration, feedforward, feedback, etc. Furthermore, the digital device will monitor the progress of learners and provide appropriate information to relevant stakeholders.

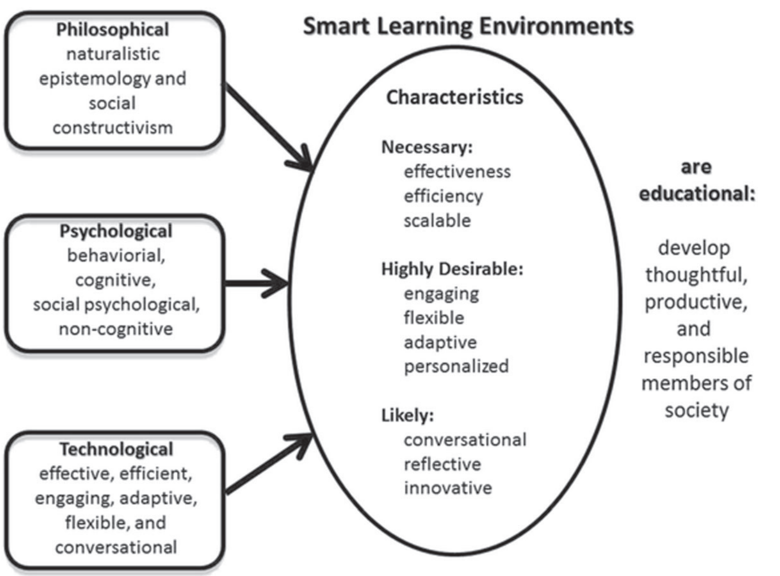


**Fig. 2** Spector's preliminary framework for SLE (Spector, 2014)

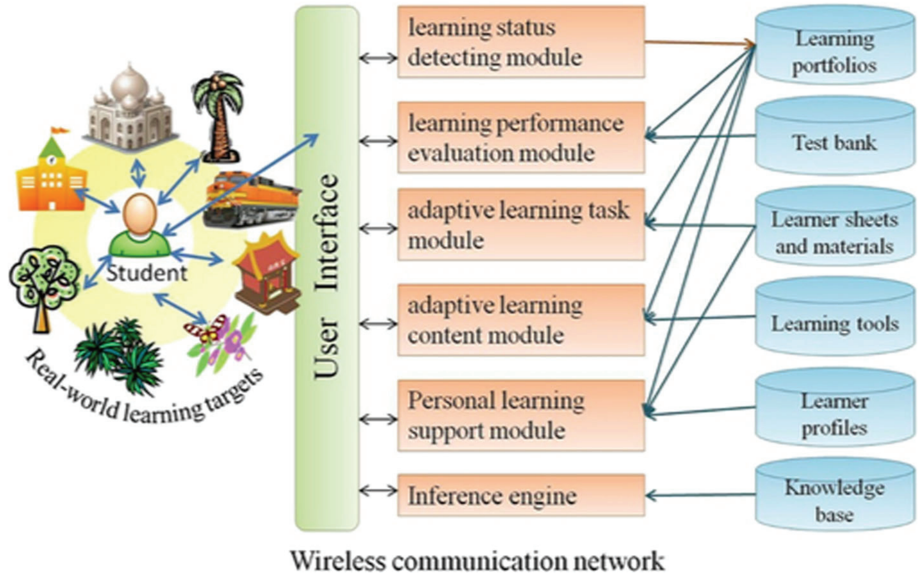


**Fig. 3** Hwang's framework of a SLE (Hwang, 2014)

To identify the requirements for the distinguishing feature of an SLE – that it provides *better and faster learning* – Koper introduces the concept of a Human Learning Interface (HLI), a "set of interaction mechanisms that humans expose to the outside world, and that can be used to control, stimulate and facilitate their learning processes". What HLIs there are to be considered in a SLE are, according to Koper, depending on what learning theories one subscribes to. Koper also delves into behaviorism, the cognitive sciences, and social psychology and discerns five HLIs that together provide a coherent set of levers to influence the quality and speed of learning (Fig. 5). This representation also shares some commonality with the famous four-dimensional SECI spiral of knowledge conversion developed by

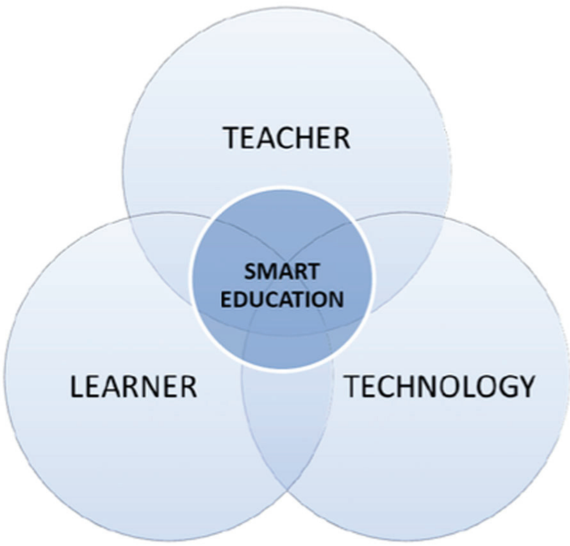


**Fig. 4** Zhu et al.'s smart education framework (Zhu et al., 2016)

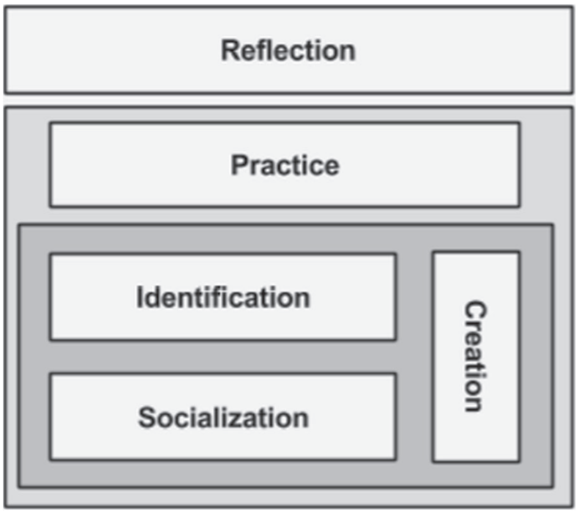


**Fig. 5** Five human learning interfaces identified by Koper (2014)

Nonaka (1990), the founder of modern knowledge management – where SECI stands for socialization, externalization, combination, and internalization. In Koper's model, *identification* represents the new situations and events in the world; *socialization* represents the settings, the social norms, values, customs, etc.; *creation* represents the activities to produce outputs; *practice* represents knowledge and actions that are repeated to prepare for high performance in future situations; and *reflection* represents creating representations of representations transforming initial representations and behaviors evident from practice.

An extended definition of Koper's SLE, with both the technical and pedagogical characteristics covered, is therefore the "physical environments that are improved to promote better and faster learning by enriching the environment with context-aware and adaptive digital devices that, together with the existing constituents of the physical environment, provide the situations, events, interventions and observations needed to stimulate a person to learn to know and deal with situations (identification), to socialize with the group, to create artifacts, and to practice and reflect" (Koper, 2014, p. 14).

## Finding a theoretical grounding of SLEs

Of the papers discussed, only Spector (2014) and Koper (2014) attempt to ground their conceptualization of a SLE in theoretical fields that underpin learning theories; however, their approaches are substantially different. For Spector, there is a serendipitous and associative way of searching for a theoretical grounding in the question: *How do these perspectives inform the development of a conceptual framework for smart learning environments?* Perhaps there are a few characteristics from these foundational perspectives that can be extracted and used as a preliminary set of indicators of the smartness of a learning environment (Spector, 2014, p. 7).

In Spector's framework (Fig. 2) each new scan through philosophical, psychological and technological perspectives will lead to new characteristics that are classified related to their desirability according to metrics that are highly contextual and temporal (e.g., efficiency, innovative). The model is without boundaries, as there are no limits to the number of iterations in search for characteristics.

In contrast, Koper has scrutinized learning theories with the aim to develop a comprehensive, but limited set of human learning interfaces that can play a role in an implementable SLE. Three core interfaces must be supported to initiate a learning activity: identification, socialization and creation. For better and faster learning to happen two meta interfaces must be supported: practice and reflection.

The contributions of Hwang (2014), and Zhu et al. (2016) have more in common with Spector's approach than with Koper's. Hwang lists characteristics of a dynamic system (context-awareness, adaptiveness, personalized), and keep his model open to any new technology trend to appear. Zhu, Sun, and Riezebos (2016) also list desirable characteristics of learning technologies, stopping at ten, but leaving the framework open to include any new approach in fashion. In the latter, a framework is abstracted to a level where everything involving a teacher, a learner and technology is considered being part of SLEs.

In conclusion, this brief comparison of these conceptual papers demonstrates a lack of work grounding ideas of intelligent and self-regulation technical systems in learning theories that could indicate which interfaces to influence to achieve the aims of better and faster learning. Arguably, the work of Koper (2014) is an exception. His five HLIs are derived from cognitive sciences, and they constitute a firm base for interfacing whatever new mode of technology supported activity to be found with the learning operations of the individual. In the following, we model Koper's conditions for effective smart learning environments, to see if this contribution could be used as a basis for further design work in the context of ITLET standardization.

## Constructing a SLE reference model – The Core

To validate the concepts defined in Koper (2014) against requirements derived from ITLET standardization use cases we have constructed a SLE core reference model described in Fig. 6.

The elements of model can be described as follows: A Learning Instance, the key element to be observed in a SLE system, is a unit of learning that has activated the main activities represented in learning, which are accessible through HLIs. The Learning Instance is instantiated through input from the Physical Environment, and through other contextual influence factors, e.g., a teacher defines a task, set up an event, define goals, etc.; and the teacher make interventions that presuppose the use of digital devices. For learning to happen, the learner must identify the situation (task, learning goals, schedule, etc.); the learner must interact with other learners, directly or indirectly; the learner must create outputs to externalize learning achievements; and the learner must perform meta activities through Practicing and Reflection. SLE system sensors monitor each activity of a learning instance; the observations are fed back to a Context-awareness & Adaptiveness engine that adjusts the input factors for the next learning instantiation.

Testing the SLE reference model can be done in two steps. First, the model must withstand requirements coming from other SLE conceptualizations. Second, the model must prove itself useful for the main purpose of this research that is related to further

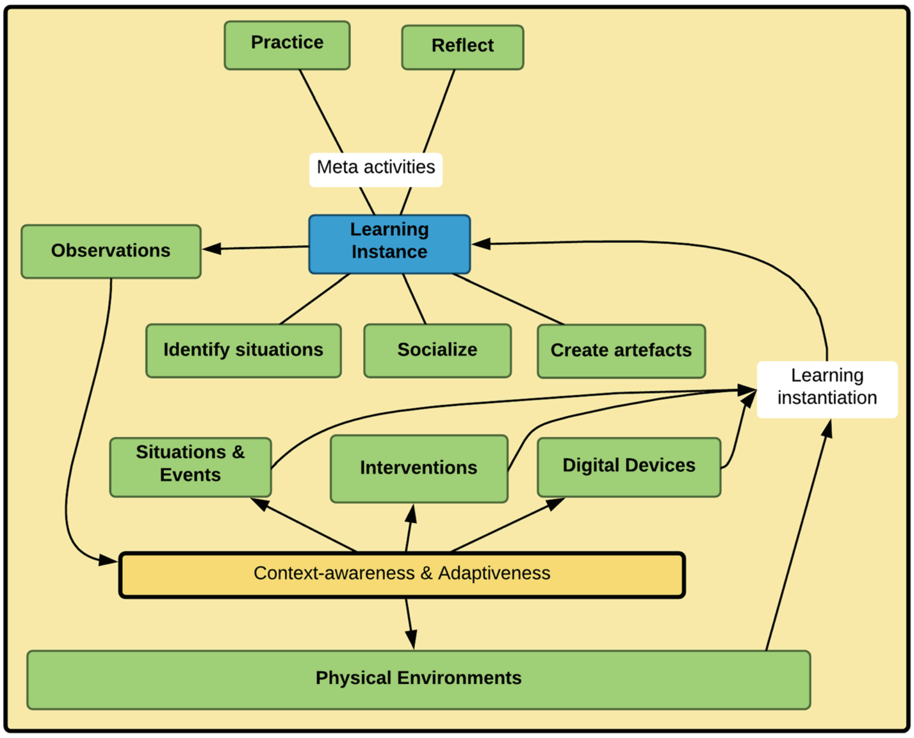


**Fig. 6** SLE core reference model (based on Koper, 2014)

standards development: Will the model work as a framework for ITLET standards development? To reach a conclusive answer this will need testing. Additionally, 'reference implementations' can support the standardization process in contexts where innovation in technology is fast moving.

### Testing against smart learning theories

We have characterized a number of conceptualizations of SLE as open and associative, while the model we have defined, based on Koper's (2014) work, is proposed to be more complete. We have wanted to develop a model that can integrate *new* smart innovations without having to introduce new system elements. To test the completeness of the model we contrast it with the framework of smart learning introduced in a recent book on smart learning in smart cities by Liu et al. (2017). Will the four types of support technologies for smart learning identified in their framework easily be integrated in the SLE model?

Figure 7 describes the smart learning framework of Liu et al. (2017). The model positions the learner in the centre, and consists of four levels (learning experience, support technologies, learning scenarios, and basic principles of teaching and learning).

Four support technologies for smart learning are identified (p. 38). Of type 1, *awareness and adaptive technologies*, artificial intelligence, sensors, and auto deduction are mentioned with applications that identify type of learning situation, provide diagnosis of learners' problems, personalized learning resources, social matching, and suggestions about learning activities. In the SLE reference model (Fig. 6), these support technologies

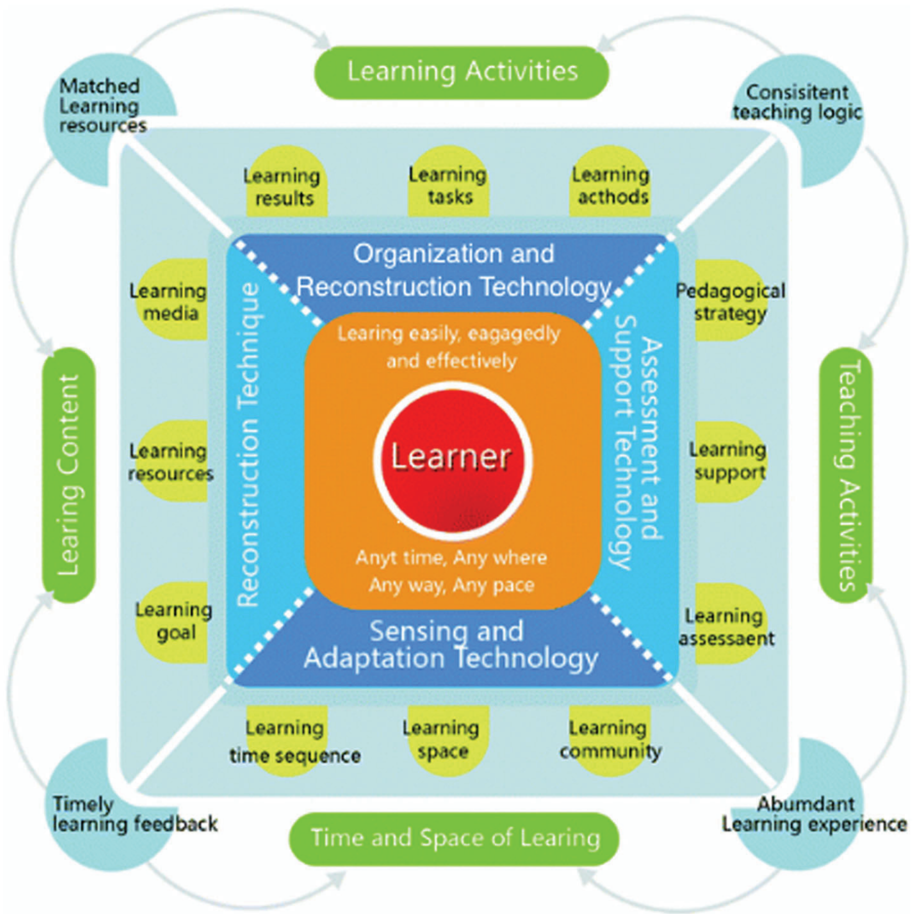


**Fig. 7** Framework of smart learning (Liu et al., 2017)

will be part of Digital Devices; Observations will register data from sensors logging Learning Instance activities; and the Context-awareness & Adaptiveness engine will provide the services described and set up Situations & Events, design Interactions, etc. The SLE reference model accommodates the first type of support technology requirements well; however, we observe that there is a need to specify more in detail the reasoning engines that are part of the adaptive system.

Within this type of support technology, Liu et al. (2017) also list environment perception technologies, like RFID, video monitoring, etc. These are covered by the Physical Environments in the SLE reference model.

Type 2 is *assessment and support technologies*, i.e., teaching assessment technologies (association rules, data mining) and learning support technologies (augmented reality, 3D printing, rich media, learning terminal). Also, these technologies are accommodated by the SLE reference model, following the same pattern as for Type 1 technologies.

Type 3 is *tracking and analytic technologies*, of which Liu et al. (2017) identified dynamic tracking technologies like motion capture, emotion calculation, eye-movement tracking; and learning analytics technologies (Classroom teaching effect analysis, interactive text analysis, text mining, video, audio and system log analysis). These technologies could also be fitted in the SLE reference model. However, we see that the model could gain more explorative strengths if the reference framework could be extended with information models detailing data flows between sensors and analytical systems.

Type 4 is *organization and reconstruction technologies,* which Liu et al. (2017) describe as learning object and semantic web. These are content management technologies that are mainly covered by the Situations & Events element of the SLE reference model.

In conclusion, we see that the technology requirements for smart learning identified by Liu et al. (2017) do not break the SLE reference model based on Koper's work (2014). When technological aspects of smart learning are identified, it is the dynamic aspects of the model related to reasoning capabilities and feedback to system components that are valued. However, the pedagogical insights that are modeled in the different learning activities described in the model, and which are an important part of the SLE reference model, are not so much requested when contrasted with technological aspects of the Liu et al. smart learning framework. This might point to a potential weakness of the model for the use in a ITLET standardization framework. Even if a model does not break when tested against new requirements, it does not imply that the model is able to drive new development, e.g., in ITLET standardization. We will come back to this question after we have tested the model against requirements coming out of scoping activities in the standards community we use as a case in this paper.

### Testing the SLE model against SC36 requirements

A challenge for SC36 is how to bring order to ad hoc study groups: augmented reality and virtual reality (AR&VR); smart learning environments and smart classrooms; digital badges; MOOCs; blockchain (electronic distributed ledger technologies; collaborative learning communication with social media; privacy and data protection for LET; etc.

The challenge for SC36 is twofold:

1. How to fit new work items into an existing organizational structure; or,
2. How to specify a domain framework that can produce the required new work items, and at the same time, support effective organization of work?

Bringing the SLE reference model (Fig. 6) into the picture, again we see that the themes listed above will fit in the model; however, a lot of specifications need to take place that are not explicated in the general SLE model. For example:

- AR&VR: These technologies typically extend both the cognitive and experiential domain with dedicated digital devices or application. Because AR and VR extend the scope of learning experience, however, questions arise as to what learner model is adequate for the learning session, etc. These issues are only implied in the SLE reference model.
- Digital badges: The Context-awareness & Adaptiveness engine will have access to assessment history and competency framework: these entities are not described in the model.
- Blockchain: This class of technologies is not covered in the model, other than as part of Observations.

- Privacy & data protection: These issues are not covered by the model; however, the human learning interface elements provide conceptual support for discussion of these issues.

The above discussion has identified technologies that the SLE model must accommodate. To generalize this, we need to ask, *is the model adequate in identifying new work items for standardization?*

One advantage of the model is its grounding in pedagogical theories with the definition of HLIs that are used to set up a learning instance. The five artifacts that are part of a learning instance could be used both for exploring potential standardization challenges, and for validation of existing projects. The reasoning behind the latter proposal is that all systems in a SLE must address one or more HLI to make learning happen. The model distinguishes between running a learning instance and setting up a learning instance. This might give inspiration to interesting standards projects.

The SLE model makes a distinction between physical and digital/virtual environments. This might lead to exploration of metrics for physical environments, project ideas that we have seen resonate with some Chinese interests (project proposal for defining standards for smart classrooms).

Otherwise, we note that the dynamic aspects of the model are represented as a simple feedback loop driven by Observations and managed by Context-awareness and Adaptiveness engines. This would need further specifications to be able to drive development of new standards projects.

In conclusion, the SLE reference model has some qualities as a reference framework for standards development. It could serve as a core model for how a learning instance is set up. However, in order to drive standards development contextual aspects of learning should be included in a SLE framework, i.e., aspects that captures the social-cultural perspective of learning (Engestrom, 2007), and how learning instances are configured in in time, locale, organization, etc. This is the focus of the next part of constructing a SLE reference model in this paper.

## Constructing the SLE context model

Conceptual work in smart learning has been complemented with laboratory work setting up and testing smart classroom solutions. In USA, Uskov and colleagues have set up a smart classroom lab at Bradley University to test out different components of next generation smart classroom systems (Uskov et al., 2015; Uskov et al., 2015; Uskov et al., 2017).

Inspired by a presentation by Derzko (2007), Uskov et al. (2015) developed an intelligence level ontology to classify different smart systems. In Table 1 we have used this ontology to analyze different pedagogical activities, different technologies, and different standardization challenges that follow from the different smartness levels of SLE.

We see that the more advanced the SLE systems are, the more difficult it is to identify pedagogical practices, examples of technologies used and acknowledged standardization challenges. One explanation for this observation is that developing new technologies for learning and new practices is work-in-progress. We would compare this to the turn experienced by the field of Artificial Intelligence some years ago when they came out of the *AI winter* through a combination of processing power and use of

**Table 1** Smartness level of Smart Learning Environments with activities, technologies etc. (Adapted from Uskov et al., 2015)

| SLE levels | Smart Classroom Activities | Technologies involved | Standardization challenges |
|---|---|---|---|
| Adapt<br>Ability to modify physical or behavioral characteristics to fit the environment or better survive in it. | • Communicate (local & remote)<br>• Share content<br>• View content in a preferred language<br>• Initiate session with voice/facial/gesture commands<br>• Ask questions<br>• Present (local & remote)<br>• Discuss<br>• Annotate | • Web technologies<br>• Session-based analytics<br>• Personal digital devices<br>• VR and AR systems<br>• Presentation technologies (Smartboards, etc)<br>• Social media<br>• Sensors (air, temperature, number of persons, participation roles, ….) | • Setting up a SLE meeting quality criteria defined in Smart Classroom standards<br>• Data governance<br>• Privacy<br>• Security<br>• Systems interoperability |
| Sense<br>Ability to identify, recognize, understand and/or become aware of phenomenon, event, object, impact, etc. | • Automatic adjustment of classroom environment (lights, AC, temperature, humidity, etc.)<br>• Real-time collection of student feedback from diverse contexts<br>• Monitoring student activity<br>• Process real-time classroom data<br>• Deliver custom support and scaffolding for special needs students<br>• Support agent-based systems<br>• Interact with smart systems<br>• Connect multi-location students | • Triggers actions, defined in assorted models (learner, school, teacher, Smart Classroom, etc.)<br>• Big Data<br>• Multiple interfaces and channels keyboard, screen, voice, agent, eye movements, gestures | • Data collection and storage<br>• Data governance<br>• Privacy<br>• Security |
| Infer<br>Ability to make logical conclusion(s) on the basis of raw data, processed information, observations, evidence, assumptions, rules and logic reasoning. | • Recognize every individual<br>• Process real-time classroom data<br>• Process incomplete classroom datasets<br>• Discuss presented learning content and assignments with remote students in real-time and using preferred language by each student | • Simple rule-based process engines<br>• More complex inference engines<br>• Natural language processors | • Pedagogical designs<br>• Student learner models<br>• Student activity data<br>• Specifying competence |
| Learn<br>Ability to acquire new or modify existing knowledge, experience, behavior to improve performance, effectiveness, skills, etc. | • Ability to suggest changes to the system<br>• Real-time skills assessment<br>• Real-time knowledge assessment<br>• Accommodate and enact multiple intelligences | • Artificial Intelligence<br>• Machine Learning<br>• Deep Learning | • Validating competence<br>• e-assessment<br>• Learning Design |

**Table 1** Smartness level of Smart Learning Environments with activities, technologies etc. (Adapted from Uskov et al., 2015) *(Continued)*

| SLE levels | Smart Classroom Activities | Technologies involved | Standardization challenges |
|---|---|---|---|
| Anticipate<br>Ability of thinking or reasoning to predict what is going to happen or what to do next. | | • Predictive engine (predictive analytics) | |
| Self-organize<br>Ability of a system to change its internal structure (components), self-regenerate and self-sustain in purposeful (non-random) manner under appropriate conditions but without an external agent/entity. | | • All above, with a strong AI component. | |

big data. The point was not to mimic human intelligence but to mine the intelligence that was buried in the data to make the machine learn how to solve certain tasks. Our claim is that we are in a similar situation regarding the utilization of SLEs.

In Fig. 8 we describe the driving forces of smartness in SLE and the corresponding smartness levels. Systems that can adapt, sense and infer what is going on within a learning scenario may also be based on real-time human intelligence as well as that captured in the form of metadata ontologies, learner models, learning designs, etc. However, when the systems start to learn and to predict actions without any human management, and then self-organize and act as an independent agent in a learning scenario, the system is prone to be based on machine intelligence and driven by big data.

The model in Fig. 8 complements the SLE core model we developed. While the latter model describes how learning is initiated, the new model describes how the learning environments – the learning context – is set up and what affordances are to be expected.

With these two models as tools we will now turn to the challenges of the standards community in SC36 to come up with a strategy for creating new work items that could make the new SLEs more interoperable. This is the focus of the next section in this paper.

## Iterations of standardization

The relentless development of new learning technologies and new pedagogical practices has led to conceptualization of techno-pedagogical frameworks, such as TPACK (Koehler & Mishra, 2009; Ferguson et al., 2017). Technically speaking, however, SLEs are part of a wider context of architectural development in the ITLET domain. For more than two decades there has been numerous initiatives aimed at defining or abstracting frameworks in which all relevant learning technology systems are modelled. A successful further development of the SLE will require a good grasp of the context – but, what are the pivotal elements in the different architectures; and even more importantly, what

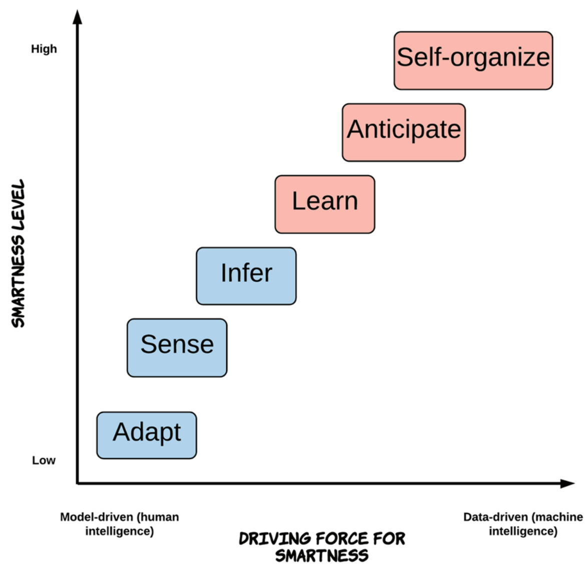


**Fig. 8** Driving forces for different smartness levels in SLE (Based on Uskov et al., 2015)

are the pedagogical principles that are supported by each framework? This latter question will likely prove more challenging because 'smartness' is not exclusively a 'systems' feature; moreover, when pedagogy is a consideration then the technical work on learning design that has been proceeding since early in the millennium is likewise an important consideration (IMS GLC, 2003b).

In the following, we highlight some prominent initiatives that have made an impact on the ITLET standards community since the turn of the century.

### IEEE learning technology systems architecture (LTSA)

The 2003 IEEE Learning Technology Systems Architecture (LTSA) (Fig. 9) represents the first purpose-built learning technology standard (IEEE, 2003). The standard has now been deprecated as it is no longer an adequate representation of the complex systems that are now used in ITLET. Nonetheless, as a stable reference point, it served its purpose and it is a concise rendering of the thinking at the time. What can we learn from this? Modelling the ITLET domain is an ongoing challenge in which new complexity is introduced with each new innovation in technology.

Thus, when defining the LTSA, IEEE defined the purpose of developing system architectures in general:

> [it] is to create high-level frameworks for understanding certain kinds of systems, their subsystems, and their interactions with related systems, i.e., more than one architecture is possible.
>
> An architecture is not a blueprint for designing a single system, but a framework for designing a range of systems over time, and for the analysis and comparison of these systems, i.e., an architecture is used for analysis and communication.
>
> By revealing the shared components of different systems at the right level of generality, an architecture promotes the design and implementation of components and subsystems that are reusable, cost-effective and adaptable, i.e., abstract, high-level interoperability interfaces and services are identified. (IEEE, 2003).

At the turn of the century, e-learning was still largely conceived as delivery of learning resources to a learner supported by a coach, with the aim of being evaluated; however, by this time it was also evident that for education *communications* is as essential

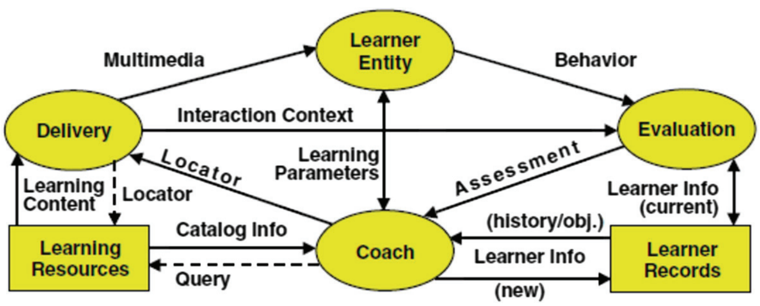


**Fig. 9** LTSA system components (IEEE, 2003)

as *information* and the acronym ICT (information and communications technology) soon became commonplace. The importance of interaction and collaboration in the ITLET domain can also be seen in the emergence of sub-fields such as Computer Supported Collaborative Learning (CSCL).

## IMS abstract framework

In the same year as the IEEE LTSA was published the IMS Global Learning Consortium (IMS GLC) also published its version of an Abstract Framework depicting the bigger picture of the technical specifications environment (IMS, 2003a). It is also of interest here that in the early years of its existence the IMS GLC branded its mission as “defining the internet architecture for learning” (Rada, 2001; Mason, 1999).

The framework (Fig. 10) defined four layers, an application layer; an application services layer; a common services layer; and an infrastructure layer.

As the IMS Abstract Framework is more abstract than LTSA, it is not that obvious what pedagogical requirements that are built into the framework. When a framework is too abstract, the threat is that it is passing above the head of the developers that should use it, which might have been the fate of this IMS initiative.

## Oki

Shortly after the Massachusetts Institute of Technology (MIT) announced its bold Open Courseware initiative to the world, making its courses and programs freely accessible for scrutiny it also initiated the Open Knowledge Initiative (OKI) was also launched (MIT, 2002; Thorne et al., 2002). This project signalled a move towards a service-oriented approach for defining ITLET architectures, developing Open Service Interface Definitions (OSIDs) as programmatic interface specifications describing services. These interfaces were to achieve interoperability among applications across a varied base of underlying and changing technologies. Given the subsequent revolution in cloud services that rendered many enterprise architectures redundant, OKI can be now seen as a bellwether of change. It is unfortunate however, that MIT has not maintained its archive on its website associated with this initiative – also signalling that innovation in digital infrastructure is itself fragile and subject to disappearance. It is worth noting here, however, the scope of OKI also reached beyond the learning domain by explicitly acknowledging knowledge as much as learning. At that time, there was a rich emergent

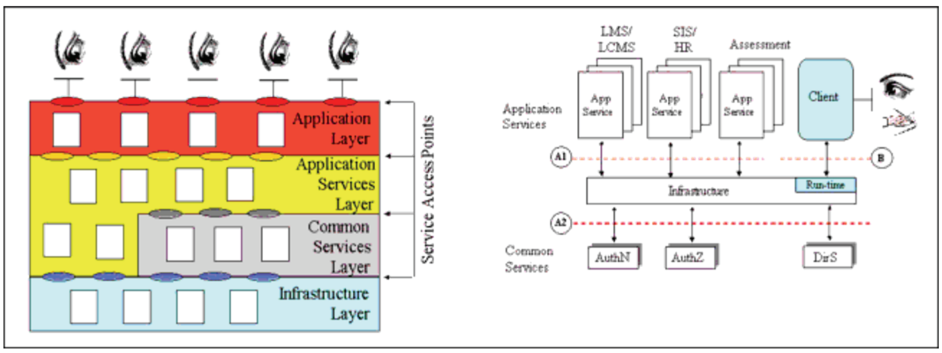


**Fig. 10** IMS abstract framework (IMS, 2003a)

discourse that articulated the notion of shared services between knowledge-based systems and learning (Mason et al., 2003).

### JISC E-learning framework

When service-oriented architectures became popular around 2005, the UK's Joint Information Systems Council (JISC) an ICT support agency for universities developed a service-oriented view of e-learning (Fig. 11). Sorting services in three categories: simple user agents, learning domain services, and common services, JISC developed a framework to "enhance learning by creating an open programming environment that supports sharing and pedagogical experimentation" (JISC, n.d.). This framework became the forerunner to an international collaboration in 2006–2007 known as the *e-Framework for Education and Research* and sponsored by government agencies in the UK, Australia, New Zealand, and The Netherlands. This framework proved useful as a reference within *ISO/IEC/TS 20013:2015 – A reference framework of ePortfolio information* published by SC36 as a Technical Specification in 2015.

### ADL – The Total learning architecture

Fifteen years after IEEE started developing general architectural frameworks for e-learning and Advanced Distributed Learning (ADL), the US Department of Defense program that developed the Sharable Content Object Reference Model (SCORM) (ADL, 2004), embarked on new work focused on developing a "total learning architecture" (TLA) (ADL, 2016). While SCORM is arguably the most implemented ITLET standard in the world, and continues to serve a purpose in some contexts, ADL has identified further standards development that aligns more with the cloud-services and data-rich contemporary environment. SCORM was architected to specify the runtime requirements of maintaining sessions for the single-learner undertaking self-paced learning within an enterprise environment. In other words, it was very specific. In recent years ADL has developed xAPI (the eXperience API), which can be understood as an architecture that places an individual's experience, data outputs and requirements as the centrepiece as distinct from the content in SCORM. xAPI specifies an interface allowing different systems to share data tracking all kinds of learning activities. While xAPI is positioned well to accommodate much of the innovation in the learning

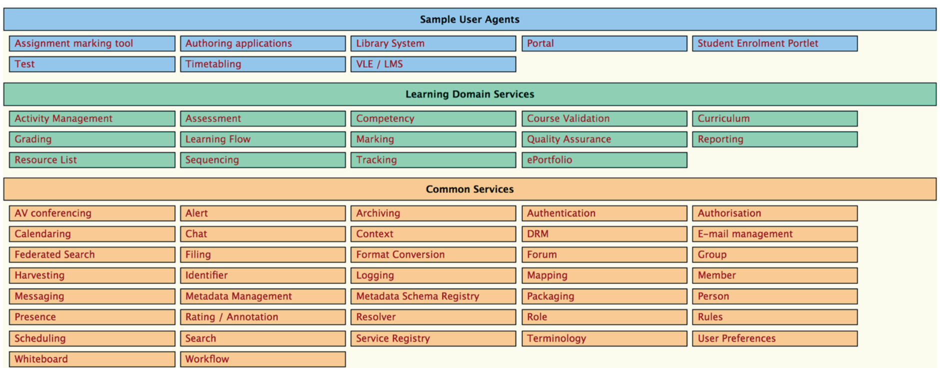


**Fig. 11** The JISC E-Learning framework

analytics space it should also be understood as serving a specific purpose and is only an activity stream format. Thus, ADL has also been progressing work on the Total Learning Architecture (TLA), depicted in Fig. 12 as an organic ecosystem.

The TLA is the development initiative that comes closest to the ideas of a smart learning environment as described in the papers referenced above outlining the ideas of smart learning.

In Table 2 we have classified the above high-level standardization frameworks according to criteria used in the SLE models.

In reviewing these various abstract frameworks and architectures, five important themes can be identified:

1. A progression from a focus on modelling systems in which content was the primary component toward ecosystems that facilitate interaction and activities in which the learner is now the centrepiece.
2. Activity data from learners and other entities (instructors and platforms) is what drives the interworking of modules, systems and processes.
3. Standards and specifications development has shifted emphasis from big picture descriptions to targeted solutions for specific requirements. Broad frameworks are still needed, but what standards activities cycle between rendering abstract frameworks that represent key components of an ecosystem to specifying IT requirements of a specific component or group of services.
4. Application Programming Interfaces (APIs) are the points of integration or interoperability, where the service innovation is driven to the periphery relying on stable conduits of information through well-defined APIs.
5. Architectural models must deal with new complexities and can only realistically be dealt with when decomposed into autonomous modular subsystems or services.

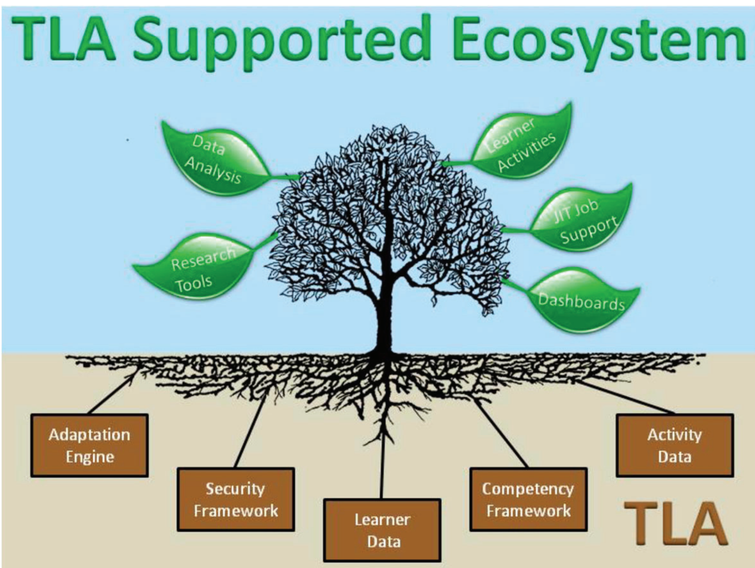


**Fig. 12** Total Learning architecture (ADL, 2016)

**Table 2** How development of standard frameworks is positioned in relation to SLE

| Standards frameworks | Level of smartness | Data-driven? | Pedagogical model |
|---|---|---|---|
| LTSA | Pre SLE model | No | Content-driven |
| IMS | Service layer model anticipating adaptive systems | No | N/A |
| OKI | Service-oriented interfaces - a precondition for adaptive systems | No | Knowledge system view |
| JISC | Service-oriented | No, based on predefined metadata models | Heterogeneous pedagogies afforded by the tools made available |
| ADL-TLA | Self-organizing | Yes | Heterogeneous |

## Conclusions and further development

In this paper, our concern has been to connect two discourses: research into smart learning and digital technology standardization. The primary motivation for doing so has been to identify the common aspects and core constructs that might form the basis of a meta-framework, thereby adding value to both discourses. Our analysis to date indicates that pursuing this represents a logical next frontier for international ITLET standardization. The most promising candidate constructs for this purpose can be drawn from the work Koper (2014) and Uskov et al. (2015). We believe we have provided the basis for the synthesis required to progress standardization of a smart learning framework.

Our analysis also reveals numerous questions that require further investigation if such an endeavour is to prove fruitful. The following list is indicative:

- What sub-systems can be identified and defined as both self-contained and interoperable within a SLE?
- What lessons can we draw from reviewing the abstract modelling of earlier standards and specification development associated with ITLET?
- In what ways might digital infrastructure development (inclusive of specifications and standards development) undertaken by organizations with a broader remit then ITLET standardization, such as the World Wide Web Consortium (W3C) and the Internet Engineering Task Force (IETF), inform both discourses in this paper?
- How many abstractions can adequately represent a SLE?
- How will we ensure that the developed SLE standardization framework is grounded in sound and stable theories of learning, so that it withstands new trends in pedagogical practices?

Our analysis suggests that for both fields of analysis – research into smart learning and ITLET standardization – there is a need for conceptual development that establishes frameworks that will guide and encourage further development. In this paper, we have developed two models, a core model of smart learning processes (Fig. 6), and a model of characteristics of the environment, in which smart learning take place (Fig. 8). Our claim is that these models can inform the development of an ITLET standardization agenda. For example, there are no activities in early 2018 on data-driven, self-organized learning environments – the highest smartness level represented in Fig. 8. However, if the core model described in Fig. 6 is used to develop requirements for such an agenda socio-cognitive issues are bound to be raised. Among questions asked would be: *How will self-organized environments support socializing? How are artefact creation being facilitated? And how are practice and reflection observed and acted upon to self-adjust the environment?*

Above, we have noted that APIs more and more will be points of interoperability; and as interoperability is often a prominent goal of standardization one could declare job done if the results from the services the APIs connect to fulfil requirements. The problem, however, with this approach is that large parts of the infrastructure will be black boxes outside the scope of both standardization and public knowledge. This is hard to avoid when relying on AI technologies and big data, which are integral parts of self-organizing systems. The understanding of what algorithms do behind the scenes is limited; and the logic developing them is very different from what happens in standardization. This poses challenges to designing a framework to drive further standardization of SLEs since the top-down, deductive logic of traditional standards-making is not what makes data-driven, incremental machine-learning work.

In progressing the abstract modelling work there is clearly a case for the development of a formal ontology describing the field based largely on the work done by Uskov et al. (2015). The problem with a conceptualization of SLE that is too loosely defined is that it will be too weak to guide further research. The same observations hold for the IT architectures we have analysed. In emphasizing the heuristic and pragmatic aspects of framework development there is a need to be explicit about the defining criteria for which direction to go. We would suggest that it is essential to clarify stakeholder perspective and domain relationship. A clearer stakeholder perspective and better understanding of the domain in which the solutions will be implemented will serve as an antidote to the technology focus that has characterized both fields. The range of content and delivery modalities, the ubiquity of learning, and the variety of facilitation – both human and machine supported – all make it clear that a one-framework-fits-all approach is obsolete. Therefore, we suggest a developing strategy that follows a two-pronged approach as follows.

First, create a top-level framework that is simple, robust, and informed by pedagogical perspectives that are themselves informed by innovation with digital technology. The model described in Fig. 6 is in our opinion a candidate for further development. Second, create smaller, well-defined domain models from different stakeholder perspectives, e.g., model describing ITLET environment for learner in math at primary education, or model describing ITLET environment for language teacher in online and distance learning.

The justification for suggesting this approach is the state-of-affairs implicit in the emerging field of SLE. From a situation of rapid change and influx of new technologies we can assume that technological problems are to be solved; there are now other issues related to semantic, organizational, legal and political interoperability that are the barriers. Therefore, in standards development we need frameworks that serve a broader agenda than only technical interoperability. In the field of SLE, there is a need for frameworks that support a research agenda as well as a political agenda of being 'smart'. Our analysis also suggests that some specific strategies for making progress would involve scrutiny of SLE test implementations and reference models of published standards to assure that modelling of the framework is based on stakeholder requirements. Therefore, to achieve optimum outcomes, it is important that further development takes place in collaboration between research and development, the standards community, and end-users testing out systems under proposal.

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**References**
ADL (2004). SCORM Reference Introduction. Advanced Distributed Learning. http://www.adlnet.gov/dodi/scorm. Accessed 03 May 2017.
ADL (2016). The Total Learning Architecture. Rationale and Design. December 2016. Advanced Distributed Learning. http://www.adlnet.gov/tla. Accessed 03 May 2017.
Baker, D. P. & Wiseman, A. W. (2008). Preface, in The Worldwide Transformation of Higher Education (International Perspectives on Education and Society, Volume 9). Emerald Group Publishing limited.
Bell, G. (2017). Fast, smart and connected: How to build our digital future. 2017 Boyer Lectures. ABC Radio National. Retrieved from http://www.abc.net.au/radionational/programs/boyerlectures/genevieve-bell-fast-smart-connected-how-build-digital-future/9062060
Derzko, W. (2007). Smart Technologies. http://archives.ocediscovery.com/2007/presentations/Session3WalterDrezkoFINAL.pdf
Engestrom, Y. Enriching the theory of expansive learning: Lessons from journeys toward coconfiguration. Mind Cult. Act. **14**(1–2), 23–39 (2007)
Ferguson, R., Barzilai, S., Ben-Zvi, D., Chinn, C. A., Herodotou, C., Hod, Y., Sharpels, M., & Whitelock, D. (2017). Innovating Pedagogy 2017 - Exploring new forms of teaching, learning and assessment, to guide educators and policy makers (Open University Innovation Report No. 6) (p. 48). Milton Keynes: Open University. Retrieved from https://iet.open.ac.uk/file/innovating-pedagogy-2017.pdf
Garrison, DR., Cleveland-Innes, M. & Fung, TS. Exploring causal relationships among teaching, cognitive and social presence: Student perceptions of the community of inquiry framework. Internet High. Educ. **13**, 1 (2010)
Hoel, T., Mason, J. (2012) Deficiencies of scope statements in ITLET standardization. In G. Biswas, et al. (Eds.) Proceedings of the 20th International Conference on Computers in Education. Singapore: Asia-Pacific Society for Computers in Education.
Hwang, G-J. Definition, framework and research issues of smart learning environments – A context-aware ubiquitous learning perspective. Smart Learning Environments **1**(1), 492–414 (2014) https://doi.org/10.1186/s40561-014-0004-5
IASLE. (n.d.) Smart Learning. Online: http://www.iasle.net/index.php/about-us/background. Accessed 5 May 2017.
IBM. (2009). Education for a Smarter Planet: The Future of Learning. Online: http://www.redbooks.ibm.com/redpapers/pdfs/redp4564.pdf. Accessed 08 Feb 2018
IEEE (2003). IEEE Standard for Learning Technology – Learning Technology Systems Architecture (LTSA), in IEEE 1484.1–2003, 1–97, 2003 https://doi.org/10.1109/IEEESTD.2003.94410.
IMS Global Learning Consortium (2003a). IMS Abstract Framework: White Paper Version 1.0. Online: https://www.imsglobal.org/af/afv1p0/imsafwhitepaperv1p0.html. Accessed 03 May 2017.
IMS Global Learning Consortium (2003b). IMS Learning Design Specification.Online: https://www.imsglobal.org/learningdesign/index.html. Accessed 06 Feb 2018
ISO, in *International Organization for Standardization*. ISO 704:2009: Terminology Work – Principles and Methods (2009)
JISC (n.d.) The E-Learning Framework. Joint Information Systems Council. http://www.elframework.org/framework.html. Accessed 03 May 2017.
Kallinikos, J. Smart machines. Encyclopedia of Softw. Eng. **1**(1), 1097–1103 (2010)
Koehler, M. & Mishra, P. What is technological pedagogical content knowledge (TPACK)? Contemporary issues in technology and teacher education **9**(1), 60–70 (2009)

Koper, R. Conditions for effective smart learning environments. Smart Learning Environments **1**(1), 90–17 (2014). https://doi.org/10.1186/s40561-014-0005-4
Lee, J-L. (2011). Korea's Choice: "Smart Education". OECD. https://community.oecd.org/community/educationtoday/blog/2011/07/26/korea-s-choice-smart-education. Accessed 05 May 2017
Liu, D, Huang, R, Wosinski, M. Smart Learning in Smart Cities. Springer Lecture Notes in Educational Technology, 1-240 (2017)
Mason, J. *Aligning Architectures for Learning–The Design and Practice of Online Educational Culture* (Proceedings of the Department of Vocational Education and Training Postgraduate Students' Conference, Melbourne, 1999)
Mason, J. Norris, D. Lefrere, P. *An Expeditionary Approach to E- Knowledge* (Proceedings of EduCause in Australasia, Adelaide, 2003), pp. 137–143
MIT (2002). What is the Open Knowledge Initiative? http://web.mit.edu/oki/learn/whtpapers/OKI_white_paper_120902.pdf. Accessed 3 May 2017
Nonaka, I. *Management of Knowledge Creation* (Nihon Keizai Shinbun-sha, Tokyo, 1990)
Overby, E. (2017). ISO/IEC JTC1 SC36 N3458: Call for Input to NBLOs on Improvement of SC36 Organization.
Rada, R. (2001). Understanding virtual universities. Intellect Books.
Roumen, E. S., & Kovatcheva, N. E. (2017). Conceptualising of Smart Education. Online: https://www.researchgate.net/publication/320623528_Conceptualising_of_Smart_Education. Accessed 06 Feb 2018
Spector, JM. Conceptualizing the emerging field of smart learning environments. Smart Learning Environments **1**(1), 5–10 (2014) https://doi.org/10.1186/s40561-014-0002-7
Thorne, S., Shubert, C., & Merriman, J. (2002). OKI Architecture. MIT. Online: http://web.mit.edu/oki/learn/whtpapers/ArchitecturalOverview.pdf. Accessed 08 Feb 2018
Tuomi, I. Open educational resources and the transformation of education. Eur. J. Educ. **48**(1), 58–78 (2013)
Universities Australia (2014). Keep it Clever. Policy Statement. http://keepitclever.com.au/ Accessed 05 May 2017
Uskov, VL., Bakken, JP., Heinemann, C., Rachakonda, R., Guduru, VS., Thomas, AB., Bodduluri, DP. in *Smart Education and Smart e-Learning*. Building Smart Learning Analytics System for Smart University, vol 75 (Springer International Publishing, 2017), pp. 191–204. https://doi.org/10.1007/978-3-319-59451-4_19
Uskov, VL., Bakken, JP., Pandey, A. in *Smart Education and Smart e-Learning*, ed. by V L Uskov, R J Howlett, L C Jain. The ontology of next generation smart classrooms (Springer, London, 2015), p. 41
Uskov, V L., Howlett, R J., Jain L C. (eds.), *Smart Education and Smart e-Learning (Smart Innovation, Systems, and Technologies, 41)* (Springer, London, 2015)
Walker, R., Voce, J., Jenkins, M. Charting the development of technology-enhanced learning developments across the UK higher education sector: A longitudinal perspective (2001–2012*)*. Interact. Learn. Environ. **24**(3), 438–455 (2016)
Zhu, Z. (2014). Emergence of Smart e-Learning and Education. Presentation at EFQUEL 2014. https://www.slideshare.net/EIFLINQ2014/keynote-zhu-zhitingsmarteducation. Accessed 17 Apr 2017.
Zhu, Z., Sun, Y., Riezebos, P. Introducing the smart education framework: Core elements for successful learning in a digital world. International Journal of Smart Technology and Learning **1**(1), 53 (2016) https://doi.org/10.1504/ijsmarttl.2016.078159
Zhu, ZT., Bin, H. Smart education: A new paradigm in educational technology. Telecommunication Education **12**, 3–15 (2012)
Zhu, Z-T., Yu, M-H., Riezebos, P. A research framework of smart education. Smart Learning Environments, 1–17 (2016). https://doi.org/10.1186/s40561-016-0026-2
Zuboff, S. *In the Age of the Smart Machine: The Future of Work and Power* (Basic Books, New York, NY, 1988)
Zuboff, S. Big other: Surveillance capitalism and the prospects of an information civilization. J. Inf. Technol. **30**, 75–89 (2015). https://doi.org/10.1057/jit.2015.5

# X

# MAKING CONTEXT THE CENTRAL CONCEPT IN PRIVACY ENGINEERING

by

Hoel, T. & Chen, W., & Pawlowski, J.M.

Submitted for review.

# Making context the central concept in privacy engineering

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*Abstract:* There is a gap between people's online sharing of personal data and their concerns about privacy. Till now this gap is addressed by attempting to match individual privacy preferences with service providers' options for data handling. This approach has ignored the role different contexts play in data sharing. This paper aims at giving privacy engineering a new direction putting context centre stage and exploiting the affordances of machine learning in handling contexts and negotiating data sharing policies. This research is explorative and conceptual, representing the first development cycle of a design science research project in privacy engineering. The paper offers a concise understanding of data privacy as a foundation for design extending the seminal contextual integrity theory of Helen Nissenbaum. This theory started out as a normative theory describing the moral appropriateness of data transfers. In our work, the contextual integrity model is extended to a socio-technical theory that could have practical impact in era of artificial intelligence. New conceptual constructs as 'context trigger', 'data sharing policy', 'data sharing smart contract' are defined, and their application are discussed from an organisational and technical level. Contributions to design science research is discussed and the paper concludes with presenting a framework for further privacy engineering development cycles.

*Keywords:* privacy engineering; contextual integrity; context; context trigger; personal data; online data sharing

## 1. Introduction

People who are concerned about privacy do not necessarily make choices about data sharing reflecting the gravity of their concerns. This gap defines the "privacy paradox", observed in a number of studies (Baruh, Secinti, & Cemalcilar, 2017; Norberg, Horne, & Horne, 2007; Taddei & Contena, 2013). In real life, intentions only explain part of our behaviour (Sheeran, 2002). In online practices, this is demonstrated by the fact that most of us use popular online search engines, well knowing the 'free services' are paid for by sharing our personal data. The gap to be concerned about, however, is not that our actions do not follow our intentions, but the fact that available privacy solutions are so far behind our online practices. We share an unprecedented amount of personal data aligning our lives to data-driven smart cities, smart public services, intelligent campuses and other online practices utilising artificial intelligence (AI). We know little about how this data is used. When pushing back, for example using the European General Data Protection Regulation (GDPR) to stop blanket acceptance of opaque privacy policies, we only seem to get more obfuscation, having to fight pop-up windows asking for permission to use our private data for every new site to be accessed. To close the gap and prevent 'privacy fatigue' (Choi, Park, & Jung, 2017) we need better privacy solutions, but both the research and design community are struggling to see where the solutions should come from.

This paper is premised on what some may characterise as a defeatist position on data sharing: We will not be able to scale back sharing of personal data, no matter how much we appeal to the GDPR principles of purpose limitations and data minimization (EU, 2012). The craving for data exposing our behaviour as consumers, citizens, and persons caring for our health and cognitive development is already strong (Mansour, 2016). And it is being strengthened by the AI arms race, where the fierce competition lessen the appetite to address contentious AI issues, such as data privacy, public trust and human rights related to these new technologies (Nature, 2019). The challenge needs to be addressed by stepping up efforts in privacy engineering searching for more adequate solutions to manage personal data sharing in a world of digital transformation.

This paper aims at advancing privacy engineering through contributions addressing both semantic, organisational and technical aspects of future solutions. In the Background section we pinpoint the weaknesses of current discourse on privacy and point to a better understanding of context as a fruitful direction of development. In the following sections we construct conceptual artefacts and draw up designs that may support digital practices in a society embracing big data and more and more use of artificial intelligence.

# 2. Background

In this paper we want to advance the field of privacy engineering, defined by Kenny and Borking as "a systematic effort to embed privacy relevant legal primitives into technical and governance design" (Kenny & Borking, 2002, p. 2). We would argue that not only legal primitives need to be embedded, but realise that adding philosophical, social, pedagogical and other perspectives make privacy engineering utterly complex. No wonder Lahlou, Langheinrich, and Röcker (2005) found that engineers were very reluctant to embrace privacy: Privacy "was either an abstract problem [to them], not a problem yet (they are 'only prototypes'), not a problem at all (firewalls and cryptography would take care of it), not their problem (but one for politicians, lawmakers, or, more vaguely, society), or simply not part of the project deliverables" (Lahlou, Langheinrich, and Röcker, 2005, p. 60). When the term "privacy" is so often misunderstood and misused in HCI (Barkhuus, 2012), there is a need to converge on a subset of core privacy theories and frameworks to guide privacy research and design (Badillo-Urquiola et al., 2018), taking into account the new requirements of data-driven society (Belanger & Crossler, 2011).

Figure 1 gives an overview of how privacy theories have developed from mainly focusing on the individual handling "small data" to dealing with data sharing in group and societal settings, where new technologies using big data set the scene. In this paper, we see the development of a contextual approach to privacy as necessary to make progress within privacy engineering.

In their interdisciplinary review of privacy-related research Smith, Dinev, and Xu (2011) found that definitional approaches to general privacy could be broadly classified either as value-based or cognate-based (the latter related to the individual's mind, perceptions, and cognition). Sub-classes of these definitions saw privacy as a right or a commodity (that could be traded for perceived benefits), or privacy as individual control of information, or as a state of limited access to information. The problem with these theories is their lack of explanatory power when it comes to shed light on the boundaries drawn between public and private information in actual online practices in our digital age

(Belanger & Crossler, 2011; Smith, Dinev, and Xu, 2011). In Figure 1 we have indicated that when met with challenges from group level interactions in data-rich networked environments both value-based and cognate-based theories will be drawn towards contextual perspectives on how information flows. We would claim that when boundaries between private and shared information are negotiated —often mediated by some ICT tool—the perspectives from the individual privacy theories may play an active role. There will still be arguments referring to individual data ownership and control, data sharing with a cost-benefit considerations and trade-offs, or the ability to uphold solitude, intimacy, anonymity or reserve (the four states of individual privacy identified by Westin (2003). However, these perspectives will serve as a backdrop of deliberations that require another set of privacy constructs, for which context will serve as the key concept.

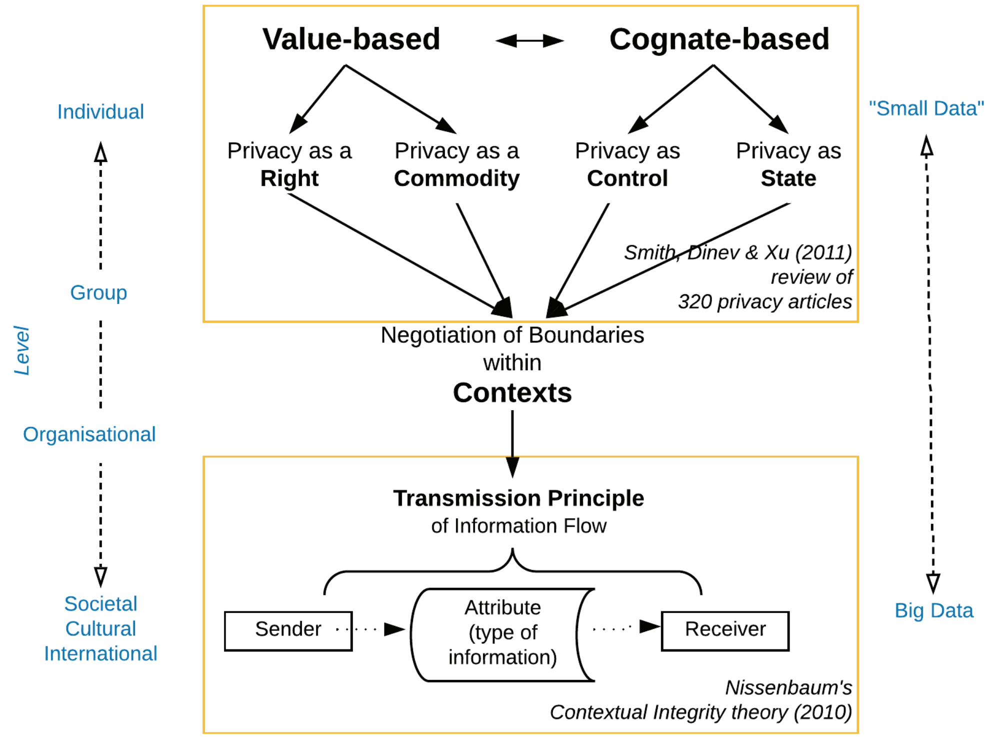


*Figure 1. Development of privacy theories toward a contextual perspective (based on Smith, Dinev, & Xu (2011) and Nissenbaum (2010)).*

It may be objected that to highlight context may just be to exchange one elusive concept (privacy) with another borderless concept (context). Smith, Dinev, and Xu (2011) were not at all sure that context-driven studies may produce an overall contribution to knowledge, "unless researchers are constantly aware of an over-arching model" (ibid., p. 1005). To contribute to an understanding of privacy context we have pointed to the theory of Contextual Integrity (CI) as a candidate for further development (see Figure 1). In the following we introduce the CI theory, focussing on how this theory's concept of context is to be understood.

### 2.1. The Contextual Integrity theory

Over the last fifteen years, CI has been one of the most influential theories explaining the often conflicting privacy practices we have observed along with the development of ubiquitous computing.

When Helen Nissenbaum first launched CI, she used philosophical arguments to establish "[c]ontexts, or spheres, [as a] a platform for a normative account of privacy in terms of contextual integrity" (Nissenbaum, 2004, p. 120). The two informational norms she focussed on were norms of appropriateness, and norms of information flow or distribution. "Contextual integrity is maintained when both types of norms are upheld, and it is violated when either of the norms is violated" (ibid, p. 120).

Privacy norms are not universal, "contextual integrity couches its prescriptions always within the bounds of a given context" (Nissenbaum, 2004, p. 136). Non-universal norms may seem like an oxymoron, as a norm is supposed to cover more than one case. What role does CI give to context is a key question we see the originator of the theory grapples with in the 2004 article. "One of the key ways contextual integrity differs from other theoretical approaches to privacy is that it recognizes a richer, more comprehensive set of relevant parameters," Nissenbaum (2004, p. 133) states, reflecting on her application of CI on three cases (government intrusion, access to personal information, and to personal space) that has dominated privacy law and privacy policies in USA. However, access to more detail—a richer set of parameters—does not alter the way traditional privacy approaches have worked, implying violation of privacy or not from the characteristics of the setting matched against individual preferences. As Barkhuus observes,

> "It (..) appears rather narrow to attempt to generate generalized, rule-based principles about personal privacy preferences. Understanding personal privacy concern requires a contextually grounded awareness of the situation and culture, not merely a known set of characteristics of the context." (Barkhuus, 2012, p. 3)

This questions on how context should be understood in relationship to preference—as *something more* than characteristics of individual preferences—represents a research gap that will be addressed in this paper as it goes to the heart of the privacy discourse: Where are norms of appropriateness of the exchange anchored—internally or externally—in the value system of the individual or in the negotiated relationships to others in situations?

First, we will explore how context is to be understood, before we return to the the question of how preference and context are related.

### 2.2. Understanding context

Context is the set of circumstances that frames an event or an object (Bazire & Brezillon, 2005). This generally accepted meaning of the term is not very helpful when wanting to use it in a specific discipline where we need a clear definition. There are, however, many definitions of context to choose from. Bazire and Brezillon (2005) collected a corpus of more than 150 definitions, most of them belonging to cognitive sciences (artificial intelligence being the most represented area). In human cognition, they note, there are two opposite views about the role of context. The first view considers cognition as a set of general processes that modulate the instantiation of general pieces of knowledge by facilitation or inhibition. In the second view (in the area of situated cognition), context has a more central role as a component of cognition by determining the conditions of knowledge activation as well as the limit of knowledge validity.

These two opposite views have parallels with our question above about the basis of a decision on appropriateness of data exchange. Context may have an internal nature, or an external one. "On the one hand, context is an external object relative to a given object, when, on the other hand, context belongs to an individual and is an integral part of the representation that this individual is building of the situation where he is involved. According to this second viewpoint, "context cannot be separated from the knowledge it organizes, the triggering role context plays and the field of validity it defines"." (Bazire & Brezillon, 2005, citing Bastien, 1999).

In the context of privacy deliberations, in this paper we would follow the second viewpoint focusing on knowledge organisation. Context is itself contextual; context is always relative to something—described as the focus of attention. For a given focus, Brézillon and Pomerol (1999) consider context as the sum of three types of knowledge. *Contextual knowledge* is the part of the context that is relevant for making decisions, and which depends on the actor and on the decision at hand. By definition, this creates a type of knowledge that is not relevant, which Brézillon and Pomerol (1999) call *external knowledge.* However, what is relevant or not evolves with the progress of the focus, so the boundaries between external and contextual knowledge are porous. A subset of the contextual knowledge is *proceduralised* for addressing the current focus. "The proceduralized context is a part of the contextual knowledge that is invoked, assembled, organized, structured and situated according to the given focus and is common to the various people involved in decision making" (Brézillon, 2005, p. 3), see Figure 2.

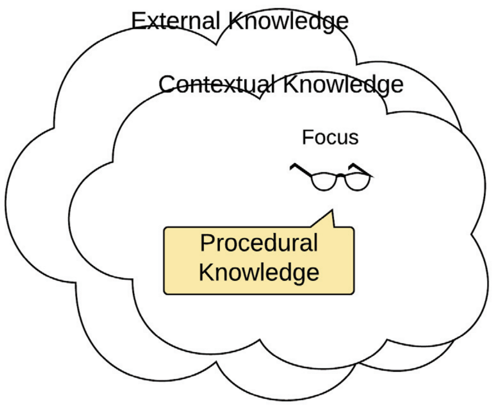


*Figure 2. Different kind of context knowledge (Based on Brézillon & Pomerol, 1999)*

The first point of view on contexts discussed above—modulation of external object by facilitation or inhibition—has similarities with what we could call a preference approach (matching individual preference characteristics with alternative actions). In the next sections we will explore limitations to this approach reviewing literature from the field of personalised learning and privacy standardisation.

#### 2.3. Limitations of a preferences approach

The individual privacy preference approach has similarities with the approach of personalised learning (Campbell et al., 2007), which has been critiqued for lack of nuanced understanding for how the needs of different learners can be understood and catered for in school. Prain et al. (2012) argues that the critical element in enacting personalised learning is the 'relational agency' operating within a 'nested agency' in the development of differentiated curricula and learners' self-regulatory capacities.

> "The construct of 'nested agency' recognises that the agency of both groups [teachers and learners] as they interact is constrained by structural, cultural and pedagogical assumptions, regulations, and practices, including prescriptive curricula, and actual and potential roles and responsibilities of teachers and students in school settings." (Prain et al., 2012, p. 661)

The main lesson learnt from the well researched field of personalised learning is the need for a better understanding of the contexts, in which the learning occurs.

A special group of learners are persons with disabilities. ISO/IEC published in 2008 the Access for All standard aiming "to meet the needs of learners with disabilities and anyone in a disabling context" (ISO, 2008). The standard provided "a common framework to describe and specify learner needs and preferences on the one hand and the corresponding description of the digital learning resources on the other hand, so that individual learner preferences and needs can be matched with the appropriate user interface tools and digital learning resources" (ISO, 2008). The Canadian Fluid Project has proposed to use the same framework to define *Personal Privacy Preferences*, working as "a single, personalized interface to understand and determine a privacy agreement that suits the function, risk level and personal preferences", so that, "private sector companies would have a standardized process for communicating or translating privacy options to a diversity of consumers" (Fluid Project, n.d.).

Using the ISO 24751:2008 framework to define personal privacy preferences implies acceptance of the standard's definition of context as "the situation or circumstances relevant to one or more preferences (used to determine whether a preference is applicable)". Then privacy is seen as a characteristic of the individual, rather than a relationship between different actors mediated by contexts. The Canadian project proposes to "leverage ISO 24751* (Access for All) to discover, assert, match and evaluate personal privacy and identity management preferences" (Fluid Project, n.d.). However, the challenge is not to facilitate matching between predefined preferences and alternative representations of web content (which was the focus of the Access for All standard); the challenge is to orchestrate dynamic privacy policy negotiations in the particular contexts of a great number of online activities. If one sees only individuals with needs, one tends to overlook other factors, like culture, social norms, and activity patterns embedded in complex settings.

To make context 'a first-class citizen' (Scott, 2006) in privacy engineering CI needs to be developed from a normative ex post theory to a theory positioned more in the middle of privacy negotiations supported by information technology. In the next subsection we will see how the theoretical base of CI has been broadened by Helen Nissenbaum and different research groups.

### 2.4. Formalising CI

Barth, Datta, Mitchell, and Nissenbaum (2006) made a first attempt to make a formal model of a fragment of CI, focussing on "communicating agents who take on various roles in contexts and send each other messages containing attributes of other agents" (ibid, p. 4). In 2010, Nissenbaum provided a nine-step decision heuristic to analyse new information flows, thus determining if new practice represents a potential violation of privacy. In this heuristic, she for the first time specified precisely which concepts should be defined to fulfil a CI evaluation, see Figure 3 (Nissenbaum, 2010, pp. 182-183).

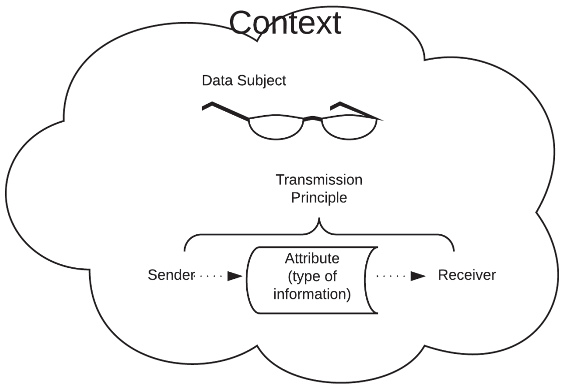


*Figure 3. The theory of Contextual Integrity (after Nissenbaum, 2010)*

From this heuristic, authors in collaboration with Nissenbaum have developed templates for tagging privacy policy descriptions (e.g., Facebook's or Google's privacy policy statements) to be able to analyse how these documents hold up to the CI theory (Shvartzshnaider, Apthorpe, Feamster, & Nissenbaum, 2018).

CI describes information flows using 5-parameter tuples, which include actors (data subjects, senders, and receivers) involved in the information flow, the type (attribute) of the information, and the condition (transmission principle) under which the information flow occurs. This combination of five factors defines contexts, which determine privacy norms.

> "Contextual integrity describes a desirable state that people strive towards by keeping perceived-private information private according to the context. For example, people expect to share medical information with doctors but not with employers. Where it in some cultures yearly salary is perceived as private, within others it is normal to share this information. Contextual integrity thereby explains how privacy is grounded in each context, governed by pre-existing norms and values." (Barkhuus, 2012, p. 3).

However, mapping pre-existing norms and values is not easy to achieve in situations where there is no pre-defined understanding of privacy. The use of social media is a case in point. "Understanding personal privacy concern requires a contextually grounded awareness of the situation and culture, not merely a known set of characteristics of the context" (Barkhuus, 2012, p. 3).

CI bridges two worlds—a world inhabited by humanists, social scientists, lawyers, and regulators; and another world inhabited by mathematicians, computer scientists, and engineers, according to Benthall, Gürses, and Nissenbaum (2017). For the latter world, "CI offers a formal structure for expressing rules of information flow (informational norms) and for building computational models of people’s privacy expectations in well-defined settings (contexts.)” (Benthall, Gürses, & Nissenbaum, 2017, p. 12). The CI theory gives the framework and the key concepts for a contextual understanding of information privacy. However, by positioning contexts as “well-defined settings”, these authors limit the potential of CI in an era when sensors and computational power allow a more dynamic reasoning about contexts. As Barkhuus has stated, the theory needs to be further developed, and new research should be informed by privacy’s

> “appropriation of behavior in the situation (..) and not a behavioristic belief that people’s actions are based on a structured set of privacy concerns. Instead of focusing on the how and what in terms of people’s preferences for personal data sharing, we need a foundation of research that looks at why.” (Barkhuus, 2012, p. 8)

However, computational reasoning about *why* goes beyond the affordance of current information technologies as practical benefits of *general AI* still need to materialise (Tuomi, 2018). Data-driven machine learning (ML), on the other side, is available, and it should be explored how this field could contribute to a contextual approach to privacy engineering.

This review of how context has become a more central concept in privacy engineering has identified a number of research gaps. We have pointed to the new era of Big Data, AI and unparalleled access to processing power, all factors that open up for dynamic and synchronous reasoning about privacy decisions. For this to happen we need to further develop ‘context’ as a concept that reaches beyond just framing pre-defined preference settings. This means to advance CI in the direction of a prescriptive theory, giving context a pivotal role in IT systems that answer user requirements. Therefore, we have identified design challenges both on conceptual, process and technical levels of design.

# 3. Methodology

This work follows a conceptual and exploratory approach; however, it is situated in the tradition of Design Science Research (DSR) (Gregor & Hevner, 2013) where the developed constructs are tested against empirical cases derived from literature and in interaction with the practice field. The methodology implies several cycles of design, however, in this paper we present the results of initial development, focussing on conceptual analysis. The main objective of this paper is to come up with novel design artefacts (Baskerville et al., 2018) that a selected group of experts will see as valuable in future privacy and information sharing scenarios. We have chosen a design approach addressing the design task as different layers of interoperability. Design theory implications of this approach play, however, a minor role in this paper.

We will use the lens of the European Interoperability Framework (EIF) to structure our approach. EIF (Figure 4) has four levels, the first covering legal interoperability. For now, we leave this aside as we might say that GDPR and other legal frameworks have levelled the legal ground for privacy engineering. The different actors know how to interoperate to exchange and handle information legally, and developers are committed to the principle of ‘privacy by design’ (PbD) (Cavoukian, 2009), i.e., the obligation, from the very beginning to build privacy into their solutions. However, in this field, clarity is lacking in the other interoperability levels of EIF—at the organisational, semantic and technical levels.

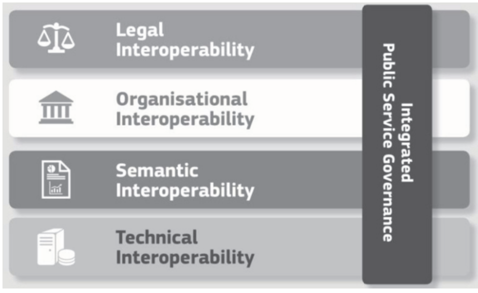


*Figure 4. European Interoperability Framework (From EU, 2012).*

In order to make privacy more than an afterthought, after solutions are designed and implemented, we must know what PbD means at different levels. We will explore privacy design at three levels, in this order:

- **semantic**: how is privacy conceptualised, and how could privacy concepts be formalised to be used in technical design to achieve precise format and meaning of exchanged data, so that information is preserved and understood throughout exchanges between parties;
- **organisational**: how institutions align their business processes, responsibilities and expectations i relation to privacy to achieve commonly agreed and mutually beneficial goals;
- **technical**: what system architecture would ensure that data could be shared between system and services without violating the privacy of users.

A first validation of design is done through semi-structured interviews with a group of 11 experts from the standards community, the learning analytics community, and the information science community, whom the authors knew have touched privacy issues in their academic work. In a web form that was used as a scaffold for the interviews, the experts were given a link to an early draft of this paper and presented with the design artefacts, i.e., Figures 1, 2, 6, and 10 in this paper; and a figure of a context graph template, and the guiding definition of data privacy. The recorded online Skype interviews were staged as a stepwise discussion, moving through 8 pages from a general discussion on privacy (Figures 1), to discussing the data flow of the application senario of the proposed solution (Figure 10). Substantial parts of the interviews, each lasting from 35 to 60 minutes, were transcribed and analysed to probe acceptance of the proposed privacy engineering approach, and to capture suggestions for improvement of constructs. In addition, the constructs were discussed in the context of an educational scenario to see how the suggested approach holds up to well known use cases in learning, education and training (LET).

# 4. Conceptual design — privacy in context

"Taking context seriously means finding oneself in the thick of the complexities of particular situations at particular times with particular individuals," Nardi (1992, p. 35) observed when considering HCI design challenges. Applying a top-down approach, finding commonalities across situations is difficult "because studies may go off in so many different directions, making it problematic to provide the comparative understanding across domains", she concluded. Nissenbaum's CI model, we have pointed out, needs to be extended with a better understanding of context. Nowadays, we do not need to handle context as a container; we can sense context more in real time as an occasioned event—relevant to particular settings, particular instances of action, and particular parties to that action—not an abstract category that generalizes over settings, actions, and parties.

In this section we will put the CI model in context of Patrick Brézillion's theory (Brézillon, 1999, 2003, 2005), extending CI with an event dimension. We then suggest a representation format to describe reasoning about privacy events. The semantic design concludes with provisional definition of a data privacy process to guide organisational and technical design.

To allow sensors and computers to work on privacy data we need a formal representation of the CI model. The core attributes of CI are formally represented as C(ds, s, r, a, t), where C = context, ds = data subject, s = sender, r = receiver, a = attribute (type), and t = transmission principle. However, C is not understood as a top-down container but as dynamic recursive settings where $C_1$ is understood in relation to $C_0$ and the shift of focus determined by other contexts (Figure 5).

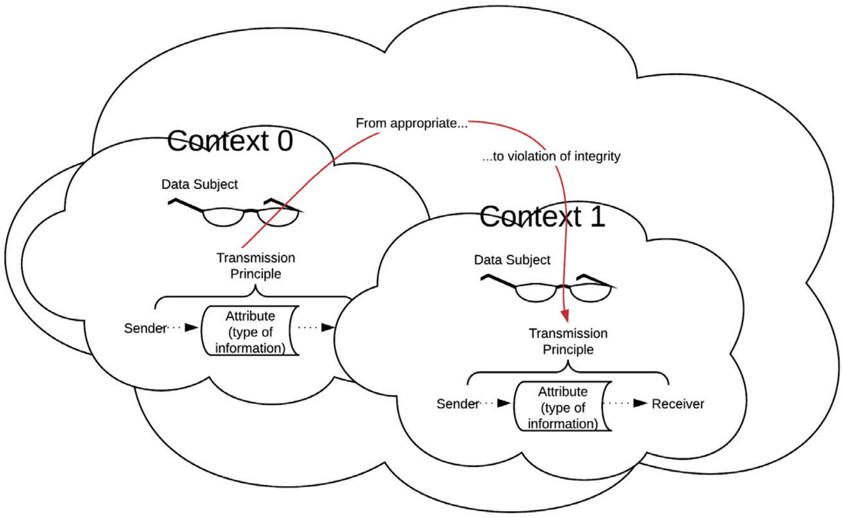


*Figure 5. Contexts as dynamic recursive settings defined by subject's focus*

Figure 5 describes a situation where sharing of data becomes a violation of integrity as the focus changes when moving from one context to another. Both contexts have a common backdrop context that could be activated. The calculation of the appropriateness of the transmission is based on the same principles in $C_0$ and $C_1$, but the change of perspective due to a new context gives different results.

We are interested in describing the knowledge production related to different situations regulating the appropriateness of information flows. What happens when the shift of focus changes the situation from one of being appropriate, to one violating the integrity of the data subject? The change is caused by moving from $C_0$ and $C_1$ in (Figure 5). However, the outcome may be influenced by events which activate knowledge held in a supra context to these two contexts. We see this process as a negotiation where the data subject interacts with different contexts drawing on different types of knowledge, see the three categories of knowledge described in Figure 2: procedural, contextual, and external (Brézillon, 1999).

A subset of the contextual knowledge is foregrounded to address the current focus. In our model this is the "calculation" of contextual integrity (the appropriateness) of the data sharing under the contextual circumstances. In terms of CI, we have the syntax for building the proceduralised context (see above); we have just to find data for who are data subject, and who are senders and receivers of what information to make a decision about the appropriateness of the applied transmission principle.

### 4.1. Events that trigger contextual knowledge creation

Once this proceduralised context has satisfied the focus, this piece of knowledge goes back to the contextual knowledge. If the context will remain active depends on the decision. If the decision do not raises further questions, or other events do not occur, the context is dissolved and the knowledge stored as external knowledge. However, just a small incident is enough to trigger the CI dynamic of establishing a context, and integrating external knowledge in building proceduralised contexts (to test transmission principle appropriateness) and further movements between the body of contextual knowledge and proceduralised contexts.

From a privacy engineering perspective, the context triggers—the events that challenge the data sharing—are of special interest (Figure 6).

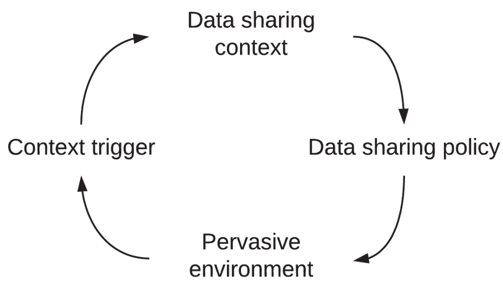


*Figure 6. Context triggers activates refinement of data sharing policy*

We assume that these events vary with contextual factors like culture, legal domain, trust, institutional actors, tools to be used, etc. In the model in Figure 6 it is the context triggers that activate the reflection on data sharing contexts, which in turn leads to confirmation of revision of data sharing policies for practice in pervasive online environments.

A context trigger is defined as an event, which implies notification and different sources triggering the event like user input, interaction with other data subjects or systems, environmental conditions, exposure to information flows (e.g.,  news), etc. These events may be internal or external to current activity context. In the end, context triggers can be understood as something similar to messages between different contexts, being able to spark knowledge processes related to information flows.

### 4.2. Contextual graphs

The concept of context trigger extends Nissenbaum's CI model. Since events add a new dimension to contexts we need a different way to represent the process other than just adding a new attribute to the C(ds, s, r, a, t)-formula. We suggest to use contextual graphs, a notation system developed by Brézillon (2003). This is a scheme that makes it possible to "represent and clearly organise operators' activities and all their variants (procedures and practices), include automatic learning and adaptation capabilities in a system, and make context explicit in the representation of operators' reasoning" (Brézillon, 2003, p. 21-22).

Conceptual graphs have been used in knowledge management projects as a tool for incremental learning (e.g., for incident solving on a subway line) (Brézillon, 2003). New practices have been compared to the existing knowledge graph and added as new nodes in the conceptual graph if they were valuable for future events. Conceptual graphs do not deal with probabilities, and there is no decision node, only “chance” nodes where the contextual element is analysed to select the corresponding path (Mostéfaoui & Brézillon, 2004).

Schematically, a contextual graph is an acyclic graph with a unique input, a unique output, and a serial-parallel organization of nodes connected by oriented arcs. A node can be an action (square box), a contextual node (circular box) or a recombination node (black box)  (Mostéfaoui & Brézillon, 2004) (see Figure 7 for an example of a context graph describing an event in a university setting).

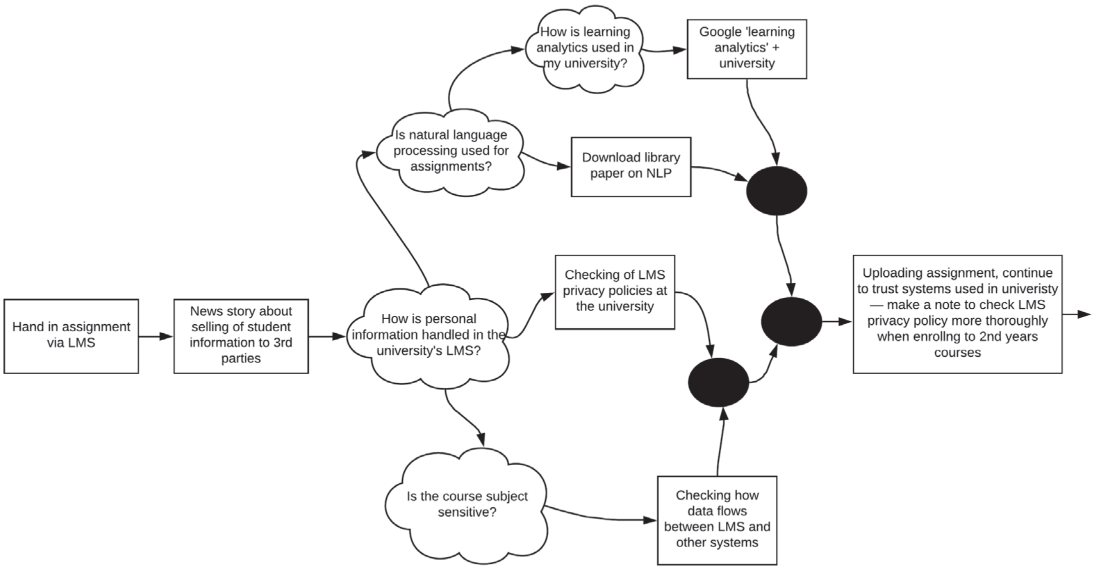


*Figure 7. Context graph of an event in a university setting*

A context trigger is registered as an action in the context graph notation. In the example in Figure 7 the triggering news story mentioned in the second box from the left could have been the news of the August 12, 2019 letter to all major edtech companies from three US senators, expressing concerns that educational technologies “may put students, parents, and educational institutions at risk of having massive amounts of personal information stolen, collected, or sold without [the students’] permission or knowledge” (Durbin, Markey, & Blumenthal, 2019). Other actions in the graph may be related to negotiations about data transmission principles. The output action is opening up or closing down the data sharing.

### 4.3. Understanding data privacy

Based on the conceptual development in this section and a validation in a first round of experts interviews we will suggest a provisional understanding of data privacy to be used in privacy engineering. We see work towards improving data privacy as

> *the process—when triggered by an event in a particular operational context—of giving the user the ability to specify data sharing policies, which will influence how personal data will be*

*handled by service providers*.

> This definition gives agency to the user, which may be a natural person or an IT agent. Execution power is delegated to a policy that is understood as relatively stable principles derived through negotiations with actors present in different contexts of interaction. Even if it is the user that defines its data sharing policies, it is the operational context that constrains the interpretation of the defined scheme of actions. The user may have a principled point of view, and a situational point of view—both views allowing practices that may seem to be in conflict with each other. However, from a contextual perspective, expressed in the same concerted policy, a range of apparently conflicting positions could be played out.

In this section on conceptual development we have extended the five tuple model of CI with a concept of context triggers to allow for a more dynamic reasoning about knowledge management in different contexts of online pervasive environments. To prepare the ground for organisational and technical design we have indicated a direction for formalising these concepts using context graph notation. The next sections in this construction part of the paper will address the two remaining levels of the EIF framework we use to structure the design process.

# 5. Organisational design — defining data sharing policies

The ultimate goal of this DSR process is a implementable and context-aware privacy preserving system, which is many design cycles away. However, even in the initial design phase it is important to develop artefacts that gives an idea of the direction of project. Business processes at the organisational level are part of this picture and are the design object in this section.

In the first stage of this DSR project we will focus on *data sharing policies,* which is a key element in our guiding definition of data privacy (see section above). Data sharing policies act on behalf of the user by allowing exchange of data without intervening in or distracting from the primary activities of the user. Furthermore, these policies are statements that are directed towards receivers of personal data, describing the user's expectations and restrictions related to use of the data. Data controllers, e.g., universities running a learning management system, are a target group of data sharing policies, and they may use these policies in setting up their own systems and interacting with their users.

For the users, defining data sharing policies is part of their personal data management. This process should be non-intrusive, i.e., it should work behind the scenes; only to be activated as a negotiation process in two cases: when data transmission is about to violate the appropriateness defined by the user; or when there is an event that triggers revisiting of the previously defined data sharing policy.

We have defined the following requirements for the process of initiating data sharing policies in a system:

- the system learns from data sharing practices related to the tools used;
- the system learns from events handling, and is able to alert of potential threats based on prior actions or practices of the user or the community of practice she participates in related to different data sharing policies;
- the system can be tuned, i.e., the sensibility of alerts can be adjusted; and
- the data sharing policies are expressed in smart contracts that IT systems act upon on behalf of the user.

For the proposed solution to be adopted a number of use cases need to be satisfied. The privacy model must be as meaningful for the users as for the institutions, the tools providers and other stakeholders. All these stakeholders should have agency and be motivated to take part in negotiation of the transmission principles, which will be written into the privacy policies. The business process should work in diverse cultural settings; and furthermore, new technologies based on AI—in particular machine learning (ML)—should play a role. As stated in the Introduction we do not see an option to rule out AI technologies and big data from future privacy solutions. We want a privacy process to be non-intrusive without blocking the opportunity to intervene when integrity is violated or threatened. This may be achieved by delegating support for event handling to ML and execution of the privacy policies to smart contracts,

### 5.1. Training the system to know what is appropriate — the role of ML

We have abandoned an approach following pre-programmed rules in favour of a contextual and dynamic approach using ML. This approach enables computers to perform specific tasks intelligently by learning from data, and the system continues to improve accuracy of results after it has been deployed (Shalev-Shwartz & Ben-David, 2014). However, a weakness of ML is that it is difficult to develop systems with contextual understanding of a problem, or 'common sense'. "When our expertise fails, humans fall back on common sense and will often take actions, which while not optimal, are unlikely to cause significant damage. Current machine learning systems do not define or encode this behaviour meaning that when they fail, they may fail in a serious or brittle manner" (Royal Society, 2017, p.30). In our proposal we suggest to make contexts the very object of ML, highlighting context triggers as the key concept for supervised machine learning. This implies we will need a certain amount of labelled data to train the system, and adaptiveness—further training—built into the system when going live. Ideally, the system should be able to know when to foreground a context trigger, based on the online activities of the user. So first, it must build a repertoire of events; next, it must learn what causes these events, and what sensibility each user has towards these events.

Figure 8 describes how training data is used for machine learning, deployed in the proposed system, which in turn generates more data used to continuously improve the system.

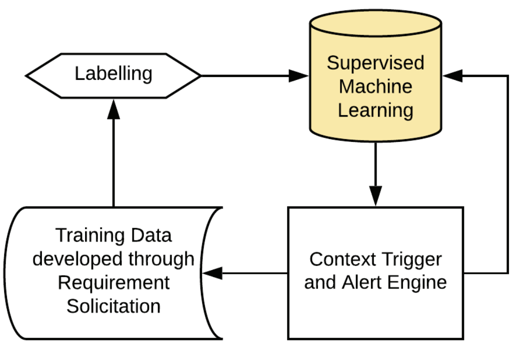


*Figure 8. How machine learning contributes to contextual negotiated policy system*

ML will also play a role in managing the data sharing policies. It is out of scope of this paper to explore how how all the diverse data sharing policies a user will meet could be reduced to a structured set of policies that could be added to and updated by the user in order to facilitate appropriate data sharing streams. However, we see that ML will be used to describe how service providers' privacy policies map to the extended CI model we propose. Shvartzshnaider, Apthorpe, Feamster, and Nissenbaum (2018) described how such a mapping could be done. In Figure 9 we describe how policy documents are mapped to a semantic model, which can be modified to represent each user's preferred data sharing configuration. In turn, this structure is used to generate a smart contract (Lyons, Courcelas, & Timsit, 2018), which will guide data sharing and in the end influence the policies of service providers.

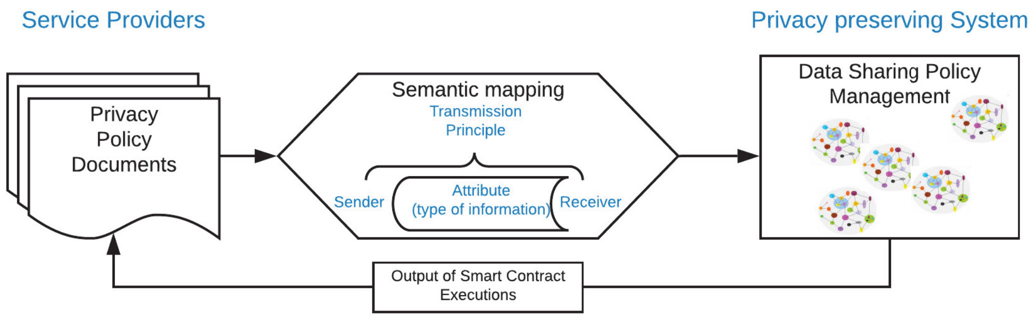


*Figure 9. Mapping privacy policy documents to personal data sharing policies*

Smart contracts execute the data sharing policies the user subscribe to. As an example, these contracts may allow sharing of one's data with 3rd party companies that might be doing special analysis to be used by the service provider. However, if an alert goes off regarding one of these companies being part of a data breach scandal, a revision of the data sharing policy may lead to a change in the smart contract blocking further data transfer.

### 5.2. Process summary

It is a challenge for privacy engineering to design a process that gradually will move practice to a safer ground. All stakeholders need to see the benefits of new solutions and be able to influence them. This is why we have made negotiation of data sharing policies the starting point for organisational design.

First, we have outlined a process of using the CI concepts to formalise the unstructured and long-winded privacy policy documents presented by service providers to construct an ontology that gives users a foundation to define their own data sharing policies.

Second, we have pointed towards a process of describing personal data sharing policy structures that are represented in executable scripts that handles sharing of personal data according to negotiated policies.

In this paper we have only introduced the concept of privacy policies; we realise that there are more work to be done to outline in detail how these policies will be defined and formalised. In the next section we will give a brief description of how a technical architecture can realise the proposed contextual model and high level business principles.

## 6. Technical design — an application scenario

The technical design task at hand has similarities with coming up with a email spam detection system, but the scope is broader and more complex. In spam detection, ML is used to train systems to recognise spam; and when deployed in live systems the user is given a role to further train the system identifying incorrect classifications. One could imagine that today's spam detection systems were extended to include spam policies, which were given roles of its own, living outside of the user's e-mail system. This is the direction of the application scenario we present below.

Even if the main thrust of this paper is not on technical architecture the overview of proposed system modules presented in Figure 10 demonstrates the direction of development and will help in soliciting expert feedback to validate our proposal.

We suggest a system that consists of following parts:

- Data sharing monitoring
- Context trigger and alert system
- Data sharing policy negotiations
- Data sharing policy management
- Institutional systems
- 3rd party systems or services

In Figure 10 these parts are integrated into an ecosystem for data sharing for a particular organisation (in the figure, an educational institution is used as an example).

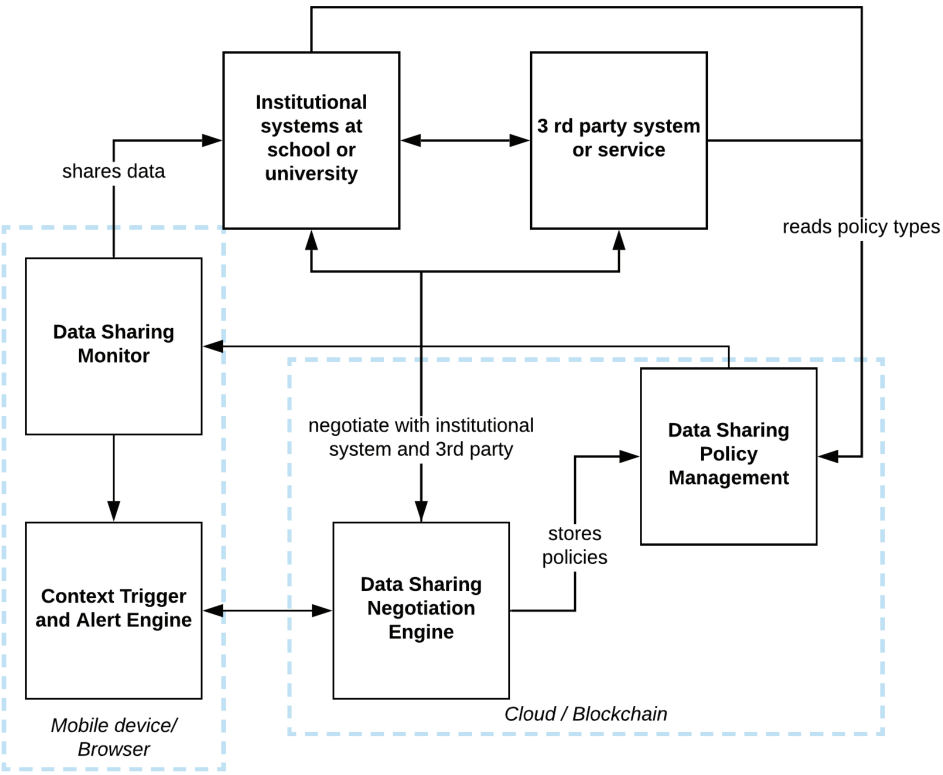


*Figure 10. Overview of proposed data sharing policy management architecture*

Data sharing monitoring takes place on the user's devices, and this engine shares the data with the institutional systems in the school or university, which in turn may share data with 3rd parties. The sharing happens according to policies stored outside of the device. On the device, the context trigger and alert engine runs, getting information from the data sharing monitor, and passing on information to the data sharing negotiation engine if there is a triggered event. Then the negotiation engine interacts with institutional systems and 3rd parties to set up or revise personal data sharing policies, which in turn are represented as smart contracts. Both artifacts are stored in the data sharing policy management system, which may be hosted on the blockchain or in the cloud. The institutional and 3rd party systems have access to the description of the data sharing policies, but no personal information is transferred about who subscribes to particular policies.

Figure 10 describes a educational scenario, where, as an example, a student using a learning management system (LMS) in a university disagrees to share data with 3rd party companies that may use her data for profiling not relevant to her learning. Denying the institution to share data with the analytics company, she knows she will meet with an impaired version of the LMS next time she uses it. However, she feels it might be worth the change of policy, perhaps for a time, till the university comes up with a new practice of data sharing with 3rd parties. Another student doing the same deliberations (see use case exemplified in a context graph, Figure 7) may decide to trust the institution and dissolve contextual knowledge about profiling threats into the external knowledge, for the time being.

This application scenario gives just a minimum of prescriptions about technologies. Ubiquitous online presence implies mobile devices and cloud services. We have hinted to use of smart ledger technology as smart contracts play an important role in use cases for blockchains. Smart contracts are capable of facilitating, executing, and enforcing the negotiation or performance of an agreement (i.e. contract) without the use of intermediaries (Lyons, Courcelas, & Timsit, 2018). In this paper, we do not prescribe use of blockchain technologies per se, but point to the fact that this direction would simplify trust and management issues related to execution of the data sharing policies. In any case, there is a need to look into the steps necessary to turn policies into code that can be executed to do the switching of a person's data streams.

We see the following steps for technical design of the solution:

- Developing high level view of the system architecture
- Designing requirement solicitation process for collecting training data
- Designing and deploying app for collecting users' CI data
- Training Context Trigger and Alert Engine
- Training Data Sharing Policy Negotiation Engine
- Designing data sharing policy system

In summary, in this section we have presented ideas for a high level technical design that uses ML and other cutting edge technologies to develop a system that should work behind the scenes and only be called upon when privacy incidents happen. The main objective is to design a system that does not clutter one's screens with privacy alerts, but does its work in the background by learning the user's contextual preferences without leading the user down a tunnel of ignorance of the adverse consequences of data sharing choices.

# 7. Validation

The constructs proposed in this paper are the result of a first design cycle (Gregor & Hevner, 2013). There are many more cycles to go to develop the solution and to be able to prove that our proposal could change the direction of privacy engineering from the traditional individual preference based solutions. The aim of the first round of validation, interviewing 11 experts, is therefore to assure that we have a sound direction of design, and to solicit ideas for improvement of designed constructs using the lens of the different levels of interoperability defined in EIF (EU, 2012), focussing on semantic, organisational, and technical aspects of design.

In analysing the recordings and transcripts of the interviews, the first question we asked ourselves was if the interviewees bought into the idea of making context more prominent in privacy engineering? In a dialogue where the interviewer uses the artefacts (figures, concepts and definitions) to build up a storyline (Strauss & Corbin, 1990) interviewees react through speech acts of different kinds (affirmations, nods, pauses, interjections, etc). Noting these acts of approval, hesitance, and disagreement we conclude that the interviewed experts did find the direction of this research valuable. In this context it is especially interesting when several interviewees used some of our proposed concept to elaborate their position and to explain back how the presented constructs should be understood. In the group of 11 we had three experts who have been actively developing specifications for the preference approach that our research criticises. All three expressed support for what they were presented. “Happy to see sound judgmental advice about 24751 [Access for All project] and I think it should be shared with…” “I think your model would work well (implemented around objects) to deal with accessibility needs, their implementation and contexts…(..) I like your ideas for privacy very much”.

A theme-based analysis of the transcripts collected feedback on key concepts in this research. The paper posits contexts as dynamic and active, but what does it mean? “Context is itself contextual, in some way the principle of fluidity is at play,” one interviewee said before mentioning complex adaptive systems and pointing to the Cynefin framework (Snowden, 2005) to describe the *habitat* of privacy engineering, stating that we were in the complex, if not the chaotic quadrant. The Cynefin framework was also mentioned by another interviewee who added: “The difficulty is that what context you’re in is a highly individual thing… you’ve bitten off one of the possibly biggest problems you can bite off, because it entrains all of human psychology.”

Even if the interviewees supported the proposed solutions to the semantic task of grasping the complexity of privacy through the concept of context they offered critical comments. The individual focus in the presented ‘provisional understanding of data privacy’ was questioned. “Could you replace that process of an individual with an entity, being a group, or society, or an institution, or a team? Given that it is not only individuals that have to maintain privacy or confidentiality…” As a response, now in Section 4.3 the concept of a ‘user’ is introduced opening up for a more active role for also IT systems. The interviews made it clear that support of machine learning and other intelligent technologies for privacy management was not controversial, at least among our experts.

At an organisational level, the interviews showed that there is need for further work. The idea of delegating decisions and negotiations to data sharing policies was supported as nobody wanted to be bothered with these issues on a daily basis, however, how is this system supposed to work? “What I hear you are saying—and I agree—is that privacy is not property of the user or their preferences, it is actually something that is transactional, and maybe even conversational. (…) actually, the privacy concerns I have will vary substantially according to the topic, what we are talking about, what conversation we are having…”. This expert foresaw a system with a clear taxonomy of relationships, “which allows allow us to put pressure on people and legal systems to give us a vocabulary for ‘we want more of this one and less of that one’…”. Other interviewees drew a parallel with Creative Commons licensing of online content. “So, is what you are talking about, slapping a CC licence on every piece of information that goes out that tells you under what circumstances it could be reproduced?”

These comments highlighted a gap in the current research, the need to explore how policies could regulate data sharing. Are these policies organised as an ontology? How are adjustments based on individual preferences registered and enacted? These questions are out of scope for this paper, but need to be addressed to prove the viability of the proposal.

When walking through the technical architecture another gap in the presented work became evident. “I think the architecture to some extent makes sense. The question is – there is an element of trust missing. How can I know that I can trust the system? Where is the trust block? How do I know this is to my benefit?” In terms of the European Interoperability Framework, we have left out the legal level in our design. Some interviewees missed an outline of the fundamentals that restricted the processes described in the high level architecture.

Overall, the interviewees saw the technical architecture as important to understand the proposed design. Even if the model indicated use of cutting edge technologies as blockchain, no expert objected to the idea. On the contrary, one interviewee even extended the design: “In your model – you have blockchain – that means the data are not really stored any more at the university - then the institution only have a token to your data - and you can revoke that token. As opposed to now, where I have to make a request to be erased.”

Table 1 summarises the implications and changes based on the interviews, and in the rest of this section we will discuss directions for further development cycles as a result of the first validation.

*Table 1. Summary of first validation by aspect*

| ***Aspects raised in the interviews*** | ***Initial position*** | ***Implications of first validation*** |
|---|---|---|
| Understanding of Context | Dynamic entity defined by knowledge focus, not a container described by a set of characteristics (e.g., individual privacy preference statements) | Dynamic definition fruitful basis for design |
| Need to extend CI theory | Context part of the theory underdeveloped | Development gap recognised |
| Knowledge aspects of context | Focus should be on the three types of knowledge (external, contextual, and procedural) | Different aspects are understood applied to privacy use cases |
| Context triggers | Event driven approach to handling privacy in context | Concept useful starting point for privacy engineering |
| Data sharing policy | Concept encapsulating preference handling on behalf of user | Considered useful as an overall idea, however, many questions about structure and management not dealt with in the first development cycle |

| | | |
|---|---|---|
| Contextual graph formalism | Graph presented as an abstract example (template) | Should be introduced in a pedagogical example related to privacy (see updated Figure 7); the graph should be explained in relation to other graph types if it should be used in applications |
| Provisional definition of data privacy | Guiding definition for use in design was provided | The definition was improved (see section 4.3) for clarity and scope |
| Organisational design | Focus on role of data sharing policies | Questions to the envisioned business process motivated extending Section 5, explaining more in dept the role of ML and the personal data sharing policies' relationship to institutional privacy policies |
| Technical design | An application scenario was presented | The role of high level technical architecture and scenarios is highlighted; design at this level could potentially drive future design cycles |
| Use of smart contracts | These artefacts are part of cutting edge technologies, and in our proposal given the role of executing data sharing decisions | According to interviews blockchain and smart contracts  should be explored |
| Use of ML | ML is positioned as a key instrument in delegating execution of policies to IT system, allowing users to focus on their main activities | Interviews showed support for making ML an important part of design |

The experts confirmed the complexity of the problem, reinforcing the need to be very clear about the ideas premising our proposals and to choose a design strategy with care.  In the Introduction we confessed a somewhat defeatist position to whether privacy can be vigorously pursued. In our research we need to turn this into a requirement that directs design of solutions that gradually work toward improved privacy, without alienating users nor service providers. In technical terms that means to specify how the user gradually may become more able to manage and control her own data sharing, which is not necessarily in the interest of companies. In information science, this is a classical design challenge balancing two problems, bootstrapping (meeting users' need now), and adaptiveness (adapting to unforeseen and new needs)  (Hanseth & Lyytinen, 2010).

The interviews also showed the need to be clear about trust. This is an issue that cuts through all interoperability layers. Many of the provisions in GDPR are so clear cut that they could be proved automatically by intelligent systems. Students seem to trust educational institutions strongly when it comes to handling of personal data (Slade, Prinsloo, & Khalil, 2019; Komljenovic, 2019), and institutional policies can be formalised so that more strict regimes for adherence could be established.

# 8. Discussion

Reflecting on this DSR, it is natural that the first phase of design is focussed on development of artefacts and less on contributions to theories. We will discuss both aspects now looking at where to go next, starting with our engineering challenge.

### 8.1. Multi-level development of artefacts

The first round of validation showed that the issues of trust should be addressed explicitly in this research. Trust is an overarching concept that spans all levels of analysis we have used in our research, but also includes the legal or policy level we have left out. Even if the data sharing policies we have given a central role in our design hinge on the personally felt appropriateness of the transmission principle and its execution could be secured by smart contracts hosted on the blockchain, there is a need to also anchor trust at the societal and legal level.

At the organisational level we assume that all relevant privacy and data sharing policies are available for semantic matching, and that we could use ML to distinguish patterns in the data sharing policies. It remains to be tested how CI negotiations could be harnessed in data sharing policies, and how well such policies could accommodate data sharing from different tools used by learners and institutions. We have foreseen a typology of principles that can be used to define smart and actionable contracts. It should also be tested whether the constructs that come with the extended CI theory could easily be turned into technical solutions.

Furthermore, at the technical level, blockchain technologies are being developed with the promise to eliminate some of the sources of ambiguity and conflict in domains where trust is essential (Lyons, Courcelas, & Timsit, 2018). We realise the need for further research to come up with a model of data sharing expressed in smart contracts that is based on laws and policies and described in a way that makes it possible for IT systems to decide whether a data stream from a user should be open or not.

The technical architecture presented in this paper proved important to explain the direction of this research. However, we realise that the high level model does not answer a number of important questions related to the privacy of the user. How is the user identity managed by the institution? A how is the connection between user identity and data sharing policies observed by the institution? There is scope for designing a number of more detailed models to see if it is possible to build a technical system that gradually can give the user more control over their personal data. It is also scope for outlining the role of ML in the solution. User agency and transparency are key values to this project; and if the result is a ‘black box’ that are inscrutable to their users and developers we have failed. Therefore, it should be tested if ML could be implemented in a way that foster users’ data literacy and understanding of contexts of data sharing.

We summarise the first cycle of design and the discussion of further directions in Table 2, presenting a first attempt to construct a conceptual development framework for privacy engineering making context the key concept of design.

*Table 2. Framework for privacy design, development cycles and levels*

| *Development cycle* | 1st | 2nd | 3rd |
|---|---|---|---|
| *Key aspect* | **Context** (semantic development) | **Trusted processes** (organisational development) | **Proof of concept** (technical development) |
| *Policy/legal level* | (not included) | What trust regime would integrate all interoperability levels? | How to engage policy level in development? |

| | | | |
|---|---|---|---|
| *Organisational level* | Process idea: Privacy as negotiation expressed in data sharing policies and executed by smart contracts. ML plays role in relieving the user of privacy tasks. | What process integrates institutional and company privacy policies, data sharing policies, and executable scripts regulating data streams? What role will ML play? | What application scenarios could could change current practice without jeopardising the CI approach? |
| *Semantic level* | Privacy decisions triggered by events activating contextual knowledge. Data sharing policy. | Any new concepts needed? | Any new concepts needed? |
| *Technical level* | Modular application scenario | How to orchestrate a suite of semantic technologies that are able to transform privacy knowledge between levels (National judiciary domain, institutional domain, personal domain, tools, contracts)? | What series of self-contained and useful apps could be developed that proves key ideas of overall solution? Alert app, monitoring activity and triggering reflection on privacy? Self-storage solutions, moving data sharing control more towards user? Negotiation simulation app, using context trigger data and privacy policy ontologies. |

While we in the table describe what we have done in the first development cycle, we indicate key aspect and research questions for the two next cycles. This is a dynamic framework as there will be rapid and minor design cycles and far more than three cycles before we have a working solution.

### 8.2. Design process

Both literature (Belanger & Crossler, 2011; Smith, Dinev, & Xu, 2011; Westin, 2003) and our interviews suggest that privacy is a complex and fuzzy field of research, something that asks for design principles and guidelines when doing privacy engineering. Reflecting on our own research we see some ideas forming that could contribute to design theories.

First, we find the EIF (EU, 2012) used in Table 2 above useful for high level structuring of development. Even if EIF is developed for another purpose, i.e., speciyiing how administrations, businesses and citizens communicate with each other within the European Union and across member state borders, the framework raises questions that are relevant also on an application level. The framework forces the developer to clarify political and legal context, specify concepts in use, and processes, before embarking upon technical design.

Second, our first validation has made us aware of the benefits of doing synchronous development at all four levels. Even if the initial development is very explorative and conceptual, focussing on business process ideas and basic constructs we have seen the value of representing design ideas in technical application scenarios to be able to communicate ideas with the developer community. Externalisation of ideas in technical diagrams reveals design flaws when discussed with fellow experts. It would have been interesting to have a set of design templates to choose from in the more conceptual phase of design as these illustrations are more conversational artefacts than implementable technical drawings at this stage.

Third, complex issues are easier to grasp through examples. In discussing the idea of contextual graphs with our group of experts we learnt that examples, use cases, scenarios, etc. communicate much better than abstract concepts. And privacy engineering is all about communication.

# 9. Conclusions

Privacy engineering can be seen as the deliberate approach of interjecting data protection requirements into complex system development based on ethical national, institutional and corporate strategies (Kenny & Borking, 2002). In time of fast development of global and data-hungry solutions based on machine learning and analytics privacy is under pressure. As we have demonstrated in this paper, solutions based on matching of ill-specified individual preferences with privacy-sensitive services of a myriad of data-driven companies are highly unrealistic. A new approach is needed, and we firmly believe that context negotiation is part of that approach. In this paper we have contributed to a new understanding of privacy context, extending the theory of contextual integrity and pointing to a direction of development that uses machine learning as a technology to design solutions that work continuously and non-intrusively for the users. We have presented a condensed understanding of data privacy to give direction to the design of solutions that give context negotiations priority, but store decisions in data sharing policies for processing in the background.

An aim of this paper is to give privacy engineering a new direction. It has long been stuck in a quagmire of politicised discourse, dominated by Western centric privacy theories (Hoel & Chen, 2019). To support global system development there is a need to realise that online practices are surprisingly similar around the world, but our understanding of the room for maneuvering may be different. To see how actual negotiations of data sharing practices would take place in different contexts, we need to establish a semantic, organizational and technical framework that allow comparisons between cultures to happen. To make context a first class citizen in privacy engineering is essential to move forward.

As work situated in DSR we acknowledge that the first results give moderate contributions to design theory, having focussed on development of artefacts that in the end will have practical application. As Peffers, Tuunanen and Nihaves (2018) have pointed out this is nothing new in DSR, where artefacts with value in a system or system component often are main, or at least, initial aim of researchers. We have, however, in this paper kept an eye on the design process itself in order to make observations that could be useful to inform design guidelines for the nascent field of privacy engineering.

# 10. References

Badillo-Urquiola, K., Yao, Y., Ayalon, O., Knijnenurg, B., PAGE, X., Toch, E., et al. (2018). Privacy in Context (pp. 425–431). Presented at the Companion of the 2018 ACM Conference, New York, New York, USA: ACM Press. http://doi.org/10.1145/3272973.3273012

Barkhuus, L. (2012). The mismeasurement of privacy: using contextual integrity to reconsider privacy in HCI. the 2012 ACM annual conference (pp. 367–376). New York, New York, USA: ACM. http://doi.org/10.1145/2207676.2207727

Barth, A., Datta, A., Mitchell, J. C., & Nissenbaum, H. (2006). Privacy and contextual integrity: framework and applications (pp. 15 pp.–198). Presented at the 2006 IEEE Symposium on Security and Privacy, IEEE. http://doi.org/10.1109/SP.2006.32

Baruh, L., Secinti, E., & Cemalcilar, Z. (2017). Online Privacy Concerns and Privacy Management: A Meta-Analytical Review. Journal of Communication, 67(1), 26–53. http://doi.org/10.1111/jcom.12276

Baskerville, R., Baiyere, A., Gergor, S., Hevner, A., & Rossi, M. (2018). Design Science Research Contributions: Finding a Balance between Artifact and Theory. Journal of the Association for Information Systems, 19(5), 358–376. http://doi.org/10.17705/1jais.00495

Bastien, C. (1999). Does context modulate or underlie human knowledge? In Quelhas, A. C. & Péreira, F., Cognition and Context. Analise psicologica: Lisbonnes.

Bazire, M., & Brezillon, P. (2005). Understanding Context Before Using It. In Business Process Models. Change Management (Vol. 3554, pp. 29–40). Berlin, Heidelberg: Springer Berlin Heidelberg. http://doi.org/10.1007/11508373_3

Belanger, F., & Crossler, R. E. (2011). Privacy In The Digital Age: A Review Of Information Privacy Research In Information Systems. Mis Quarterly, 35, 1–63.

Benthall, S., Gürses, S., & Nissenbaum, H. (2017). Contezxtual Integrity through the Lens of Computer Science. Foundations and Trends® in Privacy and Security, 2(1), 1–69. http://doi.org/10.1561/3300000016

Brezillon, P. (2005). Task-Realization Models in Contextual Graphs. In Business Process Models. Change Management (Vol. 3554, pp. 55–68). Berlin, Heidelberg: Springer Berlin Heidelberg. http://doi.org/10.1007/11508373_5

Brézillon, P. (2003). Representation of procedures and practices in contextual graphs. The Knowledge Engineering Review, 18(2), 147–174. http://doi.org/10.1017/S0269888903000675

Brézillon, P., & Pomerol, J.-Ch. (1999). Contextual knowledge sharing and cooperation in intelligent assistant systems. Le Travail Humain. 62(3), Paris: PUF, pp. 223-246.

Campbell, R., Robinson, W., Neelands, J., Hewston, R., & Massoli, L. (2007). Personalised learning: Ambiguities in theory and practice, British Journal of Educational Studies, 55 (2), 135–154.

Cavoukian, A. (2009). Privacy by Design — The 7 Foundation Principles. Online: https://www.ipc.on.ca/wp-content/uploads/Resources/7foundationalprinciples.pdf. Accessed: 2019-12-09

Choi, H., Park, J., & Jung, Y. (2017). The role of privacy fatigue in online privacy behavior, Computers in Human Behavior. doi: 10.1016/j.chb.2017.12.001

EU (2012), “Regulation of the European Parliament and of the council on the protection of individuals with regard to the processing of personal data and on the free movement of such data", COM(2012) 11 final, European Commission, Brussels.

Fluid Project. (n.d.). Project Description: Understanding, Discovering and Asserting Personal Privacy Preferences (UDAPPP). https://wiki.fluidproject.org/display/fluid/(Floe)+Privacy+Needs+and+Preferences

Gregor, S., & Hevner, A. R. (2013). Positioning and Presenting Design Science Research for Maximum Impact. Mis Quarterly, 37(2), 337–355.

ISO. (2008). Information technology -- Individualized adaptability and accessibility in e-learning, education and training -- Part 1: Framework and reference model (ISO/IEC 24751-1:2008). International Organization for Standardization. Retrieved from https://www.iso.org/standard/41521.html

Hanseth, O., & Lyytinen. (2010). Design theory for dynamic complexity in information infrastructures: the case of building internet. Journal of Information Technology, 25(1), 1–19. http://doi.org/10.1057/jit.2009.19

Hoel, T., & Chen, W. (2019). Privacy engineering for learning analytics in a global market: Defining a point of reference. The International Journal of Information and Learning Technology, https://doi.org/10.1108/IJILT-02-2019-0025

Holstein, K., McLaren, B. M., & Aleven, V. (2019). Co-Designing a Real-Time Classroom Orchestration Tool to Support Teacher–AI Complementarity. Journal of Learning Analytics, 6(2), 27–52. http://doi.org/10.18608/jla.2019.62.3

Kenny, S. & Borking J. (2002). The Value of Privacy Engineering. The Journal of Information, Law and Technology (JILT). Online: http://elj.warwick.ac.uk/jilt/02-1/kenny.html

Komljenovic, J. (2019). Making higher education markets: Trust-building strategies of private companies to enter the public sector. Higher Education, 78(1), 51–66. https://doi.org/10.1007/s10734-018-0330-6

Lahlou, S., Langheinrich, M., & Rucker, C. (2005). Privacy and Trust Issues with Invisible Computers. Communications of the ACM, 48(3).

Lyons, T., Courcelas, L., & Timsit, K. (2018). Blockchain and the GDPR. Report produced by ConsensSys AG on behalf of the European Union Blockchain Observatory and Forum.

Mansour, R. F. (2016). Understanding how big data leads to social networking vulnerability. Computers in Human Behavior, 57(C), 348–351. http://doi.org/10.1016/j.chb.2015.12.055

Mostéfaoui, G. K. & Brézillon, P. (2004). Modeling context-based security policies with contextual graphs. Proceedings of the Second IEEE Annual Conference on Pervasive Computing and Communications Workshops (PERCOMW'04) 0-7695-2106-1/04

Nature. (2019). Protect AI panel from interference. Nature, Vol. 572, p. 415. Editorial published 22

August 2019.

Nissenbaum, H. (2004). Privacy as contextual integrity. Washington Law Review, 79, 119–157.

Nissenbaum, H. (2010). Privacy in context: Technology, policy, and the integrity of social life. Stanford, CA: Stanford University Press.

Norberg, P. A., Horne, D. R., & Horne, D. A. (2007). The Privacy Paradox: Personal Information Disclosure Intentions versus Behaviors. Journal of Consumer Affairs, 41(1), 100–126. http://doi.org/10.1111/j.1745-6606.2006.00070.x

Peffers, K., Tuunanen, T., & Niehaves, B. (2018). Design science research genres: introduction to the special issue on exemplars and criteria for applicable design science research. European Journal of Information Systems, 27(2), 129–139. http://doi.org/10.1080/0960085X.2018.1458066

Prain, V., Cox, P., Deed, C., Dorman, J., Edwards, D., Farrelly, C., et al. (2012). Personalised learning: lessons to be learnt. British Educational Research Journal, 65(3), 1–23. http://doi.org/10.1080/01411926.2012.669747

Royal Society. (2017). Machine learning: the power and promise of computers that learn by example. ISBN: 978-1-78252-259-1. The Royal Society, United Kingdom.

Scott, M. (2006). Programming Language Pragmatics. San Francisco, CA: Morgan Kaufmann Publishers.

Shalev-Shwartz S, Ben-David S. (2014). Understanding machine learning: from theory to algorithms. Cambridge, UK: Cambridge University Press.

Sheeran, P. (2002). Intention behavior relations: A conceptual and empirical review. European Review of Social Psychology, 12, 1–36.

Shvartzshnaider, Y., Apthorpe, N., Feamster, N., & Nissenbaum, H. (2018). Analyzing Privacy Policies Using Contextual Integrity Annotations. Online: https://arxiv.org/pdf/1809.02236. Accessed: 2019-12-11.

Shvartzshnaider, Y., Tong, S., Wies, T., Kift, P., Nissenbaum, H., Subramanian, L., & Mittal, P. (2016). Learning Privacy Expectations by Crowdsourcing Contextual Informational Norms. Fourth AAAI Conference on Human Computation and Crowdsourcing.

Slade, S., Prinsloo, P., & Khalil, M. (2019), "Learning analytics at the intersections of student trust, disclosure and benefit", 1–1. Proceedings of the 9th Learning analytics and Knowledge Conference 2019 (LAK 19), Tempe, Arizona, USA May 4- 8, 2019.

Snowden, D. J. (2005). Complex Acts of Knowing: Paradox and Descriptive Self-Awareness. Bulletin of the American Society for Information Science and Technology, 29(4), 23–28. http://doi.org/10.1002/bult.284

Smith, H. J., Dinev, T., & Xu, H. (2011). Information Privacy Research: An Interdisciplinary Review.

Mis Quarterly, 35(4), 989–1015.

Taddei, S., & Contena, B. (2013). Privacy, trust and control: Which relationships with online self-disclosure? Computers in Human Behavior, 29, 821–826.

Tuomi, I. (2018). The Impact of Artificial Intelligence on Learning, Teaching, and Education. Policies for the future, Eds. Cabrera, M., Vuorikari, R & Punie, Y., EUR 29442 EN, *Publications Office of the European Union, Luxembourg*, ISBN 978-92-79-97257-7, doi:10.2760/12297, JRC113226.

Westin, A. F. (2003). Social and Political Dimensions of Privacy. Journal of Social Issues, 59(2), 431–453. http://doi.org/10.1111/1540-4560.00072