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## Expectations for supporting student engagement with learning analytics: An academic path perspective

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### ABSTRACT

There has been a growing interest in higher education to explore how learning analytics (LA) could be used to support student engagement. Providing actionable feedback with LA for students is an emerging area of research. Previous studies have commonly focused on course-level aspects of supporting engagement with LA, but students' perspectives have received limited attention. This study analyzed pre-service teachers' needs and expectations for LA to support student engagement on the academic path level, which means observing the continuum of study periods and academic years. Qualitative content analysis was conducted for video-recorded student small-group conversations to analyze in-depth how pre-service teachers (N = 40) described their needs for support student engagement and expectations and ethical concerns for using LA tools. Students suggested that LA tools could support their engagement by mediating information between the student and institution, facilitating effective studying, increasing awareness about themselves as learners, providing help and support in different challenging situations, and working as a feedback channel to adapt the learning conditions according to their individual needs. The results of this study demonstrate how student needs are sometimes contradictory, for example when students suggest more possibilities for agentic choices on their studies, but similarly more institutional monitoring or their study progression. This offers insights to clarify specific objectives for supporting student engagement with LA.

### Authors' individual contributions in this research

Anni Silvola: Investigation, Conceptualization, Methodology, Formal analysis, Validation, Writing – original draft, Piia Näykki: Conceptualization, Methodology, Writing – review & editing, Supervision, Anceli Kaveri: Formal analysis, Validation, Hanni Muukkonen: Conceptualization, Methodology, Writing – review & editing, Supervision Funding acquisition.

### 1. Introduction

There has been a growing interest in higher education contexts to use and explore how learning analytics (LA) can support student engagement in learning (Henrie et al., 2015). However, thus far many of the tools are in an early phase of implementation, and the

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current evidence on the impact of developed LA systems for student learning is inconclusive (Viberg et al., 2018). Students have been identified as primary, although vulnerable, stakeholders in LA use (West et al., 2020; Slade & Prinsloo, 2013). Student perspectives have been recognized as important in developing LA tools that provide evidenced support for learning, which students are motivated to use and which are ethically and pedagogically grounded (Schumacher & Ifenthaler, 2018; Slade & Prinsloo, 2013; West et al., 2020; Viberg et al., 2018). To observe student perspectives holistically, this study implements the multidimensional concept of student engagement (Fredricks et al., 2004). Student engagement provides a versatile approach for describing LA use to support student learning, since it involves aspects of observable behaviors, internal cognitions, student emotions, and student agency. In previous research, these have been identified as important, but separate issues regarding LA use as a support for learning.

Student engagement describes students' individual commitment to learning (Fredricks et al., 2004). It captures the quality of student participation, commitment and investment, and thus describes important prerequisites for student learning (Järvelä & Renninger, 2014). Student engagement consists of four dimensions, namely behavioral, cognitive, emotional and agentic engagement (Fredricks et al., 2004; Reeve & Tseng, 2011). Students who are well engaged in their studies usually perform well and enjoy their studies (Fredricks et al., 2004; Salmela-Aro & Read, 2017). Research has shown that student engagement impacts cumulative learning, long-term achievement, and promotes overall student well-being (Fredricks et al., 2004; Skinner & Pitzer, 2012; Salanova et al., 2009).

The particular focus of this study is to analyze students' expectations for LA use as support for their engagement with studies, and their concerns regarding ethical issues of LA use. We examine LA use and student engagement at the level of academic paths, which means addressing the continuum of study periods and academic years. This approach extends the commonly used course-level investigations of student engagement and performance (Henrie et al., 2015). Typically, the focus of the studies on supporting engagement at the academic path level have focused on institutional aspects of supporting students, such as developing academic analytics to improve student retention and progression (e.g. Baepler & Murdoch, 2010) or developing academic advising practices with LA tools (e.g. Millecamp et al., 2018). In the Finnish HE context, students have relatively much freedom to make individual choices and plans of carrying out their studies (Hailikari et al., 2018; Korhonen et al., 2017). As students have an important role in steering their own learning, it is important to understand how students themselves perceive and describe different conditions supporting their investments in learning. The concept of student engagement provides a holistic framework to understand these perspectives.

## 2. Student engagement

Student engagement has been described as consisting of behavioral, emotional, and cognitive dimensions (e.g., Fredricks et al., 2004; Appleton et al., 2008). These dimensions describe together observable behaviors, affective reactions, psychological investment and intentional activity in relation to academic demands. *Behavioral engagement* describes students' observable behaviors, such as participation and involvement in academic activities that are considered crucial for achieving positive academic outcomes and preventing drop outs. This includes student academic effort, persistence, attention, concentration, and lack of conduct problems, such as following institutional rules and absence of disruptive behaviors (Fredricks et al., 2004). *Emotional engagement* describes students' affective reactions to tasks, courses, teachers, academics and overall to university (Fredricks et al., 2004). Emotional dimension of engagement describes willingness to do the work, feelings of belonging in school and valuing the school-related outcomes, presence of interest, enthusiasm, absence of anger, anxiety, and boredom (Fredricks et al., 2004). *Cognitive engagement* describes students' psychological investment in learning. It describes thoughtfulness and willingness to make the efforts necessary to understand complex ideas and master difficult skills, such as the use of sophisticated learning strategies and active self-regulation of learning (Boekaerts et al., 2000; Fredricks et al., 2004). Reeve and Tseng (2011) suggested adding *agentic engagement* as a fourth dimension of engagement. Agentic engagement highlights the proactive and intentional activity of the student to personalize the conditions of learning and to enrich external learning goals based on their individual goals (Reeve & Tseng, 2011). Although the concept of engagement involves the idea of students' proactive engagement and behaviors (Järvelä & Renninger, 2014), this last dimension highlights students' agentic efforts as a coordinator of one's own studies, intentionally going towards personal interests and goals (Reeve & Tseng, 2011).

Previous studies have evidenced that behavioral, cognitive and emotional dimensions predict students' academic achievement as separate dimensions but also together form a bigger construct (Alrashidi, Phan, Bing & Ngu, 2016). The dimensions of student engagement have an interactive effect (Fredricks et al., 2004), which means that they interrelate and function simultaneously in human behavior.

### 2.1. Supporting student engagement with learning analytics

Providing students with actionable feedback through LA tools is an emerging area of research. Most is known about aspects of supporting student engagement on course-level. The earliest work on student dashboard development has focused on visualizing behavioral indicators and performance data, such as the number of clicks and logins in a learning environment and student grades (e.g., Verbert et al., 2014). These kinds of tools aim to provide actionable feedback from behavioral aspects of student engagement, such as supporting students in completing their course assignments by the deadlines. Cognitive engagement has been elaborated in previous research of LA by identifying ways to support self-regulated learning of students and focusing on process-oriented support with feedback generated from LA tools (Azevedo & Gašević, 2019; Matcha et al., 2019; Noroozi et al., 2019; Roll & Winne, 2015; Schumacher & Ifenthaler, 2018; Sedrakyán et al., 2020). Emotional engagement has been previously identified through issues such as student trust for analytics use (Ifenthaler & Schumacher, 2016; Slade et al., 2019, pp. 235–244) or willingness to use LA to support learning and positive attitudes towards LA use (Schumacher & Ifenthaler, 2018). Concerns about demotivating consequences of LA

feedback, especially regarding students with lower achievement levels (Russell et al., 2020), have been identified. However, research conducted by Russell et al. (2020) indicates that providing weekly performance feedback for students with lower achievement levels might improve their resilience and helped study participants pass their courses compared to those who did not use LA tools. Student autonomy is an important factor in agentic engagement and agency has been recognized as an important aspect in developing student-facing dashboards (Bodily & Verbert, 2017; Jääskelä et al., 2020).

Some research has addressed the academic path level support for engagement by introducing LA tools for academic advising (e.g., Charleer et al., 2018; Gutierrez et al., 2018) and has utilized student registry-based data to prevent drop outs, support at risk students, and predict student retention and academic achievement (e.g., Jayaprakash et al., 2014). These studies have provided suggestions of what educational institutions can do to support student engagement, but less examples are available about how students directly could use LA tools to enhance their engagement.

## 2.2. Ethical aspects of LA use as support for students

Ethical aspects of LA from students' perspectives have been elaborated upon. These are for example, achieving a balance between disclosure risk and the benefits students could gain from sharing their information, student trust for LA use, student agency in their privacy control, awareness of data collection, and student involvement for designing LA tools (Slade & Prinsloo, 2013; Slade et al., 2019, pp. 235–244; Kitto & Knight, 2019; Schumacher & Ifenthaler, 2018; West et al., 2020). Agency is a central principle of ethically-grounded LA use (Slade & Prinsloo, 2013). It has been recognized that students expect to have an active role in their control of privacy (Ifenthaler & Schumacher, 2016). Students' willingness to share their data for LA use varies depending on the contexts of data use and the benefits of sharing (Schumacher & Ifenthaler, 2018; Slade et al., 2019, pp. 235–244). Student awareness about data collection and the purposes of data use are important guidelines for ethical LA use and transparency (Draschler & Greller, 2012; Slade et al., 2019, pp. 235–244). From a design perspective, discovering how to engage students in using LA tools to support their learning in responsible ways connects the ethical issues of LA with student engagement. Pedagogical knowledge is required to define what type of data is actually needed and what is valuable to analyze in order to support learning (Viberg et al., 2018). These considerations align the ethical use of LA with a pedagogical understanding of how learning and engagement could be better supported. Although the previous studies have recognized the importance of these different aspects of engagement, more holistic understanding is needed about how these aspects are embodied in designing LA tools that provide actionable feedback for students on academic paths.

## 3. Research questions and goals

This study is a qualitative user needs analysis, which aims to understand pre-service teachers' perspectives on supporting student engagement with LA. The particular aim of this study is to identify how LA tools could be used to support behavioral, cognitive, emotional, and agentic dimensions of student engagement throughout the academic path in higher education. Accordingly, the aim is to understand student needs for engagement support regarding three targeted perspectives: the fluency of higher education academic paths, LA use, and ethical issues of LA. This is to better contextualize the possibilities and challenges in LA use as support for engagement at the academic path level.

The research questions in this study are:

1. How do students describe their needs for behavioral engagement support?
2. How do students describe their needs for cognitive engagement support?
3. How do students describe their needs for emotional engagement support?
4. How do students describe their needs for agentic engagement support?

## 4. Methodology

Qualitative, structured observational design was chosen to explore student groups' conversations in natural contexts (Chi, 1997; Derry et al., 2010). With this design, it was possible to explore students' authentic attitudes, perceptions, expectations and concerns regarding student engagement and LA use as a support (Derry et al., 2010). Collaborative, small-group tasks were used as a window to students' thinking about the given topics, to gain new understanding about their authentic thoughts through discussing with peers (Enyedy and Stevens, 2014). The focus of analysis was primarily on the content of the talk, rather than the interactional processes of collaboration (Enyedy & Stevens, 2014).

### 4.1. Context and participants

The participants in this study were third and fourth year pre-service teachers completing their master's degrees (N = 40) in a five-year teacher education program. The gender distribution (85% female) represents the overall distribution of Finnish teacher education. Pre-service teachers participated in two working sessions, which were part of their course design, in nine small groups, with three to five students per group.

#### 4.2. Data collection

Qualitative data were collected to explore students' expectations for LA use as a support for the behavioral, cognitive, emotional, and agentic dimensions of student engagement, as well as their concerns regarding the ethical use of LA to support student engagement. Small-group tasks structured their conversation about the given topics (Appendix 1). By recording small-group conversations during the working sessions, the aim was to capture authentic perspectives, experiences, and perceptions of students. The recording equipment (headsets and small 360 cameras) helped students work together without external interruptions. This type of data collection provided an overview to students' thinking and gave deeper insights on student reasoning (Derry et al., 2010; Enyedy & Stevens, 2014). Overall, the working sessions lasted 2 h each and the total duration of the recorded data is 27 h. All nine groups participated in both working sessions. Participation was voluntary and consent was collected from students at the beginning of the first working sessions.

#### 4.3. Procedure

The data collection procedure consisted of three phases that were conducted as a part of a course on pre-service teachers' master degree studies (see Table 1). In the first phase, students participated in the lecture about LA use in educational contexts. In the second phase, students participated in the first working session that focused on their academic paths and LA use. In the third phase, students participated in the second working session that focused on ethical and privacy perspectives in using LA. The working sessions were designed to simultaneously enable students' to create new understanding about LA and to reflect their thoughts about LA use in their own study contexts. The design also enabled students to generate new ideas about LA use and suggest ways of using it at the university. Students were provided with supportive learning material during the working sessions when it was considered important to enable discussions about given topics in collaborative tasks.

During the first working session, students were asked to reflect on their prior and current study experiences at the university level. They were also asked to improve ideas of how they would support student engagement and use LA in their studies (see Appendix 1). The second working session focused on students' expectations for LA use and concerns regarding ethical LA use (see Appendix 1). Students were asked to discuss privacy issues and explain what would increase or decrease their willingness to use different LA tools (Ifenthaler & Schumacher, 2016).

#### 4.4. Data analysis

Video-recorded small-group conversations were analyzed to understand the contexts and reasoning of students expectations of supporting student engagement, particularly in terms of LA tools as a means of support. Qualitative content analysis was conducted for the recorded small-group conversations (Chi, 1997). The NVivo-12 program was used for conducting the analysis directly to the videos.

At first, all videos were watched, and episodes for further analysis were chosen from the data. The selection criteria were to include the moments where student groups are discussing their study experiences and support expectations for student engagement. The grain size of the analysis categories was not limited to any specific conversation length, but meaningful units were coded based on the contents of small-group conversations. One such assigned code consisted of a single aspect described in the small-group conversations. No overlapping was allowed between coded categories. The initial coding protocol was defined after all the videos were watched several times. Content analysis was performed according to the previous literature's dimensions of student engagement (Fredricks et al., 2004; Reeve & Tseng, 2011). The analysis of these dimensions focused on academic path level, exploring perspectives of study periods and academic years beyond course-level observations. Descriptions of these dimensions were used as a coding criterion (see Table 2).

The dimension of *Behavioral engagement* included conversations in which students elaborated aspects that could advance their academic path fluency and aspects of how their teachers and academic advisors could support their studies (see Table 2). *Cognitive engagement* included aspects of how students could improve themselves as learners by gaining feedback that would increase their awareness of learning (see Table 2). *Emotional engagement* included aspects of how students' positive interactions and sense of belonging within the faculty could be facilitated and supported (see Table 2). *Agentic engagement* included aspects of supporting

**Table 1**  
Process of the Data Collection and Analysis.

Phases of data collection and analysis	
1.	Pre-service teachers' course participation. Lecture about LA use in education.
2.	The first working session: Academic paths and LA use as a support for studies. Data collection: Video-recorded small-group conversations with structured tasks.
3.	The second working session: Ethical aspects on LA use in education. Data collection: Video recorded small-group conversations with structured tasks.
4.	Qualitative content analysis of recorded small-group conversations. Main categories: Behavioral, cognitive and emotional dimension of engagement.
5.	Transcription of data examples. Reliability coding.

**Table 2**

Descriptions of the Main Categories of Student Engagement (Source: (Fredricks et al., 2004); Reeve & Tseng, 2011).

Main category	Description
<b>Behavioral engagement</b>	Observable behaviors and effort for studies. Fluent progression of studies and active involvement in learning. Absence of delays and distractions in studies.
<b>Cognitive engagement</b>	Psychological investment for learning, such as self-regulation and strategic use of effort. Improvement of high-level professional capabilities. Flexibility and positive coping with challenges on the academic path. Effective use of LA to support one's learning.
<b>Emotional engagement</b>	Students' relationship with studies, positive and negative attitudes for learning and LA use. Affective reactions for learning and LA.
<b>Agentic engagement</b>	Identification with studies and willingness to do the work. Individual value given for studies, interest, and enthusiasm. Students' agentic effort to adjust individual needs with study circumstances. Students' proactive personalization of learning goals, seeking ways to add personal relevance based on individual goals.

students in adjusting their personal needs and goals to the circumstances and supporting their proactive behaviors in personalizing their learning (see Table 2).

Once the coding was conducted and refined for each engagement dimension, the initial subcategories within dimensions were identified. Previous literature on ethical issues of LA (Ifenthaler & Schumacher, 2016; Slade et al., 2019; Pardo & Siemens, 2014 pp. 235–244) was used to inform this phase of the analysis. Coding of the main and subcategories was refined and improved in several phases.

A portion of the coded conversations were transcribed by the first author to clarify the definitions of categories. The transcribed conversations were also used as data examples in this article. The transcribed examples were translated from Finnish to English by the authors. To analyze the reliability of the analysis, Cohen's kappa coefficient was used to evaluate the inter-rater agreement of the coding of the main categories and subcategories. Two independent coders coded 15% of all coded items. Cohen's kappa value suggests that the analysis was conducted with reliability ( $\kappa = 0.806$ ).

## 5. Results

### 5.1. Behavioral engagement

Students actively discussed and shared their ideas in terms of the support needed for behavioral engagement ( $f = 72$  in total, see Table 2). The analysis identified four subcategories: Progression, Information mediation, Interpretation challenges and Behavioral consequences.

Support for study progression ( $f = 11$ , see Table 2), such as credit accumulation and progression according to the personal study plans, was discussed among student groups as a way to support behavioral engagement. It involved aspects for practices and processes that would help students pass their courses fluently, and within the time planned in their personal study plans. Students highlighted the importance of having correct information through well-functioning information channels in terms of their course assignments and schedules, and the importance of personal guidance and advising. Students described that clear schedules and time management help their study progression and participation. Groups also indicated that academic advisors should monitor their study progression in more detail, according to the personal study plans and institutional requirements. Students desired direct contact to alert them if they were missing some important courses or if they were falling behind in their planned progress. Students suggested active monitoring and support throughout their academic career, not just during their first year when they normally get more advising and support.

The role of LA tools emerged as mediating information ( $f = 23$ , see Table 2) between students and institutions, such as helping advisors and teachers monitor their progression, and helping students to communicate their support needs. The most frequent suggestion was a central dashboard that would gather information about ongoing courses, schedules and assignments for a student and would thus enable student monitoring of upcoming deadlines. Students suggested that such dashboards could also give positive feedback when students submit their assignments on time and give reminders if there are delays or approaching deadlines. In the following example, group 11 discussed the possible design of a dashboard that would help them monitor upcoming deadlines:

Student 1: "I think some kind of sheet would be good. Something that would help you to see visually when you are expected to submit your assignments, such as lesson plans or something. But this one (an example LA dashboard) is quite abstract for me ..."

**Table 3**

Subcategories, Subcategory Descriptions and Frequencies of Behavioral Engagement Dimension Subcategories.

Subcategories and Subcategory Descriptions					
Fluency of academic paths	<i>f</i>	LA use as a support	<i>f</i>	Ethical aspects	<i>f</i>
<u>Progression</u>	11	<u>Information mediation</u>	23	<u>Interpretation challenges</u>	20
Institutional monitoring and support of progression of studies.		LA tools to mediate information between faculty, staff, and students.		Contextual, situational, or digital environment-related challenges to interpret digital traces of student behavior.	
				<u>Behavioral consequences</u>	11
				Risk of misuse of the tools as a consequence of being monitored.	

Student 2: “Yes, it would be good to see that ok you have a deadline tomorrow and the next one is coming after that and ... You could see a couple of the first upcoming deadlines and maybe a sheet when you click it ...”

Student 1: “Yes, that would be good. But such a speedometer (presented in an example dashboard) is maybe a little distant from the concrete contents of our courses, so it’s difficult to know how to interpret it (to be on a schedule or not).”

Behavioral engagement evoked discussion about ethical issues of LA from two different aspects. Interpretation difficulties ( $f = 20$ , see Table 3) referred to the importance of understanding the contextual factors when interpreting online behaviors, such as not making misleading interpretations from behaviors such as student online activity or a certain amount of logging in to a learning environment, especially by teachers or advisors. Students discussed that the users of the data (such as teachers, advisors, students themselves) should be well aware of what kinds of interpretations could be done based on behavioral indicators of student activity and were concerned about reliability issues. Behavioral consequences ( $f = 11$ , see Table 3) referred to unintended impacts on student behavior as a consequence of being aware of the continuous monitoring of LA tools. They elaborated that students could either intentionally trick the system to pass courses more easily or that continuous monitoring could affect their learning behavior, such as reducing their online collaboration activity. A student from group 15 described concerns of behavioral consequences:

Student 1: “Would our online behavior direct that we do certain things like tweeting just because we know such an activity data would be collected? Or is it because we want to discuss certain issues on social media? I mean that would such a dashboard direct our behavior when we acknowledge its existence? For example, that I have to be active now, I will just tweet something quickly about this.”

## 5.2. Cognitive engagement

The results show that students discussed their needs related to support for cognitive engagement ( $f = 81$ , see Table 4) through four subcategories: Feedback for effort regulation, Professional development, Increase of self-awareness, and Knowledge about responsible use of LA. Aspects indicating the need for cognitive engagement support were often highlighted with high importance and personal value. Generally, students described the need for support that would help them better understand themselves as learners and guidance for using this understanding to improve themselves as strategic learners.

Students described their expectations of support for effort regulation ( $f = 19$ , see Table 4) as an important aspect of supporting cognitive engagement. That is, to have more detailed feedback about their learning and support for developing the necessary self-management and regulation skills. Students suggested more feedback that would expose the gaps in their knowledge and to help them overcome those gaps. Students considered continuity as an important aspect of feedback. Continuous, cumulative and personal feedback was highlighted as important for their motivation and skill to learn. Students stated that they would need support to improve their learning skills and their ways of studying to be more strategic and effective. They suggested a practice where they could have anticipatory and critical information about their learning challenges and strengths during and at the beginning of courses, instead of getting feedback only at the end of each course or study period. Students also suggested having information about their development over the courses and study periods, throughout their academic path. A student from group 14 specifically explained the importance of continuous feedback on the academic path:

Student 1: “... I notice that my calculations were wrong, that’s it. And we have so many examples like that [from our courses]. It would be nice to have feedback that actually helps you to develop. We can repeat the same mistakes when we do not know that something has gone wrong. Feedback would be really important to our individual development throughout the academic path.”

Students suggested more support for their professional development ( $f = 5$ , see Table 4). The discussions showed that the students sometimes experience working life as very distant and expressed their concerns about the requirements of working life. They suggested that, from a teacher’s professional development perspective, more reflection about their professional capabilities could improve their cognitive engagement.

The role of LA tools emerged as facilitating effective studying and increasing students’ awareness about themselves as learners. LA could be used to provide information that would increase their self-awareness ( $f = 28$ , see Table 4) about their learning, such as effort regulation. Time management and study planning skills were especially mentioned as important aspects to be supported with LA, for example, students suggested a dashboard where they could create a task list about their upcoming deadlines, and the service would

**Table 4**  
Subcategories, Subcategory Descriptions, and Frequencies of Cognitive Engagement Dimensions Subcategories.

Subcategories and Subcategory descriptions					
Fluency of academic paths	<i>f</i>	LA use as support	<i>f</i>	Ethical aspects	<i>f</i>
<u>Feedback for effort regulation</u> Cumulative, constructive, continuous feedback throughout the academic path.	19	<u>Increase of self-awareness</u> Information that increases students’ awareness about themselves as learners and supports them in reflection, planning of studies, and time management.	28	<u>Knowledge about responsible use of LA</u> Skills and knowledge that are required from students to be able to use LA as support for learning.	29
<u>Professional development</u> Support to reflect the professional capabilities throughout the academic path.	5				

generate feedback about their plan. Students described that information for reflection would help them study more effectively and potentially avoid extensive stress. Students expected that LA tools could give them information about their recurring learning patterns, such as how many days before the deadline they typically start writing or submit their essays. Continuity of feedback was suggested as a possibility for LA, if the data from previous courses were available.

Knowledge about responsible use of LA ( $f = 29$ , see Table 4) raised conversations about issues, such as data literacy, system understandability, reflection skills, and user awareness of the ethical guidelines for using LA. Students considered all ethical aspects as very important for users to be aware of, but similarly expressed the issue of the complexity of LA. In the following example, a student from group nine discussed LA use:

Student 1: “They cannot collect reliable information from the (educational) systems if they are not been used systematically. And it (use of LA) requires critical thinking from both teachers and students, like that this is not an entire truth that defines me as a person.”

### 5.3. Emotional engagement

The results show that the students discussed different expectations for emotional engagement support ( $f = 73$ , see Table 5). Five subcategories emerged from the analysis: Commitment to academic community, Student well-being, Supportive role of LA, Personal value and usefulness, and Motivational consequences.

Students described the importance of commitment to the academic community ( $f = 11$ , see Table 5). They elaborated that the knowledge of available support from teachers and trust for faculty supporting their studies can potentially increase emotional engagement. Students expressed the importance of teachers and advisors being interested about their studies and progression. Students mentioned the possibility of chatting on a digital platform where they could easily approach teachers and academic advisors whenever they have a question regarding their studies. Students described that it is important to be familiar and have a good atmosphere with faculty staff to have low thresholds for seeking support. Group 10 described their needs for better connection with teachers:

Student 1: “Sometimes it feels like teachers are very distant and they give guidance according to some standards. Once we are adults anyway, I wish they could advance towards students a little and that they would be more available. I mean that sometimes an email is the best way to get contact with faculty teachers and it feels like a little ...”

Student 2: “... distant?”

Student1: “Yes, like there was a wall between us.”

The value of the studies was mentioned as an important aspect of commitment to the academic community. Experiences of value can potentially increase students’ sense of capability as future professionals and thus increase their emotional engagement.

Students’ psychological well-being and stress management ( $f = 3$ , see Table 5) were described as supporting emotional engagement. Stress and exhaustion in studies evoked concerns among students and they suggested anticipatory aspects of taking care of psychological well-being.

The role of LA emerged as supporting students and providing help in different challenging situations ( $f = 12$ , see Table 5). Students described how it was important for LA tools to provide support, encouragement, and solutions when students are facing challenges, instead of adding to feelings of control, stress, and anxiety. Students described that the feedback on LA dashboards could work as a guide for learning, motivate, activate and inspire students, and personalize given support based on individual differences. This kind of feedback approach would also support their psychological well-being and help with stress management. Students also suggested LA tools providing them suggestions of how to proceed when they face challenges, instead of just showing the challenge. One of the groups discussed a dashboard example in which “traffic lights” were used as signaling fluent learning progress within a course. The idea of a traffic light dashboard raised suspicious thoughts among students in group 16:

Student 1: “Did you participate in the lecture where these dashboard examples were presented?”

Student 2 and 3: “Yes.”

**Table 5**  
Subcategories, Subcategory Descriptions, and Frequencies of Emotional Engagement Dimension Subcategories.

Subcategories and Subcategory descriptions					
Fluency of academic paths	f	LA use as support	f	Ethical aspects	f
<u>Commitment to academic community</u> Positive interactions and sense of belonging among the students and faculty staff.	11	<u>Supportive role of LA</u> Expectations of LA supporting students in the face of a challenge.	12	<u>Personal value and usefulness</u> Personal evaluation of the value of LA tools.	32
<u>Student well-being</u> Anticipatory support for psychological well-being during studies.	3			<u>Motivational consequences</u> Positive and negative consequences of LA feedback. Risk of negative impact on students’ emotional engagement or motivation.	15

Students 1: “They were quite interesting, all these applications where it was marked with red and green ... I don’t really know how it might feel to see your own data in such a dashboard ...”

Student 2: “And then if you would blink red all the time ...”

Student 1: “Yes, and a message that the end of the course is approaching and you have not done anything, alert alert! But on the other hand, it might also be helpful ...”

The same group elaborated their suggestions of LA tools having a supportive role in students’ academic paths:

Student 1: “If there would be functionalities that say: hey, no worries if you have not done your assignments until this date, the next possible deadline is on this and this day. That it would kind of have such a ... It would comfort you when you have not done anything and tell you that everything will be fine!”

Student 2: “And it could work in a way that you could add information yourself and all the course deadlines and things could come from the study registry system directly and that part would be the same for all.”

Personal evaluation of the value and usefulness of LA tools ( $f = 32$ , see Table 5) was raised as a concern from an ethical aspect of using LA to support emotional engagement. It included concerns about whether the information on the dashboards is personally relevant and informative for students and if the given feedback is reliable.

Motivational consequences were described as another concern from an ethical aspect ( $f = 15$ , see Table 5). Students were concerned whether feedback would discourage the student with negative reminders or increase students’ stress levels, which could lead to students working too hard and experiencing exhaustion. Students highlighted the importance of sensitivity as an aspect of feedback since all students interpret it from their own perspectives and stances.

#### 5.4. Agentic engagement

The results show that students discussed agentic engagement support as an important aspect of supporting student engagement ( $f = 142$ , see Table 6). Six subcategories emerged from the analysis: Student autonomy, Active involvement, Possibilities to decide about LA use, Privacy, Transparency of purposes, and Transparency of data collection.

Student autonomy ( $f = 17$ , see Table 6) was described as an important aspect of supporting agentic engagement. Students described that by having more flexibility, such as online lectures, possibilities to make individual choices within the study program on the academic path, and possibilities to combine individual lifestyles with studies, they would have a better sense of autonomy and the possibility of adapting studies with individual goals and needs.

Active involvement ( $f = 12$ , see Table 6) of students was described as another aspect that could increase students’ agentic engagement. Students suggested a practice of being more involved in the faculty to design what kind of feedback and assignments there would be during the courses, so they could express their feedback needs and receive direct support from their teachers before upcoming courses.

The role of LA emerged as a feedback channel, facilitating adaption of student learning according to individual needs and goals. Possibilities to decide about the use of LA tools ( $f = 16$ , see Table 6) were seen as beneficial in supporting agentic engagement by increasing possibilities to make individual choices on the academic path. A frequently occurring aspect of supporting agentic engagement with LA tools was to have the opportunity to decide how and when they would use LA as well as which tools or visuals they consider to be the best. For example, LA tools were suggested as support for studying from distance, plan individual academic paths and choose the right visualizations based on the personal needs and goals. Students elaborated that LA is a good way to help students, but it shouldn’t be the only director of their activity. In the following example, group 10 discussed student autonomy in deciding how to use LA to support learning:

Student 1: “And also that you could choose yourself what kind of visualizations there would be on your dashboard. But student can also trick oneself and color one’s own situation.”

**Table 6**  
Subcategories, Subcategory Descriptions, and Frequencies of Agentic Engagement Dimension Subcategories.

Subcategories and Subcategory descriptions					
Fluency of academic paths	<i>f</i>	LA use as support	<i>f</i>	Ethical aspects	<i>f</i>
<u>Student autonomy</u>	17	<u>Possibilities to decide about LA use</u>	16	<u>Privacy</u>	32
Flexibility to support individual choices on academic path. Need for autonomy as a learner.		LA tools enabling proactive behavior for learning and provide possibilities for students to decide how they use available tools to support their learning. Customizable dashboards, availability of different features.		Proactive role in privacy control and possibility to opt out from data collection.	
<u>Active involvement</u>	12			<u>Transparency of purposes</u>	38
Student involvement in designing the academic paths and courses in the faculty.				Awareness of the purposes of use for data collected.	
				<u>Transparency of the data collection</u>	27
				Awareness of data being collected about oneself.	

Student 2: "It is this point two (in their notes)."

Student 1: "But if you know your own weaknesses and are capable of realistically thinking about that this kind of visualization might help me now, then .... "

Use of LA tools to enable student autonomy raised also critical discussions among groups. Some students were critical about any LA tools helping them develop agency as learners. In the following example, group 14 described their thoughts about a dashboard that displays upcoming deadlines:

Student 1: "I do not think we need someone to tell us all the time ... We should already know ourselves of how to do these .... "

Student 2: "Indeed, we should be able to comprise the understanding (of upcoming deadlines)."

Student 1: "Yes, we do not need someone to tell these things all the time ... I believe that if I would have a certain deadline, I would not need any dashboard to tell me whether I am late or not."

Student 2: "Yes, and like this we also learn how to actually do these things ourselves rather than having someone else to always say how to do."

Student 1: "I do not trust anything else than my own notes anyway."

Student 2: "Indeed."

Student privacy ( $f = 32$ , see Table 6) was broadly discussed as an ethical aspect of LA use to support engagement. An important aspect of discussions about privacy was that student agency in defining and communicating institutional LA practices should be acknowledged. Students elaborated their willingness to individually define their limits for data collections, and that these limits could vary depending on the context of the data collection and the benefit they would derive. The importance of separating the contexts of personal life and studying was highlighted. Students rejected the idea of using data from their social media accounts in the context of LA and some groups discussed the possibilities of opting out from data collection. However, students discussed whether opting out would cause inequities between students.

Transparency of purposes ( $f = 38$ , see Table 6) was described as an important aspect to reduce ambiguity of LA practices from students' perspective. Students expressed their concerns about their current awareness of what kind of purposes the data collected about them would be used. It was also described as an important aspect to reflect when evaluating willingness to share data for LA use, that for what purposes collected data would be used.

Students expressed that all data collection must be transparent and thus well-informed for students ( $f = 27$ , see Table 6) Students described that ambiguity in transparency might reduce their willingness to use LA tools or be involved in data collection.

## 6. Discussion

This study examined what type of support needs pre-service teachers described in small-group conversations regarding behavioral, cognitive, emotional, and agentic aspects of student engagement at the academic path level. Students' support needs were targeted from three perspectives: the fluency of higher education academic paths, LA use, and ethical issues of LA.

This study provides a case to demonstrate how LA could be used to help students to connect their effort and experiences with their engagement. The results of this study evidence that all dimensions of engagement were identifiable in student support needs and expectations for LA. The findings on student needs regarding fluency of academic paths can advance and contextualize the understanding of engagement support needs. These include support for progression on the academic path, effort regulation, professional development, commitment to the academic community, student well-being, and supporting student autonomy and active involvement. Specific LA roles were recognized within each dimension according to student expectations. These roles described the ways students suggested LA tools could be used to support dimensions of engagement. For behavioral engagement, the identified role of LA tools was typically suggested as *mediating information between the student and institution*. For cognitive engagement, the role of LA was suggested as *facilitating effective studying and increasing students' awareness about themselves as learners*. For emotional engagement, the role of LA tools was suggested as *providing help and support in different challenging situations*. For agentic engagement, the role of LA tools was suggested as a *feedback channel for facilitating students in adapting their learning conditions according to individual needs and goals*.

A high amount of ethical concerns was identified related to LA use as support. The students were concerned, for example, about the difficulties of interpreting LA feedback, behavioral consequences of constant monitoring of student learning behavior, whether all users of LA data have sufficient skills and knowledge of using the tools in ethical ways, motivational consequences, the personal evaluation about the value of LA tools as support for students, and the aspects of awareness and privacy control regarding student data use in an institution. Students' conversations about ethical issues demonstrate the importance of aligning the ethical concerns of students with the design of LA tools in order to create tools that students feel safe to use, want to use, and that they consider as personally valuable in support of their engagement. Observing the ethical concerns within each dimension of student engagement specify and contextualize the role of different concerns raised in this study.

### 6.1. Student engagement provides holistic understanding about student support with LA

The results support the findings of the previous literature regarding the need for institutional support for student progression on the academic path (e.g., Jayaprakash et al., 2014). The previous findings have emphasized the need to understand the process-oriented

nature of learning when designing LA tools (e.g., Sedrakyan et al., 2020). Other topics that the previous studies have also highlighted are the importance of supporting student agency in LA use from the aspects of pedagogical and ethical issues (Slade & Prinsloo, 2013; Jääskelä et al., 2020), the importance of designing tools that students are willing to use (Schumacher & Ifenthaler, 2018), and the active role of students in privacy control and institutional LA use (e.g. Pardo et al., 2014; Ifenthaler & Schumacher, 2016). However, as this study implemented a holistic approach for analyzing student perspectives on engagement support needs, we gained novel insights about the body of different and partly contradictory needs for supporting students. For example, students suggested support for behavioral engagement as external monitoring of their progression, but to foster their agency, they suggested having more individualistic choices and opportunities to make decisions about the use of LA. Another contradiction was identified from suggestions to develop encouraging and supportive tools to enhance emotional engagement, while students similarly suggested support for cognitive engagement with detailed and even critical feedback. Contradictions represent how different the dimensions of engagement are and how support requires different attention, understanding, and intervention.

Emotional and agentic engagement also provided novel understanding about how issues, such as student commitment within the academic community, well-being, active involvement, and support for agency, are related to using LA tools to support engagement. These are issues that exceed the digital contexts of learning, and should be considered when planning LA tool use and interventions.

This study provides an example of how students can be involved for designing and developing LA tools as equal collaborators. Their experiences of the study environments provided important differentiations to understand what are the contexts and the possible roles that LA tools could take to enable development and sustainment of engagement on their academic paths.

## 6.2. Limitations

Field-specific examples are needed to better understand students as diverse user groups of LA tools (Viberg et al., 2018; West et al., 2020). This study gives an example of the experiences of a small sub-population in a field specific context of teacher education. These experiences give an in-depth understanding of students' perspectives for using LA to support engagement. Students' understanding about what constitutes LA can be limited, and they may not fully understand the implications of different LA tools (Slade & Prinsloo, 2013). Students of this study participated in the course where they were learning about LA use in education and working together to provide novel ideas of how LA could be used as a support. Their understanding of the topic of LA might have been limited to those aspects explained during the course. An observational set-up of this study provides research possibilities to analyze and identify such aspects of support from student conversations that they might not have pointed out otherwise, for instance issues that would not have risen in individual interviews. Students' knowledge provides valuable perspectives for improving LA tools, since they were able to make specific and exact observations of the possibilities and concerns regarding LA use. Pre-service teachers in this study were familiar with theories of learning and they had advanced knowledge to reflect on the use of LA as a means of learning support.

## 7. Conclusions

The holistic approach for understanding LA use to support student engagement resulted in suggestion of different roles of LA tools to support each dimension of engagement. These roles can be used as design principles for developing new dashboards and aligning the design process of LA tools with previous learning research, such as identifying the process-oriented aspects of supporting learning, designing features that help and motivate students in challenging situations (Koivuniemi et al., 2017), and enable students in taking on an agentic role in their academic path.

Current research of LA has identified the importance of connecting theoretical understanding of learning with the current methodological solutions developed in information and computer sciences (Teasley, 2019). This study provides a theoretical contribution for the field of LA by discussing how the dimensions of student engagement could be supported with LA tools. Further, it generated suggestions about how the different nature of these dimensions could be recognized as part of the LA tool design process. Holistic perspectives of student engagement cement the importance of aligning current research of LA with concepts of learning sciences.

The results provide important direction to understand how LA might have an important role by providing actionable feedback for students about their effort. To obtain a broader in-depth understanding about students' perspectives for LA use, further research could explore student perspectives for LA use in different fields, with broader student populations and between students in different countries. More research is required about the ways the results of this study can be implemented for designing LA tools and interventions. Additionally, the study findings encourage further observation of student engagement from the academic level perspective. Advanced understanding of students' perspectives about the continuities of different engagement processes, and students' prolonged efforts to proactively engage in their studies could be gained.

## Declaration of competing interest

No potential conflicts of interest were reported by the authors.

## Appendix 1. Data Collection Procedure for the Working sessions

The first working session consisted of the following phases:

1. Academic path task. To map the current context of university studies, students were asked to draw a academic path of their group. With reflective questions, students were instructed to discuss currently provided support for student engagement and main events during the academic paths, main challenges during the studies, and their expectations of the upcoming academic path.
2. Idea generation. Students were asked to first generate new ideas on how to develop the current learning environments, courses and study services in the university, and how to solve the challenges they had encountered. Suggestions were given to focus specifically on digital services and LA use. After that, student groups drew a mind map which described their vision of the campus in ten years.
3. Development ideas. After drawing a mind map, students were requested/invited to discuss the open-ended questions regarding LA use to support fluent academic paths and support for student engagement. Students were asked to think about the possibilities of LA use, but also about other solutions to better understand what students described in regards to their needs.

The second working session consisted of the following phases:

1. In the beginning of the working session, a short introduction was given to students about LA, related ethical issues, and risks.
2. To get started with the conversation, students first read the Jisc guidelines for ethical use of LA (Sclater & Bailey, 2015). After that, reflective questions were presented to structure student small-group conversation. Students discussed their expectations, concerns, and perceptions regarding LA use. While having conversations among small-groups, students wrote their group answers on the answer sheets.
3. During the second task, students individually filled out a questionnaire replicated from the study of Schumacher and Ifenthaler (2016). Questionnaire items tested students' perceptions of privacy by asking what kind of information they would be willing to share for LA use. No further questions were asked about the questionnaire, but it sparked conversation among small groups.
4. In the third task, students were asked to reflect if they would be willing to use three different LA tools presented by the instructor (Bull & Wasson, 2016; Van Leeuwen et al., 2015; Verbert et al., 2014). The first tool described data visualization used for language learning support (Bull & Wasson, 2016). The second tool was designed for teachers to monitor collaborative learning online and help teachers to intervene at the right time (Van Leeuwen et al., 2015). The third example presented a tool that was designed by university students to support their studying (Verbert et al., 2014). From each tool, visualization, data used, user groups, and purposes of use were described. Three reflective questions were presented to help student groups talk about each tool: 1. How would you evaluate the purposefulness of the tool? 2. What kind of risks can be related to the use of the tool? 3. What kind of ethical responsibilities does the user of the tool (student or teacher) have?
5. Finally, students got to reflect their thoughts about possibilities and concerns related to LA use, describe ideas of what types of issues should be considered, and whether they would be willing to use LA in the future to support their fluent academic path.

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### References

- Alrashidi, O., Phan, H. P., & Ngu, B. H. (2016). Academic engagement: An overview of its definitions, dimensions, and major conceptualisations. *International Education Studies*, 9(12), 41. <https://doi.org/10.5539/ies.v9n12p41>
- Appleton, J. J., Christenson, S. L., & Furlong, M. J. (2008). Student engagement with school: Critical conceptual and methodological issues of the construct. *Psychology in the Schools*, 45(5), 369–386. <https://doi.org/10.1002/pits.20303>
- Azevedo, R., & Gašević, D. (2019). Analyzing multimodal multichannel data about self-regulated learning with advanced learning technologies: Issues and challenges. *Computers in Human Behavior*, 96, 207–210. <https://doi.org/10.1016/j.chb.2019.03.025>
- Baepler, P., & Murdoch, C. (2010). Academic analytics and data mining in higher education. *International Journal for the Scholarship of Teaching and Learning*, 4(2). <https://doi.org/10.20429/ijstol.2010.040217>
- Bodily, R., & Verbert, K. (2017). Review of research on student-facing learning analytics dashboards and educational recommender systems. *IEEE Transactions on Learning Technologies*, 10(4), 405–418. <https://doi.org/10.1109/TLT.2017.2740172>
- Boekaerts, M., Pintrich, P. R., & Zeidner, M. (2000). *Handbook of self-regulation*. San Diego (Calif.): Academic Press.
- Bull, S., & Wasson, B. (2016). Competence visualisation: Making sense of data from 21st-century technologies in language learning. *ReCALL*, 28(2), 147–165. <https://doi.org/10.1017/S0958344015000282>
- Charleer, S., Moere, A. V., Klerkx, J., Verbert, K., & De Laet, T. (2018). Learning analytics dashboards to support adviser-student dialogue. *IEEE Transactions on Learning Technologies*, 11(3), 389–399. <https://doi.org/10.1109/TLT.2017.2720670>
- Chi, M. T. H. (1997). Quantifying qualitative analyses of verbal data: A practical guide. *The Journal of the Learning Sciences*, 6(3), 271–315. [https://doi.org/10.1207/s15327809jls0603\\_1](https://doi.org/10.1207/s15327809jls0603_1)
- Derry, S. J., Pea, R. D., Barron, B., Engle, R. A., Erickson, F., Goldman, R., & Sherin, B. L. (2010). Conducting video research in the learning sciences: Guidance on selection, analysis, technology, and ethics. *The Journal of the Learning Sciences*, 19(1), 3–53. <https://doi.org/10.1080/10508400903452884>
- Enyedy, N., & Stevens, R. (2014). Analyzing collaboration. In *The Cambridge handbook of the learning sciences* (2nd ed., pp. 191–212). Cambridge University Press. <https://doi.org/10.1017/CBO9781139519526.013>
- Fredricks, J. A., Blumenfeld, P. C., & Paris, A. H. (2004). School engagement: Potential of the concept, state of the evidence. *Review of Educational Research*, 74, 59–100.
- Gutiérrez, F., Seipp, K., Ochoa, X., Chiluita, K., De Laet, T., & Verbert, K. (2018). *Lada: A learning analytics dashboard for academic advising*. *Computers in Human Behavior*. <https://doi.org/10.1016/j.chb.2018.12.004>
- Hailikari, T., Tuononen, T., & Parpala, A. (2018). Students' experiences of the factors affecting their study progress: Differences in study profiles. *Journal of Further and Higher Education*, 42(1), 1–12. <https://doi.org/10.1080/0309877X.2016.1188898>

- Henrie, C. R., Halverson, L. R., & Graham, C. R. (2015). Measuring student engagement in technology-mediated learning: A review. *Computers & Education*, 90, 36–53. <https://doi.org/10.1016/j.compedu.2015.09.005>
- Ifenthaler, D., & Schumacher, C. (2016). Student perceptions of privacy principles for learning analytics. *Educational Technology Research & Development*, 64(5), 923–938. <https://doi.org/10.1007/s11423-016-9477-y>
- Jääskelä, P., Heilala, V., Kärkkäinen, T., & Häkkinen, P. (2020). *Student agency analytics: Learning analytics as a tool for analysing student agency in higher education*. Behaviour and Information Technology. <https://doi.org/10.1080/0144929X.2020.1725130>
- Järvelä, S., & Renninger, K. A. (2014). Designing for learning: Interest, motivation, and engagement. In R. K. Sawyer (Ed.), *The cambridge handbook of the learning sciences* (2nd ed., pp. 668–685). Cambridge University Press. <https://doi.org/10.1017/CBO9781139519526.040>
- Jayaprakash, S. M., Moody, E. W., Laurfa, E. J. M., Regan, J. R., & Baron, J. D. (2014). Early alert of academically at-risk students: An open source analytics initiative. *Journal of Learning Analytics*, 1(1), 6–47. <https://doi.org/10.18608/jla.2014.11.3>
- Kitto, K., & Knight, S. (2019). Practical ethics for building learning analytics. *British Journal of Educational Technology*, 50(6), 2855–2870. <https://doi.org/10.1111/bjet.12868>
- Koivuniemi, M., Panadero, E., Malmberg, J., & Järvelä, S. (2017). Higher education students' learning challenges and regulatory skills in different learning situations/ Desafíos de aprendizaje y habilidades de regulación en distintas situaciones de aprendizaje en estudiantes de educación superior. *Infancia Y Aprendizaje*, 40(1), 19–55. <https://doi.org/10.1080/02103702.2016.1272874>
- Korhonen, V., Inkinen, M., Mattson, M., & Toom, A. (2017). Student engagement and the transition from the first to second year in higher education. In E. Kyndt, V. Donche, K. Trigwell, & S. Lindblom-Ylänne (Eds.), *Higher education transitions: Theory and research* (pp. 113–134). Abingdon: Routledge.
- Matcha, W., Ahmad Uzir, N., Gasevic, D., & Pardo, A. (2019). A systematic review of empirical studies on learning analytics dashboards: A self-regulated learning perspective. *IEEE Transactions on Learning Technologies*. <https://doi.org/10.1109/tlt.2019.2916802>, 1–1.
- Millecamp, M., Gutiérrez, F., Charleer, S., Verbert, K., & De Laet, T. (2018). A qualitative evaluation of a learning dashboard to support advisor-student dialogues. In *Proceedings of the 8th international conference on learning analytics and knowledge* (pp. 56–60). New York: ACM.
- Noroozi, O., Alikhani, I., Järvelä, S., Kirschner, P. A., Juuso, I., & Seppänen, T. (2019). Multimodal data to design visual learning analytics for understanding regulation of learning. *Computers in Human Behavior*, 100, 298–304. <https://doi.org/10.1016/j.chb.2018.12.019>
- Pardo, A., & Siemens, G. (2014). Ethical and privacy principles for learning analytics. *British Journal of Educational Technology*, 45(3), 438–450. <https://doi.org/10.1111/bjet.12152>
- Reeve, J., & Tseng, C. M. (2011). Agency as a fourth aspect of students' engagement during learning activities. *Contemporary Educational Psychology*, 36(4), 257–267. <https://doi.org/10.1016/j.cedpsych.2011.05.002>
- Roll, I., & Winne, P. H. (2015). Understanding, evaluating, and supporting self-regulated learning using learning analytics. *Journal of Learning Analytics*, 2(1), 7–12. <https://doi.org/10.18608/jla.2015.21.2>
- Russell, J. E., Smith, A., & Larsen, R. (2020). Elements of success: Supporting at-risk student resilience through learning analytics. *Computers & Education*, 152. <https://doi.org/10.1016/j.compedu.2020.103890>
- Salanova, M., Schaufeli, W., Martínez, I., & Bresó, E. (2009). How obstacles and facilitators predict academic performance: The mediating role of study burnout and engagement. *Anxiety, Stress & Coping*, 23(1), 53–70. <https://doi.org/10.1080/10615800802609965>
- Salmela-Aro, K., & Read, S. (2017). Study engagement and burnout profiles among Finnish higher education students. *Burnout Research*, 7, 21–28. <https://doi.org/10.1016/j.burn.2017.11.001>
- Schumacher, C., & Ifenthaler, D. (2018). Features students really expect from learning analytics. *Computers in Human Behavior*, 78, 397–407. <https://doi.org/10.1016/j.chb.2017.06.030>
- Slater, N., & Bailey, P. (2015). *Code of practice for learning analytics*. *Jisc*, (June) (pp. 1–4). Retrieved from <https://www.jisc.ac.uk/guides/code-of-practice-for-learning-analytics>.
- Sedrakyan, G., Malmberg, J., Verbert, K., Järvelä, S., & Kirschner, P. A. (2020). Linking learning behavior analytics and learning science concepts: Designing a learning analytics dashboard for feedback to support learning regulation. *Computers in Human Behavior*, 107. <https://doi.org/10.1016/j.chb.2018.05.004>
- Skinner, E. A., & Pitzer, J. R. (2012). Developmental dynamics of student engagement, coping, and everyday resilience. In *Handbook of research on student engagement* (pp. 21–44). Springer US. [https://doi.org/10.1007/978-1-4614-2018-7\\_2](https://doi.org/10.1007/978-1-4614-2018-7_2)
- Slade, S., & Prinsloo, P. (2013). Learning analytics: Ethical issues and dilemmas. *American Behavioral Scientist*, 57(10), 1510–1529. <https://doi.org/10.1177/0002764213479366>
- Slade, S., Prinsloo, P., & Khalil, M. (2019). *Learning analytics at the intersections of student trust, disclosure and benefit*. *ACM International Conference Proceeding Series*. Association for Computing Machinery. <https://doi.org/10.1145/3303772.3303796>
- Teasley, S. D. (2019). Learning analytics: Where information science and the learning sciences meet. *Information and learning science*, 120(1/2), 59–73. <https://doi.org/10.1108/ILS-06-2018-0045>
- Van Leeuwen, A., Janssen, J., Erkens, G., & Brekelmans, M. (2015). Teacher regulation of cognitive activities during student collaboration: Effects of learning analytics. *Computers & Education*, 90, 80–94. <https://doi.org/10.1016/j.compedu.2015.09.006>
- Verbert, K., Govaerts, S., Duval, E., Santos, J. L., Van Assche, F., Parra, G., & Klerkx, J. (2014). Learning dashboards: An overview and future research opportunities. *Personal and Ubiquitous Computing*, 18(6), 1499–1514. <https://doi.org/10.1007/s00779-013-0751-2>
- Viberg, O., Hatakka, M., Bälter, O., & Mavroudi, A. (2018). *The current landscape of learning analytics in higher education*. *Computers in Human Behavior*. Elsevier Ltd. <https://doi.org/10.1016/j.chb.2018.07.027>
- West, D., Luzeckyj, A., Toohey, D., Vanderlelie, J., & Searle, B. (2020). Do academics and university administrators really know better? The ethics of positioning student perspectives in learning analytics. *Australasian Journal of Educational Technology*. <https://doi.org/10.14742/ajet.4653>