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Title: TEL@work: Toward integration of theory and practice

Year: 2014

Version:

Please cite the original version:

Tynjälä, P., Häkkinen, P., & Hämäläinen, R. (2014). TEL@work: Toward integration of theory and practice. *British Journal of Educational Technology*, 45(6), 990-1000.
<https://doi.org/10.1111/bjet.12164>

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Abstract

This article examines technology-enhanced learning at work in the context of the integrative pedagogy model (Tynjälä, 2008; Heikkinen, Tynjälä, & Kiviniemi, 2011; Heikkinen, Jokinen, & Tynjälä, 2012; Tynjälä & Gijbels, 2012). The basic idea behind this model is to create learning environments whereby the four basic elements of professional expertise – i.e., theoretical, practical, self-regulative and sociocultural knowledge – can be integrated. The article illustrates two basic ways of applying the model in technology-enhanced learning at work. First, examples of how to make use of existing technologies, especially social media, to empower learning at work is presented, and second, an instance of the way the model is used in the design of specific technologies for enhancing collaborative learning in the work context is described. The article concludes that the integrative pedagogy model has the potential to serve both as a principle for designing technologies and for applying existing technologies for workplace learning.

Practitioner notes

What is already known about this topic

- Today's work contexts are in constant change
- The use of technology has potential to support workplace learning
- There are many challenges in the use of technology for workplace learning
- There is a need for theory-based frameworks to enhance TEL at work

What this paper adds

- The paper provides a framework for designing and applying technologies for workplace learning
- The framework contributes particularly on integration of theoretical and practical knowledge
- The paper discusses the potential of social media in learning at the workplace in the light of the integrative pedagogy model
- The paper describes how the integrative pedagogy model can be used as a framework for designing 3D environment

Implications for practice and/or policy

- The integrative pedagogy model may serve as a principle for designing technologies for workplace learning
- The integrative pedagogy model can be used as a framework for applying existing technologies for learning at work

- The integrative pedagogy model can be used in analyzing mediating tools that integrate theory and practice

Introduction

Twenty-first century work contexts face rapid and constant change with exponentially increasing amounts of available information. Consequently, both workplace organisations and their individual employees are continuously invited to develop competencies. Technology-enhanced learning (TEL) at work covers the broad area of potential solutions to support work activities. Recent research related to TEL at work has been conducted from various approaches such as computer-supported collaborative learning at work (Goggins, Jahnke & Wulf, 2013), knowledge building and networked expertise (Hakkarainen, Palonen, Paavola & Lehtinen, 2004) and social media in the workplace (Dabbagh & Kitsantas, 2012; Fiehl, 2012, see also Cheng, Wang, Mørch, Chen & Kinshuk, 2014). Several added values of TEL at work have been indicated in these studies. For example, mobile tools can broaden the physical boundaries of the learning and working environment. Social media can provide mass empowerment for corporate learning by enabling the joint production of content as well as participation in community building and social networking (Dabbagh & Kitsantas, 2012; Fiehl, 2012). Furthermore, simulations, virtual worlds and game-like solutions offer semi-authentic and usually motivating ways to practice a variety of skills (e.g., Krange, Moen & Ludvigsen, 2012).

TEL is still often associated with formal training activities in the workplace. However, learning at work commonly takes place through social and intellectual actions that are not intentional learning activities. For example, reflection, interaction, collaboration, knowledge sharing, participation in different communities of practice, networking, and so on, are informal activities by which such learning is often described to happen. It has been suggested that the integration of formal and informal learning is an essential prerequisite for developing the kinds of expertise needed in response to changes taking place in working life (e.g. Guile & Griffiths, 2001; Tynjälä, 2008, p. 130). The purpose of the present article is to examine this issue especially in light of the model, integrative pedagogy, presented by Tynjälä and her colleagues (e.g., Heikkinen, Tynjälä & Kiviniemi, 2011; Heikkinen, Jokinen & Tynjälä, 2012; Tynjälä, 2008; Tynjälä & Gijbels, 2012; Tynjälä, Slotte, Nieminen, Lonka & Olkinuora, 2006).

The need for integrative approaches in workplace learning and TEL

Recent technological developments have the potential to change the way in which employees work individually and collaboratively, and to enhance capacity building. In their review of virtual workplace learning, Brookshire, Lybarger and Keane (2011) list the following benefits for employees: flexibility and control over their learning experience; the ability to take extra time with more challenging material; a safer environment with less pressure than classroom learning; the ability to learn anytime, anywhere; and adaptability for a variety of learning styles and needs. In terms of benefits for employers, they mention, for example, cost-effectiveness, reduction in travel expenses, consistency across a global workforce, and enhancement of organisational learning options.

Although modern technologies offer possibilities for supporting workplace learning, there are also many challenges. Brookshire et al. (2011) have grouped these challenges into three categories: characteristics of the design of the training or training system, workplace characteristics, and characteristics of the learners themselves. Recent research has highlighted critical success factors for TEL at work, such as ease-of-use, flexibility and adaptability of the system, learners' motivation, learners' needs as a starting point, managerial support, changing organisational culture; interaction between learners, facilitation of learning, and the inclusion of face-to-face components (e.g., Aggarval & Makkonen, 2009; Brookshire, Lybarger, & Keane, 2010; Lim, Lee & Nam, 2007; Luarn, Chen & Lo, 2007).

When dealing with the use of technology in workplace learning, it is important to examine not only technologies but also the nature of learning at work in general. Usually, workplace learning is characterised as experiential, social, situated, and practice-bound. Research in this area has indicated that learning situations at work vary from purely informal, where learning takes place unintentionally, to more structured and formalised practices, where working people “teach” their colleagues or “become taught” by them (e.g., Billett 2002a, 2002b, 2004, 2011a; Eraut, 2004; Marsick & Watkins, 1990; Tynjälä, 2008; 2013).

It has been pointed out that in formal education, the emphasis is often on reproducing what is already known, whereas workplace learning often emphasises the creation of new knowledge (Goggins & Jahnke, 2013). The integration of these two perspectives has been considered important. Brown (2013) has referred to the need for theories, practices and technologies that would bridge “formal and informal learning, didactic and experiential learning, peer-based and master-based mentoring, local and distributed learning, and the cognitive and the social dimensions of learning”. Especially in the context of TEL at work, it is important for learners to *conceptualise* their experiences and *re-contextualise* learning that takes place in different contexts. For example, Guile & Griffiths (2001) use the term connectivity to describe the importance of the integration of conceptual and experiential (or theoretical and practical) knowledge. We suggest that the *integration of theoretical and practical* (or conceptual and experiential) *knowledge* should be a starting point in the design of any learning environment for professional development. Tynjälä and her colleagues (e.g., Heikkinen et al., 2011, 2012; Tynjälä, 2008; Tynjälä & Gijbels, 2012; Tynjälä et al., 2006;) have presented a model called integrative pedagogy for this purpose. In the following section we briefly review the justifications for using this model in TEL.

The integrative pedagogy model

The integrative pedagogy model (the IP model; Figure 1; Heikkinen, et al., 2011; 2012; Tynjälä, 2008; Tynjälä & Gijbels, 2012; Tynjälä et al., 2006;) is a pedagogical principle for designing learning environments. It is based on the idea of professional expertise as an integrated entity of theoretical, practical, self-regulative and socio-cultural knowledge (e.g., Bereiter, 2002; Bereiter & Scardamalia 1993; Eraut, 2004; Heikkinen et al., 2011; 2012; Tynjälä, 2008). Because these components of expertise are not separate, and are tightly integrated, the basic idea of the model is to create learning environments whereby these different forms of expert knowledge are present and can become interconnected. In the present paper, we modify the model for the purpose of technology-enhanced learning at work.

INSERT FIGURE 1 ABOUT HERE

The IP model emphasises the unity of theory and practice. Therefore, *conceptual or theoretical knowledge* should be transformed so that it can be applied in practice; vice versa, *practical or experiential knowledge* acquired from work experience should be explicated and conceptualised with the help of theoretical concepts and models. Thus, conceptual or theoretical knowledge provides tools to understand practice. The third element of expertise, *self-regulative knowledge*, including metacognitive and reflective skills (e.g., Bereiter, 2002), develops through *reflection*. In the IP model, reflection is linked to the use of theoretical and practical knowledge. Thus, learners are encouraged to use conceptual tools such as theoretical concepts, principles or models while reflecting on their practical experiences. In this way, they will be able to rise from the concrete experience to a more abstract level in their thinking, and their understanding will deepen. (Tynjälä, 2008; Tynjälä et al., 2006)

While theoretical, practical and self-regulative knowledge represent personal forms of knowing, *sociocultural knowledge* is embedded in social practices as well as artefacts used in these practices (e.g., Bereiter, 2002; Hakkarainen et al., 2004; Heikkinen et al., 2011, 2012). All workplaces have their own ways of doing things, unwritten rules and practices. This follows that participation in communities of practice is necessary to encounter this form of knowledge (Heikkinen et al., 2011). Therefore, in the further development of the integrative pedagogy, sociocultural knowledge was included in the model (Heikkinen et al., 2011, p. 97; Heikkinen et al., 2012, p. 25; Tynjälä & Gijbels, 2012, p212). The ideal in applying the IP model is that practical and sociocultural knowledge components would be provided by authentic workplace practice. When this is not possible, various simulations, such as virtual simulations, role play simulations or practical exercises, can be used (Heikkinen et al., 2011).

The integration of theoretical, practical, self-regulative and socio-cultural knowledge requires certain pedagogical arrangements and *mediating tools* that intercommunicate between different forms of knowledge. Any learning task that helps learners to make connections between theory and practice and to reflect on their experiences may serve as mediating tools. Mediating tools are thus pedagogical arrangements that do not necessarily require any technological means. However, in the present article, we examine how modern information and communications technology can offer new possibilities for the purpose of knowledge integration. In Figure 1, we call these tools analytic and technological mediating tools, thus modifying the model for the purposes of technology enhanced learning.

The main *mediating process* for the integration of different forms of expert knowledge is that of *problem solving*. According to Bereiter and Scardamalia (1993, p. 66), formal or theoretical knowledge is transformed into an expert's flexible informal knowledge when used for solving practical problems (see also Heikkinen et al., 2011, 2012; Tynjälä, 2008). It can even be said that problem solving is the core process in the development of expertise. In the process of solving problems and integrating different forms of knowledge, people need to utilise a form of mature thinking called *integrative thinking* (e.g., Kallio, 2011). Thus, in the present modification of the IP model we added integrative thinking into the model as another mediating process (see Figure 1). This form of thinking goes beyond everyday thinking and requires a combination of different forms of knowledge or even conflicting information. This process results in new kinds of knowledge for the individual. Furthermore, given that the learning environment involves participation in authentic work practices and the development of these practices, the ideal outcome could also be the production of new knowledge at the community level.

The IP model has been applied in the contexts of formal education and workplace learning (see, e.g., Heikkinen et al., 2011, 2012; Tynjälä, 2008; Tynjälä & Gijbels, 2012). As the model is a pedagogical principle for organising learning, rather than a particular training method, it can be applied in different ways with the use of a variety of methods. Depending on the particular context, the model integrates not only different forms of expert knowledge but also work and learning, conceptual understanding and practical action, formal and informal learning, domain-specific knowledge and generic skills, individual and social learning, and possibly physical, social and virtual learning environments. Professionals use multiple tools for individual access, manipulation and analysis of information as well as for communication, sharing and joint knowledge construction with other people. Modern work and learning environments can be seen as complex entities in which learners are surrounded by a variety of resources distributed across different settings and utilised both in individual and collaborative learning activities (Arvaja, 2007). Thus, technological tools can mediate individual and social learning processes as well as the integration of different forms of knowledge.

When dealing with the application of the integrative pedagogy model in technology-enhanced learning, a distinction can be made between the *use* of technology and *designing* new technologies to support learning at work. Following this distinction, the next section focuses, in the context of the IP model, on how to make use of existing technologies, especially social media, to empower workplace learning. Following this, we will present an example of the manner in which the model can be used to design specific technologies for enhancing collaborative learning in the work context.

Social media in empowering workplace learning

The role of social media in corporate learning has gained increasing attention in recent years. In corporate settings, social media comes close to knowledge management practices (Earl, 2001). However, knowledge management mainly concentrates on capturing and coding existing knowledge (McElroy, 2000), whereas in workplace learning, the focus is more on knowledge creation practices (Goggins & Jahnke, 2013) (see Figure 1: creation of new knowledge). Particularly, changes to the Web content consumer-producer paradigm have made social media a forum for participation, conversation, cooperation, knowledge creation and mass empowerment (Colomo-Palacios, 2010). This social nature of the tool's use is particularly crucial in work organisations since teams and project work are often natural forms of working in this context.

As the IP model suggests that communities of practice should be the link to sociocultural knowledge, social media can offer new ways of thinking about learning as a sociocultural activity (see Figure 1: sociocultural knowledge). Social media can contribute to purposeful building of communities (Fernando, 2010). In an organisational context, communities of practice usually refer to group or project work; however, communities of practice can also involve individuals with a common interest. Particularly, social networking sites and communities of interest can contribute to building and sharing professional resources for exchanging ideas and expanding professional learning networks (Thomas & Brown, 2013). Berners-Lee, Hendler and Lassila (2006) have defined social media “as a collection of software tools which enables individuals to share information, collaborate, and create and grow communities”. Furthermore, MacAfee (2006) has emphasised the importance of social media in enabling contextual, agile and simplified information exchange and collaboration to distributed work teams and partner networks. According to Fiehl (2012), social media can

have the potential of providing personalised, portable and engaging experiences for workplaces and developing so-called soft skills. However, as social media tools are not specifically designed to support workplace learning, it is important to realise that the core process is the pedagogical take-into-use of existing tools. The IP model, in turn, can help in this process by organising learning activities and mediating tools to empower workplace learning.

From the perspective of the IP model, social media can provide mediating tools (see Figure 1: analytic and technological mediating tools) to make tacit knowledge more explicit by expressing ideas relating to individuals' personal experiences or informal discussions and distributing them at a community level (Fernando, 2010; Maier & Schmidt, 2007). Ravenscroft, Schmidt, Cook and Bradley (2012) have presented an approach for designing social media to support informal learning in authentic work-based contexts (varying from career guidance to construction industry). In their study, they introduce this approach through the design and evaluation of tools to support a form of informal learning called "knowledge maturing" (Maier & Schmidt, 2007). Their approach bears similarities with collaborative knowledge building processes as it looks at informal learning and knowledge advancement from both individual and collective viewpoints. Ravenscroft et al. (2012) have developed a tool to enable people with *tagging for organisational development* (Braun, Kunzmann & Schimdt, 2010). In practice, this means finding out "who is competent in what", and hence, finding people who can help each other in work activities or problems. This collaborative tagging for expertise can contribute to more explicitly generating collective knowledge about others.

The role of social intranets has gained increasing attention in building "organisational memories" in corporate settings. In a social intranet, employees can create content and connect in a meaningful way with other content providers. An example of a social intranet is the use of internal blogs within organisations. Blogs can also be regarded as one potential mediating tool that, according to the IP model, could help learners to reflect on their practical experiences with the aid of conceptual tools or theory (see Figure 1: practical experiential knowledge and conceptual theoretical knowledge). Baxter, Connolly and Stansfield (2010) have examined the concept of blogs and their uses within organisations in the context of software project environments. Blogs were used for producing content and were associated with dialogue and information sharing. For example, programmers and the database development team used blogs for sharing codes to assist in their project work. Baxter et al. (2010) have also noted many challenges in the experimentation of blogs in software projects. For example, during intensive periods of project work, blogs were more seldom used and updated only after the project ended. Employees were also often unsure of how blogs should be used or their added value. Arguably, the potential of blogs can become evident and appealing for individuals when they have a real need to exchange views and opinions about issues of mutual interest. The IP model suggests that mediating tools can cover, for example, discussion and writing assignments such as essay writing, analytic writing, portfolios, learning journals, and other forms of reflective writing. At its best, blogs can represent the notion of "thinking by writing" (Nardi, Shiano, Gumbrecht & Swartz, 2004, p. 45), thereby allowing bloggers to reflect on personal experiences or actions and enabling them to share tacit knowledge with others (Baxter et al., 2010). A project or group blog can also allow its users to informally communicate information about their roles in the project as well as objective or other thoughts related to project.

Design of technological tools for workplace learning

As previously stated, the increasing demands of work life challenge us to develop new ways of empowering professional development; particularly, we need to find better ways of enhancing workers' abilities to apply and integrate *theoretical*, *practical*, and *self-regulative knowledge* in problem solving. It has become evident that there is potential to enhance learning at work – not only by utilising existing technologies (e.g., social media tools) in work life contexts – but also by designing new technological environments based on the needs of authentic work life (Krange, Moen & Ludvigsen, 2012). Nowadays, illustrative working and learning environments have become a natural part of the information society, and today, we can apply 3D techniques to empower the integration of different forms of expert knowledge (Söderström, Häll, Nilsson & Ahlqvist, 2012). A significant advantage is related with using 3D environments, which allows for more realistic representations of topics compared to textual environments or 2D representations (Chittaro & Ranon, 2007). Illustrative 3D environments can serve as mediating tools that intercommunicate between different forms of knowledge and offer added value for professional development, for example, by rehearsing specific work tasks (Banks & Sokolowski, 2011; John, 2007). In line with this, simulative 3D environments have been designed and used to train contextual work life skills. Simulations for pilots, drivers, military training, etc., are well-known examples (Adamson, 2012; Hays, Jacobs, Prince, & Salas, 1992; Rizzo, Parsons, Lange, Kenny, Buckwalter, et al., 2011). Recently, it has been understood that 3D environments can also offer added value in relation to the social aspects of learning (e.g., by enabling new ways of rehearsing different group processes, see Bluemink & Järvelä, 2011). Thus, accounting for 3D environments seems to be a rising trend in empowering workplace learning. However, thus far, the IP model has not been discussed in the context of 3D environments. Therefore, we describe how the principles of the model were taken into account in designing software to support learning processes in the work context. We discuss in greater detail how *theoretical*, *practical* and *self-regulative knowledge* represented in the IP model are integrated in the design of a specific 3D environment.

For instance, GameBridge (GB) is a 3D multi-user environment that offers opportunities for workers to find new ways of collaborating in the area of human sustainability. In line with the IP model, the GB environment transforms the theoretical knowledge of collaboration (for a detailed description, see Hämäläinen & Oksanen, 2012) into a form in which it becomes available for solving real-life based (practical) problems between inter-professional experts in a 3D setting. Thus, theoretical knowledge is integrated within problem-solving cases stemming from authentic work life (see Figure 1: mediating process). The 3D environment is in line with the notion of Heikkinen and colleagues (2011) that when it is not possible to rehearse the practical and sociocultural knowledge components in an authentic work context, virtual exercises should be used. The added value of the 3D environment is that it enables an illustration of the nature of collaboration and helps workers witness successful shared processes by both emboldening good practices and avoiding bad ones. In practice, the 3D environment includes theory-based problems (see Figure 1: theoretical knowledge) illuminating the *dependency between workers* (Brown & Campione, 1994), integration of inter-professional expertise (Paloniemi & Collin, 2012) and the solving of socio-cognitive conflicts during shared work tasks (Moscovici & Doise, 1994).

Through the problem-solving process, workers' actions are tied together to enhance the skills needed in the inter-professional workplace (cf. problem solving). For example, in the task, "restaurant", workers have supplementary inter-professional roles: a cook, two waitresses, a receptionist, and a serviceman. During the task, the receptionist first invites the customer to

the restaurant; the waitress takes the customer's order and sends it to the cook. The cook prepares the meal and gives it to the waiter, who then serves the portion to the customer (cf. dependency between workers). In addition, grounding on the theoretical idea of solving socio-cognitive conflict, the team enters an unexpected problem-solving situation while serving a rock band in the restaurant. The lead singer has special requirements for his meal, and while ordering, he says something ambiguously, and the waitress does not understand him. A second later, the cook is informed that the singer wants to have a chicken meal. If the player, who took the order, does not react in any other way to the singer's message and serves him a regular chicken meal, the singer refuses the meal. The problems cannot be solved until the receptionist becomes aware of the band's requirement that the lead singer cannot eat the regular chicken meal as it contains nuts. As in authentic inter-professional problem-solving contexts, the plot includes additional tasks that hamper shared work processes.

Additionally, the environment aims to increase the awareness of *self-regulative knowledge*, especially in the area of shared regulation (for a detailed description of self-regulation, see Hadwin & Järvelä, 2011). To highlight shared regulation, the team has to maintain the balance between the different workers' skills and energy resources as well as tasks performed. Furthermore, certain tasks have time limits and financial reporting requirements. Thus, the team needs to balance out in order to synchronise its work, breaks, and resources. Running out of energy or failing to perform tasks forces players to take a break. During breaks, the team has time to reflect on what is wrong in their group processes and are presented with the possibility of developing strategies for future action.

Conclusions

In the present article, we have discussed technology-enhanced learning at work in the context of the integrative pedagogy model (Heikkinen et al., 2011, 2012; Tynjälä, 2008; Tynjälä & Gijbels, 2012). The basic idea behind the model is to create learning environments whereby the four basic elements of professional expertise – i.e., theoretical, practical, self-regulative and sociocultural knowledge – can be integrated. In particular, we focused on the use of existing technologies, the example of social media, and on the design of 3D environments. In the workplace of the future, novel kinds of learning are called for: forms of learning that “enable people to engage in innovative and transformative rather than reproductive learning, and in networked and social rather than individual learning” (Tynjälä, 2013, p. 12). In this respect, studies on TEL in work contexts have reported several benefits of technology use. Through our examples, we illustrated that technology in the workplace can be helpful in empowering workers and organisations to engage in innovative and transformative forms of learning.

Our brief review showed that social media can provide mediating tools that enable the integration of different forms of expert knowledge based on the integrative pedagogy model. However, despite the potential of social media in empowering workplace learning, it also poses significant challenges for both the design and take-into-use of these tools. Learning environments utilising social media tools are often loosely structured environments which presuppose that learners have strong self-regulative knowledge and skills.

Ravenscroft et al. (2012) have also indicated that it is not only about the design of social media for a known purpose and context, but developing the next generation social media is a complex process that needs to take into account technologies, people and communities. According to Ravenscroft and McAlister (2008), “design” often means intervening with existing practices of using different tools and reconfiguring them towards desired practices.

However, instead of merely focusing on features of particular social technologies, there is an evident need to use theory-based frameworks in design and development of TEL practices at work. As one example, we described the design of 3D environments which support the integration of theoretical and practical knowledge in work life contexts. In this example, we showed how integrative pedagogy can serve as a structural model for designing technological tools for workplace learning and professional development. The GameBridge environment (see Hämäläinen & Oksanen, 2012) represents a technological design which is firmly grounded in learning theories that are transformed into a form whereby they become available for solving real-life problems. Thus, training contextual work life skills and social aspects of learning are examples of the added value that 3D environments can offer in terms of empowering future workplace learning. However, despite optimistic notions about 3D environments in work contexts, research has also shown that the quality of participants' activity, rather than the virtual environment itself, brings about changes in the development of competences (Söderström et al., 2012; see also Hew & Cheung, 2013).

It is also important to notice that interactive and collaborative learning models presented here involve challenging aspects as well. Some studies on technology supported training have reported better outcomes without collaboration component than with it (for a review, see Gegenfurtner, Veermans, & Vauras, 2011). Collaborative learning may be faced differently by individuals, and this raises guidance into an important role (Hämäläinen & De Wever, 2013). Furthermore, it is important to remember that the integrative pedagogy model represents a general notion on how to organize learning environments, while it does not discuss on how individual characteristics such as motivation, personality traits and previous experiences of technology can support or delimit the use of new technologies for work and learning. For example, Gegenfurtner (2011) has shown in his meta-analysis that motivational factors influence transfer of training. Therefore, further studies are needed to cast light on the effect of individual characteristics on the processes and outcomes of technology-enhanced learning at work.

In sum, our examples showed that the integrative pedagogy model can be utilised as a framework for developing practices that foster holistic professional development, whereby conceptual tools are used for reflective practice. The model may also be used as a theoretical basis for the design of technological learning environments in the workplace. Thus, we conclude that the integrative pedagogy model has the potential to serve both as a principle for designing technologies and for applying existing technologies for workplace learning.

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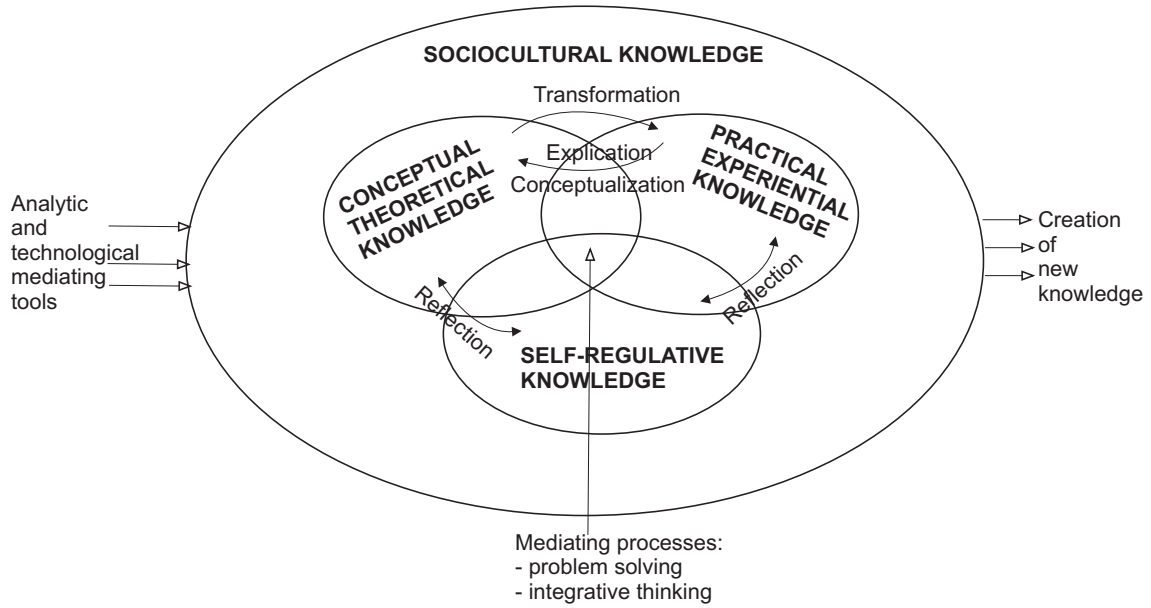


Figure 1. The model of integrative pedagogy (The IP Model; modified from Heikkinen et al., 2011; 2012; Tynjälä, 2008; Tynjälä & Gijbels, 2012)