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Lewin, Catherine and Cranmer, Sue and McNicol, Sarah (2018)Developing digital pedagogy through learning design: An activity theory perspective. British Journal of Educational Technology, 49 (6). pp. 1131-1144. ISSN 0007-1013

**Downloaded from:** http://e-space.mmu.ac.uk/621745/

**Version:** Accepted Version

**Publisher:** Wiley

**DOI:** https://doi.org/10.1111/bjet.12705

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To cite this article: Cathy Lewin, Sue Cranmer and Sarah McNicol (2018) Developing digital pedagogy through learning design: an activity theory perspective. British Journal of Educational Technology, 49(6), 1131-1144. https://doi.org/10.1111/bjet.12705

# Developing digital pedagogy through learning design: an activity theory perspective

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**Abstract**

Learning design is growing in importance but is not yet widely adopted by teachers. This paper describes the development of a scenario-led learning design process, divided into two stages, which was implemented with over 500 teachers altogether from 15 European countries. Activity theory is used to explore the contradictions that arose when such changes were introduced into the established activity system of lesson planning. Data were collected through interviews and questionnaires from a small sample of participants including national coordinators (stage 1: n=8; stage 2: n=13) and teachers (stage 1: n=13; stage 2: n=23). These participants perceived that the scenario-led learning design process, involving a wide range of stakeholders, was collaborative,

supportive and innovative (compared to previous lesson planning practices). However, a number of contradictions were identifiable between: (1) the shift to collaborative learning design from teachers preparing their lessons alone; (2) the new tools and the existing rules of the national/regional education systems; (3) the time required to both understand and implement learning design, and the impact of competing demands. This paper discusses the challenges faced when attempting to scale-up European school teachers' development of digital pedagogy. The structured (yet flexible) approach was welcomed and the tools promoted teacher reflection but, as commonly noted, the complexity and time-constraints were major issues.

## Introduction and background

### Structured practitioner notes

What is already known about this topic:

- Learning design, a means of formalising technology-enhanced activity design, can support teachers to develop digital pedagogy.
- It is often collaborative; teachers can share and re-use resources, saving them time and effort.
- Tools need to be simple, easy to use and flexible.

What this paper adds:

- A small-scale study (including interviews with 36 teachers) of scaling up learning design with 500+ teachers across Europe.
- A structured approach to developing and sharing learning design ideas is innovative for some European countries and welcomed by teachers.
- It highlights the influence of dominant traditional practices and the difficulties of introducing new approaches at scale.
- In common with others, the challenges of learning design include complexity and competing demands on teachers' time; despite understanding these challenges it proved difficult to overcome them.

Implications for policy and practice:

- The learning design process needs to be led by facilitators who understand the process and can adapt it to meet local and regional needs.
- More should be done at national level (ie through policy) to cultivate a shared object amongst teachers of developing digital pedagogy. Changing an activity system is more likely to succeed when it is driven by the key members of the community (ie teachers).
- Further work is required in the field to develop learning design tools that achieve the difficult balancing act of providing structure and flexibility, yet are simple and easy to use.

The majority of European teachers use ICT primarily for lesson preparation; students' use is still limited despite infrastructure having improved substantially (EC, 2013; OECD, 2015). It is widely asserted that, to enhance learning and in order to remain competitive in global markets, education and training needs to be transformed; one of the means to address this is through mainstreaming the use of technology for learning and teaching through national policies (Brečko, Kampylis & Punie, 2014). Given that uptake of digital pedagogy is still low, it is essential to explore mechanisms that can support system-wide change to realise policy directives (Brečko et al., 2014).There is, thus, a growing need for teachers to be supported in the development of digital pedagogy, which should be scalable

and sustainable. This can be achieved through adopting learning design processes and tools (Mor & Craft, 2012; Persico & Pozzi, 2015; Asensio-Pérez et al., 2017).

Learning design is a formal process for planning technology-enhanced learning activities, usually supported within a community where designs and ideas can be shared and re-used (Asensio-Pérez et al., 2017; Kafyulilo, Fisser & Voogt, 2016; Persico & Pozzi, 2015). Learning design demands 'subject knowledge, pedagogical theory, technological know-how, and practical experience' and should also 'engender innovation in all these areas' (Emin-Martínez et al., 2014, p.4). Providing access to exemplars to share and re-use can address the time-consuming nature of designing from scratch (Gustafson, 2002) and is one of the key objectives of learning design (Persico & Pozzi, 2015). Such exemplars should be adaptable and editable to maximise flexibility (Laurillard et al., 2013). Learning design tools with repositories of exemplars must also have effective search mechanisms and tagging systems, making recommendations based on specified criteria to ensure ease of use (Laurillard et al., 2013).

Enabling teachers to collaborate and share pedagogical knowledge and resources, within and beyond their institutions, has been of interest for some considerable time but has not yet become common practice (Goodyear, 2015) despite the recognised benefits for professional development and practice (Duncan-Howell, 2010). Participatory approaches and collaboration are key features of many learning design processes (e.g. Laurillard et al., 2013; Mor & Mogilevsky, 2013) and are becoming increasingly important (Kafyulilo et al., 2016; Persico & Pozzi, 2015). Co-designing rather than re-using ready-made resources can lead to increased integration of technology-enabled learning activities although this is more time-consuming for teachers (Cviko, McKenney & Voogt, 2014). Furthermore, there are also cultural barriers to developing a participatory culture of learning design which are inhibiting its take-up (Asensio-Pérez et al., 2017).

Whilst learning design is growing in importance it is not yet widely adopted by the teaching profession (Emin-Martínez et al., 2014). Yet many different learning design processes exist, some of which are underpinned by specific pedagogic approaches (Persico & Pozzi, 2015). Learning design processes are supported by different resources which typically include templates for conceptualising and authoring learning designs that can be text-based or visual (Asensio-Pérez et al., 2017; Persico & Pozzi, 2015; Pozzi, Asensio-Pérezc & Persico, 2016). Text-based representations can be more abstract, increasing the flexibility and thus the potential for scalability (Persico & Pozzi, 2015); others can be more detailed and prescriptive. Types of resources include 'reflection tools and pedagogical planners' to support decision making, 'authoring and sharing tools' to represent the learning design, 'repositories' for sharing designs and experiences, and 'delivery tools' (Persico & Pozzi, 2015, p240). However, processes, tools and resources for learning design are unlikely to scale up unless they are

simple, easy to use and can be used independently (Gustafson, 2002; Pozzi et al., 2016). Teachers must be provided with effective support materials and tools that have been subjected to extensive pilot testing (Borko, 2004; Kafyulilo et al., 2016).

iTEC (Innovative Technologies for an Engaging Classroom) (2010-2014) brought together ministries of education, technology providers and research organisations, with the shared aim of scaling-up and sustaining the adoption of digital tools in school classrooms. One outcome of the project was a digital toolkit for teachers, school leaders and educational policy makers to support scenario-led learning design, facilitating the creation, sharing and adaptation of resources to develop digital pedagogy. The toolkit was piloted in two stages with over 500 teachers from 15 different countries and subsequently revised to improve usability. This paper revisits small-scale qualitative studies of the toolkit in use through the analytical lens of activity theory. It explores how teachers experienced this pedagogical shift, what challenges they faced and how such challenges could be addressed. This paper focuses on understanding the impact of introducing scenario-led learning design into a teacher's activity system with the object of developing digital pedagogy.

Activity theory (Engeström, 1987) considers the whole activity system, including the community who share the same object, individuals' roles and the rules governing the activity. More recent developments encourage researchers to consider the interplay with related and overlapping activity systems. It is also useful to focus on "[c]ontradictions [which] are historically accumulating structural tensions within and between activity systems" (Engeström, 2001, p137). Resolving contradictions can lead to system improvements (Engeström, 2008; Engeström & Sannino, 2010) although an activity system is in a constant state of flux rather than being a fixed entity (Engeström, 2008). However, introducing culturally more advanced forms of activity (Engeström, 1987) in educational systems demands substantial change:

> Activity theory suggests that significant and sustainable change in the nature of schooling may not be attainable by manipulating any single component or isolated group of components in the activity systems. Change requires construction of a new object and cultivation of new motives. This, in turn, is attainable only by transforming all components of the activity systems in concert, including and strategically emphasizing [the rules, the community and their roles]. (Engeström, 2008, p90)

It is challenging in school contexts to achieve transformation of all activity system components, resulting in systemic contradictions between culturally more advanced activity systems and dominant traditional practices (Engeström, 1987). The wholesale transformation of educational activity systems are constrained by aspects such as assessment requirements, timetabling, and teachers being used to

working in isolation rather than with their peers (Engeström, Engeström, & Suntio, 2002). In addition, the multivoiced nature of systems (Engeström, 1987) means that inevitably community members may have different understandings of the activity focus and be striving to achieve different ends.

We focus here on teachers' lesson planning as a core activity system nested within teaching and the introduction of learning design within lesson planning, an approach which was novel for the teachers involved in the project. For these teachers, learning design leading to a more systematic development of digital pedagogy was culturally more advanced (from an activity system perspective) in relation to their existing lesson planning practices. The questions we address in this paper are: How does the culturally more advanced activity system of scenario-led learning design differ from previous lesson planning practices? What are the (as yet) unresolved contradictions in the scenario-led learning design activity system and how might these be addressed?

**The development of a scenario-based learning design approach**

iTEC primarily aimed to facilitate innovation, at scale and across Europe, through the development of challenging yet feasible educational scenarios enabled by technology. Scenarios in iTEC presented narrative descriptions of how innovative and effective digital pedagogies might be realised in the classroom (or other learning contexts) that were generic and abstract so as to be flexible and transferable into different contexts. (See http://fcl.eun.org/directory/ for scenarios created using the process both within iTEC and in other related projects). The aim was to inspire teachers to change their practice through adaptation of the ideas presented rather than providing a lesson script. Although there are many learning design tools in existence, this process was developed to help realise the project aims through involving multiple stakeholders and experts, enabling teachers and others, such as learning technology specialists, to collaborate. The process combined learning design with the well-established field of futures methodologies, in which the scenario is a fundamental building block, drawing on the expertise offered by the iTEC team. To help teachers implement the scenarios, more concrete descriptions of learning activities were also developed, providing detailed guidance of how to integrate technology and change practice. Thus, the scenario-led development process drew on existing scenario development techniques and consultative processes. It was developed and tested by pedagogical and technological experts initially. The process was refined over five implementation cycles within the iTEC project to improve criticality and widen stakeholder involvement (Cranmer & Ulicsak, 2015).

Towards the end of iTEC, a digital toolkit was developed to enable teachers and other educationalists, rather than technology specialists, to undertake the process of scenario and learning activity development independently (http://fcl.eun.org/toolkit). The toolkit has five toolsets, each with suggestions for workshop activities that support scenario and learning activity development, together

with guidance on piloting and evaluation. As well as creating scenarios from scratch, teachers can access exemplars which they could use or adapt.

The process begins with the identification of trends and challenges that could affect education such as external economic, social or technological factors. These trends provide a stimulus to generate new ideas, ensuring that scenarios address the current concerns of classroom teachers and take account of likely future developments. For example, one of the trends identified during the project was that the flow of information between home and school was becoming more seamless. The toolkit supports participants to identify trends for themselves that would impact on education in their own context from relevant organisations (e.g., OECD, Pew Research, Eurydice) and from their own experience of technology.

The drive to ensure the innovative quality of all scenarios led to the development of the Future Classroom Modelling Toolset which enables stakeholders to assess both overall innovation and the relative levels of innovation in each key area of the scenario. This maturity modelling tool can be used 'as a design tool to highlight factors that the scenario should contain to ensure that innovation occur[s]' (Cranmer & Ulicsak, 2015, p27). The model focuses on the learner's role, teacher's role, learning objectives and assessment, school capacity to support innovation in the classroom, tools and resources. Five levels of innovation are described for each of these dimensions.

The final stage of scenario development is to use the trends and maturity modelling outcome (current level, desired level) to develop a narrative for an educational scenario involving technology. This is undertaken collaboratively with teachers through a workshop. Alongside the narrative, information is recorded about the learning objectives, the learner's role, the tools and resources required, and the context.

Once the scenarios have been created, the next step is to develop learning activities. Learning activities describe discrete sets of actions underlying scenarios in more concrete terms (for instance, publishing and presenting designs to an audience). A scenario may be realised through implementing a bundle of learning activities which serve as building blocks. The learning activity development process is designed to enable teachers to translate scenarios into classroom practices. Collaboration and sharing ideas is central to the process, ideally with teachers working together in groups of 3-4. The process identifies: challenges and opportunities relating to scenario implementation; potential solutions; and tools and resources. Finally, the resulting learning activities are documented providing clear guidance for teachers on the steps and interactions required to undertaken the activity, with information about teacher and student roles, technology and resources, preparation and assessment.

The toolset in the toolkit is based on a process that was developed in the iTEC project (Toikkanen, Keune & Leinonen, 2015).

**Methodology**

The iTEC toolkit, encompassing two main stages – scenario development and learning activity development, was piloted in the fifth and final implementation cycle in the project. A small-scale study of the scenario development process was undertaken (April 2013-July 2013). National workshops, supported by facilitators, resulted in 22 scenarios being created by over 180 teachers and another 100 stakeholders who used the prototype toolkit, supported by a facilitator and working collaboratively in groups. (A further 6 scenarios were created by 26 teachers at a workshop held in Brussels). Typically a group of 20 participants worked together to create 1-2 scenarios. National coordinators (who managed the project at national level) were asked to recruit 1-2 teachers and 1-2 other stakeholders who participated in the workshops and could speak English. Ten national coordinators suggested 20 teachers and 15 stakeholders who were then asked to completed the online questionnaires in English. Data collected included questionnaires from: eight national coordinators (8 countries), 13 teachers (9 countries) and two stakeholders (2 countries). These data were from 13 different countries overall. In addition, interviews were conducted with 41 policy makers and senior managers from 16 different countries (2-3 per country) to develop national case studies which focused on the change and innovation introduced by iTEC and perceptions of the scenario development process. Interviews were conducted online, in English, and were not recorded. Instead, extensive notes were taken, national case study reports were produced and then sent to interviewees for checking.

Similarly, a small-scale study of learning activity development was undertaken (Nov 2013–Feb 2014) involving over 400 participants, the majority of whom were teachers. As for scenario development, facilitator-led learning activity development workshops were undertaken involving teachers and other stakeholders including head teachers, teacher educators, trainee teachers, commercial providers, students and parents. The learning activity development process was simplified and adapted to meet local needs, reflecting the underlying philosophy of iTEC to avoid prescription and to support sustainable autonomy and flexibility. The guidance for the learning activity development process was not rigidly followed in any participating country.

National coordinators from five countries elected to conduct a case study of learning activity development and were provided with an evaluation handbook. They were asked to conduct a group interview with workshop participants at the end of the workshop, and follow-up interviews with four participating teachers, either face-to-face or online. They transcribed and translated all interviews following guidance in the evaluation handbook. In addition the research team administered short

online questionnaires to the workshop facilitators (some of whom were national coordinators) and the national coordinators. Data were collected from: two group interviews held after workshops involving 10 teachers and three other stakeholders, follow-up individual interviews with 13 teachers and one teacher educator, questionnaires from 8 workshop facilitators (5 national coordinators and 3 others) and questionnaires from 10 national coordinators. Thus, data were collected from 13 national coordinators, 3 additional workshop presenters and 23 teachers representing 14 of the 15 different countries.

Data were analysed using an activity theory lens to identify emerging themes relating to how the activity of learning design differed from previous practices of lesson planning, and how the new mediating tools were perceived by teachers and others. In addition, the data were interrogated to identify contradictions both within this culturally more advanced lesson planning activity system which incorporated learning design, and also between it and related teaching activity systems.

**Developing a more culturally advanced lesson planning activity system**

One aim of the iTEC project was to introduce learning design into a teacher's lesson planning activity system with the object of teachers developing their digital pedagogy. The rationale was to ensure that learners make more effective use of technology in the classroom in order to enhance learning, to raise achievement and prepare them for the needs of employers in a globalised society. That is, there was an expectation that shifting the teachers' activity system would have an impact on the learners' activity system. Although learning design per se is not new, and the use of templates and collaborative processes is common in learning design implementations, its uptake by teachers in school contexts is low (Asensio-Pérez et al., 2017; Emin-Martínez et al., 2014; Goodyear, 2015). When we refer to changing a teacher's lesson planning activity system and the introduction of new elements, it relates specifically to the individuals concerned rather than the elements themselves being novel. Here we review how the teachers' revised lesson planning activity system (Figure 1) was framed in terms of tools, rules, community and division of labour.

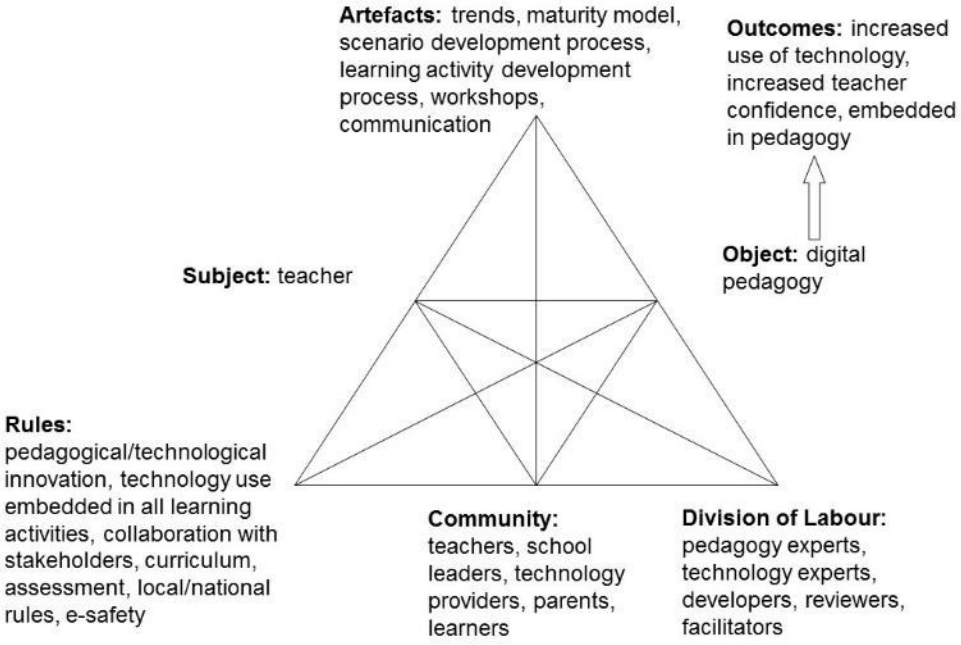


Figure 1: Lesson planning through learning design

New tools were developed, as described above, to support teachers to develop scenarios and learning activities, working in collaboration with a wide range of stakeholders such as head teachers, students and parents. These new tools include trends analysis, maturity modelling, and templates. In addition, the learning design process is designed to be collaborative thus demanding increased levels of communication across the community. Some rules of the lesson planning activity system remained unchanged such as meeting the needs of the curriculum, local/national rules and safe use of the internet. However, new rules relating to the design process were introduced. Teachers were required (within the new activity system of learning design) to develop lessons that were innovative in relation to their own previous practices through the integration of new technology enhanced learning interventions; digital pedagogy was the new object of lesson planning. Furthermore, the process was designed to be collaborative (rather than individual). Thus, another new rule introduced to the learning design activity system was that teachers should work with a range of stakeholders in the design of scenarios and learning activities. Therefore, the community was extended in relation to the previous (and well established) activity system of lesson planning in isolation, and included head teachers, technology providers, parents and students. Members of the community had different roles, including pedagogical and technological experts, developers and reviewers, and process facilitators. The division of labour was markedly different from the previous activity system; the introduction of learning design and the focus on developing digital pedagogy demanded additional technological knowledge.

*New ways of working: from individualised lesson planning to collective learning design*

There was a shift from teachers preparing lessons alone to working collaboratively with peers and other stakeholders, a novel experience for those participating in the project. Although one aim of learning design is collaboration (Gustafson, 2002; Persico & Pozzi, 2015), the teachers involved in this study were more used to working on their own; they had no knowledge and/or experience of learning design. This shift reflects the new rule introduced to the lesson planning activity system directing teachers to work collaboratively alongside the broadening of the community that shared the object of digital pedagogy. In addition, the division of labour in the new system changed such that teachers and other stakeholders, who participated in different roles, took collective responsibility for developing the learning designs. The teachers involved embraced this shift.

> The teamwork and discussion with different stakeholders is of great value. (Slovakia, national coordinator questionnaire, scenario development)

> It was very nice to work with so many colleagues. You gain ideas; you can tell your ideas; you get constructive criticism to enrich your ideas. It's a nice way of working. It adds something extra to your teaching. (Finland, teacher interview, learning activity development)

While the collaborative approach was highlighted as positive, there was a clear contradiction between the new division of labour in collaborative learning design and the historical activity system of teachers planning lessons alone. This dominant traditional approach to lesson planning is difficult to shift:

> Another significant problem is that teachers in Israel do not tend to share. They are not used to discussing what they are doing and collaborating. Such attitudes take time to change and teachers need to feel comfortable doing this. (Israel, national case study report, scenario development)

> At this stage, the challenge is to involve teachers in the whole [learning activity design process] and to make them change their point of view. They tend to create learning activities as they used to do and they aren't used at all to revise their lesson plans following someone else's opinion. One more difficulty is to engage [as wide a range] of staff as possible and to make them work together. (France, national coordinator questionnaire, learning activity development)

*New artefacts perceived as pedagogical innovation*

The scenario development process and its tools were perceived to be innovative by policy makers in eight of 16 countries (national case study reports). The structured nature of the process was considered to be particularly beneficial in supporting the object of developing digital pedagogy. Documenting the scenarios and learning activities through the templates provided was seen as a useful means of sharing good practice within the teaching community, thus supporting other teachers to develop digital pedagogy.

> The most far-reaching change relating to the iTEC process is perceived to be the structured approach to documenting and sharing best practices facilitated through the scenario development toolkit. (Hungary, national case study report, scenario development)

> Clearly, new ways of learning and teaching are needed. The [scenario development process] is highly valuable to provide room and a structured approach to develop these ideas. (Austria, stakeholder questionnaire, scenario development)

The new artefacts of identifying trends, maturity modelling and scenario development were considered to support innovation (6 of 11 national coordinators, scenario development).

> Normally people don't think about trends, it's something very abstract, a concept which is there, but you really don't think about those processes. It made [teachers] think… (Estonia, national coordinator questionnaire, scenario development)

> The [maturity modelling tool] served as a basis for reflection and participants had the chance to position their schools regarding the different stages and to think about ways of moving forward and above. (Portugal, national coordinator questionnaire, scenario development)

However, similar but different maturity modelling tools were already in existence in six countries which had already been added to the repertoire of tools recommended for change management through national educational activity systems. Concerns were raised by two national coordinators about the potential confusion arising from the introduction of similar tools; therefore there was a tension between the new tools and existing tools designed for scaling up the use of technology in the classroom. Furthermore, in two countries it was noted that there was a contradiction between the maturity modelling tool as a mediating artefact for developing digital pedagogy and existing national rules and norms within the interrelated national educational policy activity system. In these countries

schools had limited autonomy and could not necessarily make changes that a maturity modelling tool might highlight.

> There is a risk of confusion in schools if they are confronted with competing scenario planning tools and similar but different maturity models. (UK, policy makers interviews, scenario development)

> …education in Portugal is very much centralised, and the Ministry of Education dictates what schools should do. A [maturity modelling tool] only works if schools are autonomous and have a degree of control over their destiny. … there is no funding either for support or development. Therefore the [maturity modelling tool] might raise expectations that cannot be met. (Portugal, national case study report, scenario development)

The learning activity development process was also viewed as enabling teachers to think differently about their practice (six of 15 participants interviewed). That is the new set of artefacts were considered to support the shift from previous practices to digital pedagogy. Moreover, teachers could see that the shift in the activity system was achievable.

> It has been very inspiring…I still have to step beyond my comfort zone and that is challenging, but I realise it is good for me because I need to know these new things about teaching with technology… this is one way to train myself and to get familiar with it. (Finland, teacher interview, learning activity development)

> We started to think that we can teach differently. The most important was I stopped [being fearful]. (Slovakia, teacher interview, learning activity development)

*Challenges of lack of time and complexity of artefacts*

The most common issues raised by facilitators and participants were lack of time (due to competing pressures arising from interrelated activity systems) and the difficulties of working with complex artefacts.

Both the scenario development and learning activity development processes, including tools such as maturity modelling, were noted to be particularly time-consuming for teachers. This suggests a contradiction between the enhanced activity system of lesson planning through learning design and other interrelated activity systems which demand teachers' time, such as delivering the curriculum. If the learning design process is perceived as too time-consuming then teachers may not adopt it. They

may no longer have the motivation to pursue the object of developing digital pedagogy and may instead focus their attention elsewhere. Or they may identify alternative mediational artefacts such as professional development materials or consulting with colleagues to help them to achieve their goals through different means. That is they may develop digital pedagogy but without adopting the processes developed within the iTEC project.

> Everyone has time constraints and it is very difficult to find an occasion when you can bring together a school head, the ICT co-ordinators and a number of teachers. (Belgium, policy makers interviews, scenario development)

> It's too much work for them. They normally don't plan activities like this… it's much more like a toolset for curriculum designers…normally teachers don't do so much work, they don't spend so much time…. (Estonia, national coordinator interview, scenario and learning activity development)

The complexity of the new artefacts provided through the project, including some of the terminology used to communicate the concepts, created a tension in the system. The tools and processes were not always considered to be suitable for the participating teachers; some found it difficult to engage with learning design, even when supported by facilitators and stakeholders with expertise in technology and pedagogy. That is, there was a contradiction between the artefacts mediating the activity and the object of developing digital pedagogy. Some national coordinators chose to present the scenario development processes in short sections and all coordinators selected elements of learning activity development to ensure relevance for their teachers rather than applying the process in full. The facilitators of the learning design processes chose to simplify them; their understanding of the process and the needs of their teachers was key. Some national coordinators felt that the scenario development process in any form was not suitable for classroom teachers, instead having potential applications in teacher training and professional development. As a result of the evaluation undertaken in the project (Lewin & McNicol, 2015), the scenario and learning activity development processes were simplified.

> After a long interesting discussion we had a set of identified trends, we knew our place in the [maturity modelling tool] but it was still hard to turn them into an exciting scenario. When it should have come to writing the narrative, we were quite confused by the complexity of things our scenario should include or address. (Hungary, national coordinator, scenario development)

> Our teachers are not educated for such kind of teaching and learning. This is a design process which is not familiar to many teachers, and teachers hesitate to undergo new

> unfamiliar approaches […] Mainstream teachers will not undergo design process. This development process is more suitable for 5-10% of creative teachers. (Slovakia, teacher educator, learning activity development)

To some extent the new object of developing digital pedagogy within the iTEC project was imposed on teachers rather than jointly constructed, although teachers did volunteer to participate. The community in the more culturally advanced lesson planning activity system that included learning design approaches did not necessarily view the object in the same way as those responsible for introducing the project (for example, Ministries of Education and organisations advocating the use of technology in the classroom).

**Discussion and conclusions**

The introduction of a new object of developing digital pedagogy to expand and develop a teacher's lesson planning activity system, through the introduction of learning design, involved new mediational artefacts, new rules, widening the community and the creation of new roles. The iTEC scenario-led learning design process was collaborative, involving a wide range of stakeholders, and in contrast to the dominant activity of individualised lesson planning that teachers often engage in. Collaboration between teachers is at the heart of learning design approaches which intentionally aim to transform teachers 'from lonely practitioners into networked professionals' (Persico & Pozzi, 2015, p231). Both teachers and facilitators in the iTEC project noted that this aspect of the process was beneficial, supportive and innovative; indeed many policy makers held similar views. Therefore, the development of these processes through iTEC is timely given the increasing importance of collaborative learning design tools (Gustafson, 2002). In addition, the process led to teachers embedding technology throughout their curriculum design rather than using it as an add-on activity (i.e. students using technology for research or presenting findings) (Lewin & McNicol, 2015). The structured process, which included a template for recording the scenario design, provided a new way of sharing practice for the teachers involved, which was seen to be an improvement. This accords with claims that sharing and re-use of resources needs to be facilitated and is beneficial (Asensio-Pérez et al., 2017; Emin-Martínez et al., 2014; Voogt et al., 2011). The scenarios offered a more abstract text-based narrative, in common with other learning design representations (Persico & Pozzi, 2015), which stimulated and extended thinking about the role of pedagogy in technology and led to a change in teachers' confidence about their ability to change their pedagogy (Lewin & McNicol, 2015).

However, a number of contradictions were clearly identifiable. There was a clear contradiction between the shift to collaborative learning design (non-dominant) and the previous activity system of teachers preparing their lessons alone (dominant). The interplay between dominant and non-dominant activities can impact on success and sustainability (Sannino, 2008). Such significant shifts are most

likely to lead to change when supported by 'transitional actions' or smaller steps (Sannino, 2008). Although this could be resolved through experience, further support and/or professional development is likely be required to address this systemic contradiction.

In some countries, there were contradictions between the learning design activity system and the national educational activity systems which inform rules and constrain school autonomy. Activity systems in educational contexts are interconnected and interrelated (Engeström & Sannino, 2010). Thus there are more possibilities for contradictions to occur whilst addressing those that arise between activity systems (at regional and national levels) and these can be more challenging to address.

There was also an important contradiction between the time required to both understand and implement the scenario-led learning design approach and other demands placed on teachers by other interrelated activity systems (at local levels) such as teaching and assessment. This is commonly noted in educational contexts (Asensio-Pérez et al., 2017; Cviko et al., 2014; Karasavvidis, 2009; Sannino, 2008). If teachers (or their managers) do not view the development of digital pedagogy as a 'legitimate teaching-related activity' then it is not prioritised and they need to find additional time outside their normal daily duties to make this happen (Yagamata-Lynch, 2003, p115). As noted previously, new activity systems may not be sustained if the rules, the community and their roles are not transformed in tandem (Engeström, 2008). Here also, the new (prototype) tools and the language used to explain them were too complex for teachers, suggesting that the approach was not sustainable (Gustafson, 2002). The complexity of the processes and terminology employed is a common issue for developers of learning design systems (Asensio-Pérez et al., 2017). Although members of the iTEC team put substantial effort into creating the scenario-led learning design approach through iterative cycles of refinement and the involvement of teachers and other stakeholders in its development, it proved difficult to achieve the right balance between support and flexibility, and to communicate the complexities clearly enough to an international audience.

Some of these contradictions in the new artefacts were acknowledged in the final stages of the iTEC project and steps were taken to resolve them. For example, the process was simplified, flexibility was increased, and further guidance and exemplification were provided. The revised toolkit was made available as part of the European Schoolnet Future Classroom Lab portal in order to sustain the outcomes (http://fcl.eun.org). Nevertheless, the amount of support required to enable teachers to collaboratively engage in learning design should not be underestimated (Persico & Pozzi, 2015; Kafyulilo et al., 2016). Some systemic contradictions remain and it could be argued they are difficult to resolve when teachers in many countries are driven by the demands of the curriculum and have limited time (if any) for innovation. More needs to be done at national and regional levels to enable teachers to transition to collaborative lesson planning and to have more autonomy over their day-to-

day practices. Ownership of innovation is also a significant factor. Teachers need to share the object of an expanded activity and contribute to its development. In this project, the teachers did elect to participate in the learning design process but they did not initiate it, a factor which can contribute to the success of an innovation (Engeström et al., 2002). However, the most significant systemic contradiction that all teachers face is that learning design is not (yet) a dominant form of activity (Engeström 1987; Sannino, 2008).

This paper has reported on a significant piece of research, given the substantial number of countries and teachers involved. Empirical studies of learning design undertaken to date with teachers typically involve relatively small numbers of participants (e.g. Asensio-Pérez et al., 2017; Manathunga & Hernández-Leo, 2018). A wide range of data collected over the course of the iTEC project has been subjected to a rigorous re-analysis through the adoption of a theoretical lens, activity theory. Taking such an approach to the introduction of a scenario-led learning design process within the lesson planning activity system, which was novel for the teachers involved, highlighted the innovative elements of the system. These teachers had not undertaken learning design before and were not used to collaborating with their peers, let alone other stakeholders such as learning technology specialists. Contradictions which could potentially prevent the activity system from being successful have also been identified. Revisions of the toolkit have partially addressed some of these contradictions. It remains unknown as to whether the potentially unresolvable contradiction between developing digital pedagogy and the demands of other related activity systems such as meeting the needs of the curriculum will restrict teachers' take-up of learning design approaches, thus constraining opportunities for the development of teachers' digital pedagogy.

**Acknowledgements**

We would like to thank the teachers and other stakeholders who participated in iTEC and on whom the success of the project was dependent. Also, all our colleagues in the iTEC project team who were central to the development and evaluation of the process. We would also like to thank the two anonymous reviewers who provided helpful feedback. This work was supported by the European Commission [Grant agreement Nº 257566].

**Statements on open data, ethics and conflict of interest**

The iTEC project was conducted between 2010 and 2014 during which time a substantial amount of data were collected through five cycles of intensive research activity, primarily through questionnaires and interviews. These data have not been made available through an open data repository, given their complexity. Data relating to this paper, including the national case study reports, anonymised interview transcripts and anonymised questionnaire data summaries, can be accessed by emailing the corresponding author.

The evaluation of the iTEC project was subject to Manchester Metropolitan University's ethical guidelines; approval of the ethics application was granted by the faculty ethics committee. Informed consent was obtained from all participants. Data have been anonymised and no individual is identifiable in this paper.

There are no conflicts of interest. The learning design process is available for open access via European Schoolnet's website (fcl.eun.org).

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