Co-Creation of Learning Designs: Analyzing Knowledge Appropriation in Teacher Training Programs

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Abstract. Adoption of technologies in schools is still behind expectations, investments are often made without a clear educational objective, and teachers are not sufficiently included in the process. We contribute to the emerging perspective of learning design by proposing co-creation practices that should lead to more effective designs for technology enhanced learning and their adoption in the classroom. Using the Knowledge Appropriation Model, we analyze how teachers and university researchers co-create materials and lesson plans for technology-enhanced math lessons in two case studies involving 42 teachers. The results point out that teachers' appropriation of new learning design was stronger when they perceived themselves as equal partners with university researchers and the primary goal of creating learning designs was sharing these with other teachers. Teachers also perceived that one of the greatest benefits of such co-creation partnership was expansion of their peer network. We close the paper with recommendations of how learning design should be integrated into teacher training programs.

Keywords: co-creation, learning design, technology-enhanced learning, professional learning, co-creation.

1 Co-Creation in TEL

The government investments into technologies used in schools have increased rapidly in the last years, and significant investments have also poured in from the private sector. Despite this increased access to technology, learning gains remain unimpressive [1]. Simply investing into technology for schools, however, will not lead to necessary changes in teaching and learning practices [2] and teachers feel left alone, lack sufficient support for connecting their subjects with implemented ICT, bringing about an adoption gap [3], i.e. not adopting an existing innovative technology as an optimal tool for teaching purposes. For example, in Estonia more than 60% of basic education schools have educational robots [4], while only 8% of teachers have tried using these robots in their everyday teaching [5]. Different forms of co-creation have been suggested to address this adoption gap. In co-creation processes, several stakeholders are

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involved to collaboratively create new technologies together with new teaching and learning practices, each of them having a specific role. For example, teachers commonly focus on their existing teaching practices and they tend to add technology to their already existing routines [6], university researchers and didactics bring in latest teaching innovations, and educational technologists might focus on affordances of technologies to support them. Taken together, co-creation turns into a cross-professional boundary crossing activity for professional development [7].

The field of learning design [16] has the goal to improve the quality of teaching by supporting practitioners along the process of designing innovative and effective learning situations. LD as a methodology enables teachers to (co-)create, redesign and share pedagogically thoughtful designs and practices [6]. By focusing on learning and teaching, LD complements the technology-centered approach with a pedagogy-centered approach. It helps to scaffold teachers and builds confidence towards using technological tools in teaching, while also relying on teachers' phenomenological views and intuitive knowledge for making design decisions [8].

Collaborative forms of LD that involve teachers seem to be especially effective in promoting adoption of TEL practices in the classroom. Several LD environments promote collaborative design such as GRAASP [9] or LDShake [10]. Co-creation in the design of learning resources has been found to lead to higher adoption of inquiry learning practices in schools [9]. Joint reflection and sharing student data help teachers to better understand the influences of their design in a real classroom application, directing teachers thus towards more efficient learning designing [11].

Despite these promising results, co-creation is not yet part of the regular teacher education practices. This limits the scope and sustainability of these initiatives. Our assumption in this paper is therefore that co-creation in LD needs to be integrated into teacher education programs to lead to wide-scale adoption. This is a challenge as teaching is a relatively new field of design sciences [12], and co-creation is an open process where learning goals are difficult to determine in advance. The question is now what factors would make LD as part of teacher education programs more effective and encourage ownership and higher adoption of technology-enhanced learning practices in the classroom. We introduce the Knowledge Appropriation Model (KAM) that has been developed to describe various collaborative learning practices in the process of knowledge creation. Using the model, we analyze two teacher training cases, identify the social practices that are likely to lead to adoption of TEL LDs, and derive some general conclusions of how to practically implement co-creation in teacher training.

2 Knowledge Appropriation in Cross-Professional Co-Creation

Teacher education for adopting technologies has usually focused on teachers' individual skills and beliefs [13]. In contrast to this, recent research on professional learning in innovative domains recognizes the need to co-construct knowledge and appropriate practices [7], and the importance of co-creation in the LD process where teachers are active participants in the process of creating teaching practices [6].

The Knowledge Appropriation Model [14] makes it possible to observe such informal learning practices in the context of innovation adoption. The model (Figure 1) draws on existing sociocultural models of learning (knowledge maturation and scaffolding) and explains the interconnectivity of these processes in workplace learning [9]. The model distinguishes three types of knowledge practices that support individual and collective learning, and help knowledge created informally to become formalized and available to a wider variety of contexts.

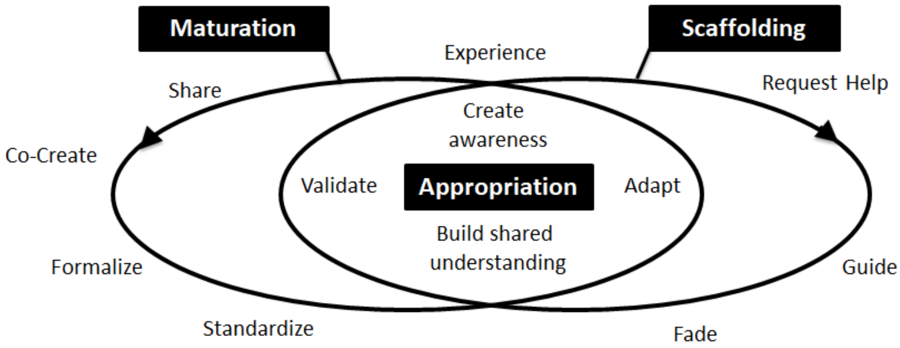

Fig. 1. The Knowledge Appropriation Model connecting knowledge creation and maturation (left), and workplace learning through scaffolding (right) [14].

Knowledge maturation describes the practices of knowledge creation, namely how an individual experience becomes a shared knowledge in communities and is further transformed and formalized to be more widely used. Specifically, it describes how knowledge, for example, materials for new teaching methods, is created, shared and refined [14]. Participants have an **idea** and **share** it (making it accessible to a small group of people), **co-create** (extend the idea in a collaborative manner), **formalize** (by documenting it and making it available), and **standardize,** whereby it becomes a generalized guideline that allows the idea to move towards wider adoption.

Knowledge scaffolding explains how the created knowledge can be applied in real-life settings, such as in formal training activities, but also at the workplace. Scaffolding practices are **help seeking** (an individual will use formal or informal support of a group, organization or from materials to get help from more knowledgeable peers or experts), **guiding** (knowledgeable peers or experts provide support layer that provides individual with needed help and guides towards a solution), **fading** (the support fades as the learner competence increases).

Both scaffolding and maturation are based on **knowledge appropriation practices** that explain how knowledge is arranged into general patterns that are later adapted to local needs trough: **awareness creating** (created knowledge is shared both formally and informally), **building shared understanding** (allowing communication between peers and experts of the problem situation), **adaption** (applying previously created knowledge to new situations by de- and re-contextualization), **validation** (through gathering evidence for a solution, social support, or formal authorization/approval).

3 Methodology

Using the KAM model, we analyze the co-creation practices of two training programs, both of which introduced a different form of technology-enhanced learning into the math classes in Estonian schools. Different forms of co-creation methods for LD were applied, involving teachers, educational technologists and university experts. The programs were conducted during the school year 2017/2018.

3.1 Robomath Program Context and Design

The Robomath research studies the effects of robot supported math learning in the basic education grades 3 and 6. The aim of the training was to provide participants with a collaborative training environment that would facilitate appropriation of the Robomath method. The training consisted of six contact days with additional collaborative and individual work between the contact days. The time between contact days was about one month, allowing participants to use co-created LDs for conducting at least one lesson, gather evidence about their ramifications, and analyze the data to understand the effectiveness of the intervention.

The training was led by six university's researchers (didactics, educational psychologists and TEL methodology experts) and 21 teachers participated. All lectures were videotaped and shared later with the rest of the Robomath learning community. The co-creation of new learning materials happened partly during the contact days and partly in the virtual learning groups that were formed during the first contact day, consisting of up to 5 members. The researchers and the participants used a virtual teaching-learning community environment eDidaktikum[1] for the purposes of communication, distributing learning materials, submitting tasks, and sharing co-created LDs. For ongoing discussion and sharing ideas an Internet message board was used.

During co-creation the participants shared their existing knowledge and their understanding about the new method first within their team, later with the members of other groups, and eventually also with colleagues of their schools. After testing the learning designs in their respective classes, the team members, based on their reflected experience, made alterations to the co-created learning designs, making this reusable for other teachers outside the training group community.

3.2 Digimath Program Context and Design

Digimath case was built on a larger project, which aimed to develop digital learning resources for Estonian schools to implement new student-centered pedagogy in secondary education. The project was running for 10 months and digital learning resources were co-created in collaboration of Estonian teachers, university didactics and educational technology experts, who supported each other practically, methodologically, didactically and technologically. The school-university community met once a month at the university, having trainings on different topics, and co-designing materials together.

[1] https://edidaktikum.ee/en/home

In the Digimath case, 21 teachers were involved, but compared to Robomath, the course was not announced as a formal training program for the teachers. Instead they were told to be the experts in their domain when participating in the process to design digital learning resources and learning scenarios for math classes. Expert work was paid, but in addition to creating materials, teachers were supposed to participate in the training program. Training topics were mostly suggested by the university team (methodological and didactic topics), but also occasionally suggested by the teachers (technology-oriented topics). Digimath teachers and the university team worked together from the start on the concept of the pedagogical principles and technological solutions of the digital learning resources. The university team introduced an initial idea that was further developed with the teachers who are the practitioners in the classroom. In the first phase teachers developed resources individually, but quite soon the drafts were made visible for other teachers to negotiate the common ideas and style. Teachers addressed the university team face-to-face, through social media, e-mails and also invited them to check materials to get feedback. Finally, the materials were reviewed, updated and made available in repository for teachers.

3.3 Data Collection and Analysis

We used a semi-structured questionnaire, which consisted of six open questions. Questions were focused on collecting teachers' experiences in the program and identifying knowledge practices. We received responses from 18 Robomath teachers and 14 Digimath teachers. Deductive content analysis approach was used to identify the knowledge appropriation practices. We coded the data based on the categories suggested by the KAM model, having multiple iterations in cases where the researchers assessed the information differently, in order to reach a uniform understanding.

4 Results

By analyzing the social practices that were involved in LD creation in our two teacher education programs, we aimed to investigate the conditions of teachers developing ownership for novel technologies in their classroom.

4.1 Knowledge Maturation Practices

During the program, both groups of teachers worked together with other math teachers and university experts. Both groups highly appreciated the **co-creation** experience, which was embedded into the design of the program. Digimath teachers also valued the role of the university researchers who were supporting teachers methodologically and technologically, while they mainly stressed the valuable experience working together with other Estonian math teachers (TDM3: "*Working together with other math teachers, supporting each other, was one the main values of the program*").

Once the confidence of the teachers increased, they started to **share** their materials. Digimath teachers shared their experiences at their schools (TDM4: "*I have shared my* *experience regarding the program and technologies with colleagues at school. I have another colleague focusing on biology materials, we often share our experiences"*). Robomath teachers shared the new knowledge about novel methods in some form with their study peers, colleagues and teachers of other schools (TRM4: "*We have reflected our activities to school team and parents and in the future, we plan to share our integrated lessons in social media channels*"). Developed materials were made available for other teachers (TRM16: "*We created tasks in collaboration and now it's easy to share them with other teachers when needed*").

Digimath teachers made learning resources available in national repository eKoolikott, as it was a requirement of the program. However, only a third of the participants of Robomath teachers transformed their creations into more widely shareable format to become accessible by other Estonian teachers (**formalization**). We saw even less evidence for standardization practices.

As a result of the programs, both groups admitted that they feel ownership regarding new technology enhanced methodologies – the teachers are using created materials in their teaching practices, adapting and improving them. Programs demonstrated that by working together with teachers, we can build their ownership regarding new technology-enhanced learning practices. They are adopting materials and continue using them after the program is finished. We also saw that working together with other teachers on similar problems is motivating for them and highly appreciated.

4.2 Scaffolding Practices

Scaffolding of the process is needed to help teachers to develop their expertise through guided mentoring by experts to internalizing new developed knowledge.

In both programs, the program participants sought help intensively. About half of the Robomath teachers sought help from their program peers when needed (TRM5: "*We were two of us from our schools and had a chance to discuss the challenges, but we also communicated with other program participants to ask advice*"). Help from the university researchers, colleagues and school specialists of their schools was rarely used by Robomath teachers. Digimath teachers were mainly seeking methodological support from university experts (TDM3: "*Often we were not sure if my proposed task is methodologically suitable for developing critical thinking skills and then I contacted university methodologist to get a second opinion*") and technological help from peers (TDM1: "*Sometimes I just did not know how to use formulas in interactive template, then I asked technical advice in our Facebook group*").

In both cases, guidance was first provided by the university team, but more experienced teachers soon started to support each other, because such support was more immediate. Also, above third of the Robomath teachers recognized their roles as guides for other teachers. Once teachers became more skillful and confident, in both cases the university expert support was slowly fading away and the support was minimized, because teachers themselves had become trainers (TRM3: "*In the Robomath classes at my own school, my role is to be the mentor, because I work as an educational technologist*").

Although the two training programs were designed with a different purpose, the support for the teachers was integrated to the program intensively. Such arrangement of the program enabled teachers to get guidance until they become confident and did not need any expert help, but they were able to teach and support themselves in the process.

4.3 Knowledge Appropriation Practices

One of the main aims of the training programs was to support teachers to understand that novel technologies can be integrated meaningfully to teaching process. Therefore, it was essential to build teachers' competence and ownership regarding new technologies and learning designs. As a result of the programs, most of the Robomath teachers had recognized that robots can change teaching practices (TRM1: "*The most what we got from the training, is the positive feeling that robots can be actually integrated to math teaching to acquire and apply new knowledge*"). One of the key indicators for the program designers, showing that teachers had built some ownership regarding new methods, was the implementation and adoption of the resources in their own teaching. Almost all of the Robomath participants adopted the co-created designs and used these in their math lessons and almost half of the Digimath teachers did it (without such request). Additionally, some of the participants of Robomath had also implemented the method outside the original boundaries – i.e. they used it in the lessons of other subjects and in after-school clubs. Program participants started voluntarily spreading the word about developed methodologies. Robomath teachers targeted colleagues of their schools, teachers of other schools, parents and to some extent management of schools.

The channels used were unofficial discussions, conferences and demonstration lessons (TRM14: "*In October, we had guests from other schools who participated in our math classes. Later we discussed how are they using robots in their class and agreed to meet later to share experiences and materials*"). Also, Digimath teachers volunteered themselves to meet other math teachers and to introduce the pedagogical and technological innovation behind the digital learning resources (TDM5: "*Once the trainer was ill and I was happy to meet other math teachers to introduce the materials. I think I was even a bit more competent to train other math teachers, because I also know the subject content, which is often a weakness of the university people"*). Such discussions in math teachers' community were highly appreciated, as in these the common vocabulary was built, concepts explained, and teachers' understanding about the method harmonized.

Validation was highly suggested by the Robomath teachers. A large proportion of the teachers piloted LDs and collected feedback about the piloting process. In Digimath case validation was not discussed, because materials and LDs were supposed to be piloted by other math teachers. However, as our study indicated, one third of Digimath teachers piloted the materials with their own students to get the feedback about the materials and to improve the planned LDs.

5 Conclusions and Discussions

This paper has addressed the importance to support teachers in the process of adopting the novel learning design practices in the classroom. Analyzing teachers' training programs through KAM lens, enabled us to understand important mechanisms in cross-professional co-creation activities in teacher professional development. We found evidence for three knowledge maturation practices: co-creation, sharing and formalization. Standardization was not identified, but it was not the clear goal of the programs and assumes some school-level decision making. We have planned some follow-up activities with the teachers once they will go to their school and start spreading the innovation and this approach is believed to lead to the adaptation of resources and standardization in program level.

We found evidences for all the scaffolding practices – teachers requested help in cross-professional community, supported and guided each other in methodological and technological level until they did not need any help from the experts and started to provide scaffold for the teachers outside of the community. Scaffolding practices worked efficiently, because they were systematically planned into the program along the design and implementation activities. Scaffolding practices seemed critical to build an ownership regarding new novel learning design.

Finally, we identified three knowledge appropriation practices for Digimath case and four practices for Robomath case. Awareness regarding the need and the nature of the innovation was created in both groups through dialogue, reflection and co-creation. Also, the shared understanding about the value of such novel approaches for the students was jointly shaped. We identified episodic adaptation practices in Robomath case, but not in the Digimath case. Practices were episodic probably because the programs focused more on building the ownership and adaptation was not encouraged enough.

Both cases also demonstrated episodically validation practices, which was not the requirement of the program. However, it demonstrated for us that some teachers adopted the novel learning design and felt motivated to pilot the new learning design in classroom. Although validation practices were less explicitly done, it demonstrated promising results that teachers are interested in piloting the innovative solutions and reflect the experience. In the future, we are planning to encourage both adaptation and validation practices more by putting more emphasis on the implementation in the teachers' own classroom and reflection of the results. For this, we will more systematically integrate the approach of Teacher Inquiry into Student Learning [15].

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References

1. Fullan, M., Langworthy, M.: A rich seam: How new pedagogies find deep learning. London: Pearson. (2014).
2. Halonen, N., Hietajärvi, L., Lonka, K., Salmela-Aro, K.: Sixth graders' use of technologies in learning, technology attitudes and school well-being. The European J. of Social & Behavioural Sci, 18(1). pp. 2307-2324 (2016).
3. Daniela, L., Visvizi, A., Gutiérrez-Braojos, C., Lytras, M. D.: Sustainable Higher Education and Technology-Enhanced Learning (TEL). Sustainability (2018).
4. HITSA.: ProgeTiiger programmis toetuse saanud haridusasutused 2014-2018. https://www.hitsa.ee/ikt-haridus/progetiiger, last accessed 2019/05/11.
5. Leppik, C., Haaristo, H. S., Mägi, E.: IKT-haridus: digioskuste õpetamine, hoiakud ja võimalused üldhariduskoolis ja lasteaias. Praxis (2017). http://www.praxis.ee/wp-content/uploads/2016/08/IKT-hariduse-uuring_aruanne_mai2017.pdf, last accessed 2019/05/11.
6. Buus, L., Georgsen, M.: A Learning Design Methodology for Developing Short Learning Programmes in Further and Continuing Education. J. of Int. Media in Educ. 8, pp. 1–10 (2018).
7. Alderman, M. K.: Motivation for achievement: Possibilities for teaching and learning (3rd ed.). New Yourk: Routledge (2018).
8. Garreta-Domingo, M., Hernández-Leo, D: Evaluation to support learning design: Lessons learned in a teacher training MOOC. Austr. J. of Educ. Tech. 34(2) (2018).
9. Rodriques-Triana, M. J., Prieto, L. P., Ley, T., De Jong, T., Gillet, D: Tracing Teacher Collaborative Learning and Innovation Adoption: a Case Study in an Inquiry Learning Platform. International Conference on Computer Supported Collaborative Learning. Proceedings (2019).
10. Hernández-Leo, D., Romeo, L., Carralero, M.-A., Chacón, J., Carrió, M., Moreno, P., et al.: LdShake: learning design solutions sharing and co-edition. Comp. Educ. 57, pp. 2249–2260 (2011).
11. Michos, K., Hernández-Leo, D., Albó, L.: Teacher-led inquiry in technology-supported school communities. Brit. J. of Educ. Tech. 49(6) (2018).
12. McKenney, S., Kali, Y., Markauskaite, L., Voogt, J: Teacher design knowledge for technology enhanced learning: an ecological framework for investigating assets and needs. Instr Sci (2015).
13. Twining, P., Raffaghelli, J., Albion, P., Knezek, D.: Moving education into the digital age: the contribution of teachers' professional development. J. of Comput. Assist. Learn. 29, pp. 426-437 (2013).
14. Maier, R., Schmidt, A.: Explaining organizational knowledge creation with a knowledge ma-turing model. Knowledge Management Research & Practice. 2014, pp. 1–20 (2014).
15. Hansen, C. J., Wasson, B.: Teacher Inquiry into Student Learning: The TISL Heart Model and Method for use in Teachers' Professional Development. Nordic Journal of Digital Literacy, volume 11, no 1-2016 p. 24–49 (2016).
16. Conole, G.: Designing for Learning in an Open World. Berlin, Heidelberg: Springer (2012).