# Technology-enhanced Learning Design of a Pre-service Teacher Training Course in a Research-based Learning context

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## Abstract

Research-based learning is an educational approach that aims at enhancing an active student engagement through research activities that are typical of the field. In the case of student teachers, this implies getting involved in educational research and in the development of educational innovation based on research. A valid method for this aim is design-based research, which combines theory and practice through designing different types of educational products. In this work we present a technology-enhanced learning design of a pre-service teacher training course within the frame of research-based learning and, concretely, of design-based research. The course had the focus on the use of technology in the school, as well as on the development of the digital competence, and it was organised around the preparation of an educational proposal in which the use of technology was integrated and based on a research question. As results, we share the vision of the course instructor and the student teachers. Conclusions address the innovative character of the learning design and the educational practice presented and suggest future lines of work.

**Keywords:** initial teacher training, research-based learning, higher education, educational technology, learning design, design-based research.

## Resumen

El aprendizaje basado en la investigación es un enfoque educativo que busca potenciar la implicación activa de los estudiantes a través de actividades investigativas propias de su área. En el caso de los maestros, implica involucrarse en la investigación educativa y en el desarrollo de innovación educativa basada en la investigación. Un método válido para este propósito es la investigación basada en diseño, que busca combinar teoría y práctica a través del diseño de diferentes tipos de productos educativos. En este trabajo se presenta un diseño educativo enriquecido por tecnología para un curso de formación inicial de profesorado en el marco del aprendizaje basado en la investigación y, concretamente, de la investigación basada en diseño. El curso tenía como foco el uso de la tecnología en las aulas escolares, así como el desarrollo de la competencia digital, y estaba organizado alrededor de la preparación de una propuesta educativa en la que se integraba el uso de la tecnología a partir de una pregunta de investigación. Como resultados se comparte la visión de la profesora del curso y de los estudiantes. Las conclusiones abordan el carácter innovador del diseño y de la práctica y apuntan a futuras líneas de trabajo.

**Palabras clave:** formación inicial de profesorado, aprendizaje basado en la investigación, educación superior, tecnología educativa, diseño educativo, investigación basada en diseño.

## 1. Introduction

Research-based learning (RBL) has been considered as a way of approaching professionalism of student teachers in higher education (Saunders, 2017), understood as a set of teaching and learning approaches in which students engage in an active way in research activities, in line with van der Rijst (2017). Benefits from RBL in teacher education programmes are diverse: enhanced integration between theory and practice for more successful classroom practice, trained flexibility and agency competences, and the development of a critical-reflective mindset (Saunders, 2017).

However, there is still some debate around the role of educational research in teacher educational, along with different views of what is understood by educational research (Brew & Saunders, 2020). In this paper, we propose design-based research (DBR) as a possible format to embed RBL in teacher education programmes. DBR is a common method used in educational research that consists of developing, implementing and evaluating different kinds of products or artefacts that seek to address a particular educational situation and to solve a specified problem in that context (Aditomo et al., 2013; de Benito & Salinas, 2016).

Furthermore, as part of the same object and method of the course presented, technology-enhanced learning designs are cornerstone for supporting student teachers in developing digital competences as educators (Redecker & Punie, 2017). However, there is a lack of literature on the use of technology-enhanced learning designs in the context of RBL, despite teaching and learning methods using digital tools have been considered suitable for this approach (Marín & Schirmer, 2018; Schirmer & Marín, 2020).

In this paper we propose a technology-enhanced learning design in an initial teacher training course within a RBL context as an innovative pedagogical proposal and discuss guidelines for practitioners in order to set up their RBL designs with the integration of technology.

## 2. Theoretical framework

The most common targeted learning objectives when planning RBL are acquiring and/or applying topic-specific knowledge and develop professional and research skills, but other goals could be present; for instance, encouraging critical thinking and self-regulated learning skills, or developing collaboration, communication or presentation skills (Aditomo et al., 2013), which are relevant goals for student teachers (Saunders, 2017). Some recent literature has addressed RBL in the context of education programmes.

Wessels, Rueß, Gess, Deicke and Ziegler (2020) state that most of the RBL studies have been focused on STEM, and much less on social studies, and examined the effectiveness of RBL in study programmes within the social disciplines, including education programmes. The results showed a significative increase of students' research knowledge over the course of RBL participation, as well as students' uncertainty tolerance, which is important for dealing with the unpredictability of the research processes and prepares students for their professions. On the other hand, interest and joy in research also increased, although it decreased over the course of RBL participation. This was partially explained by the "instructor's perceived interest in the students' research and the perceived usefulness of the course for their later

career (both rated by the students)", which can be managed by "bringing one's own (teacher) research topics into the classroom" (Wessels et al., 2020, p. 11). Another interesting result of this study for practice is that "the number of research steps performed, and the autonomy students were given during the RBL experience did not have an effect on changes to any of the affective-motivational research dispositions. This indicates that even working on predefined research problems or completing only a limited amount of research steps has a positive effect on students" (Wessels et al., 2020, p. 12).

Brew and Saunders (2020) looked at the views of academics implementing RBL courses in teacher education with the aim to understand how learning autonomy was fostered. The authors found out that teacher educators' pedagogical decision-making in the courses was based on their own research learning experiences. In addition, some over-riding concerns had a relevant influence in teacher educators' decision-making: "1. Balancing freedom and guidance within the research process; 2. Fostering multiple perspectives through open and accepting classroom integration, 3. Integrating opportunities for reflection and multi-faceted feedback, and 4. Utilising their own research experiences to deepen pre-service teachers' understandings of research" (Brew & Saunders, 2020, p. 7).

As previously mentioned, DBR is one of the educational research approaches commonly used for fostering educational innovation through the development of educational products. These artefacts may consist, e.g. of educational materials, online courses, lesson plans or pedagogical strategies (de Benito & Salinas, 2016). This way, DBR combines empirical educational research with theory-driven design of learning environments and scenarios (The Design-Based Research Collective, 2003), being considered a meta-methodology. In other words, DBR may integrate different design process phases in an iterative way that recursively nest other research processes (Easterday et al., 2018). DBR is mostly used within the educational technology field – which is also the approach of the course presented in this paper –, among educational studies (Amiel & Reeves, 2008; de Benito & Salinas, 2016; Reeves, 2006). Considering the process described by Reeves (2006), DBR includes the following phases (see Figure 1):

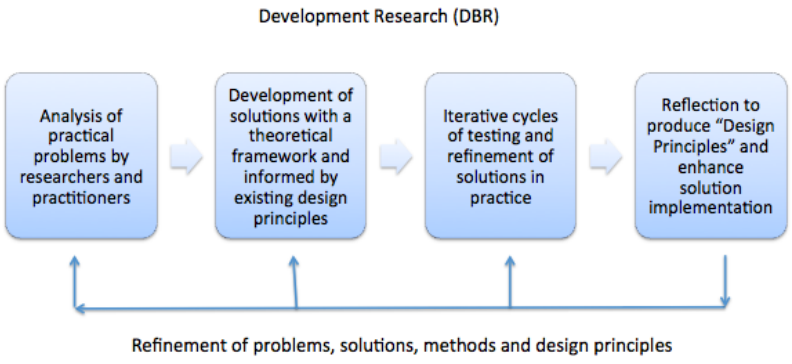


Figure 1. DBR phases

When considering the integration of digital tools in a RBL context, the suitability in terms of supporting key competences in research, such as individual and group self-directed learning, information competence, the competence for solving problems, the ability for self-organisation and social learning, within pedagogical contexts based on constructivism, situated learning and connectivism needs to be acknowledged (Marín & Schirmer, 2018; Schirmer & Marín, 2020). In the context of educational studies, the autor also studied how group RBL processes could be supported by e-Portfolios based on blogs, being documentation, reflection and collaboration as relevant enhanced group RBL processes. Digital tools considered suitable for the first two phases of the DBR (Marín, 2019) were especially considered in the practice described in this paper.

On the other hand, the development of digital competence as educators by student teachers is an important aim behind the use of digital tools in this RBL course design, both as part of its object and its method. According to the EU framework for the digital competence of educators (Redecker & Punie, 2017, p. 8), "educators need a set of digital competences specific to their profession in order to be able to seize the potential of digital technologies for enhancing and innovating education". Among these digital competences, there are three areas: educators' professional competences, educators' pedagogic competences and learners' competences; being the emphasis in the course design presented here - according to the module in which the course is included - on the educators' pedagogic competences. Four areas are part of these latter competences: digital resources, teaching and learning, assessment and empowering learners; putting a special focus in this course design on the first two areas.

Based on the Synthesize Qualitative Data (SQL) model proposal by Tondeur et al. (2012), 7 key themes impact on pre-service teachers' integration of technology into their future classrooms. As far as possible, those themes were integrated into the course design: aligning theory and practice, using teacher educators as role models, reflecting on attitudes about the role of technology in education, learning technology by design, collaborating with peers, scaffolding authentic technology experiences, and moving from traditional assessment to continuous feedback. Therefore, following an active student-centred approach based on the RBL perspective, learning activities in the course design that aim at developing competences in the areas of digital resources and teaching and learning must necessarily combine investigation, practice and production of digital artefacts, but also collaboration and discussion (Conole, 2007; Laurillard, 2012). Teacher educators' modelling technology-enhanced teaching and learning strategies, focus on authentic learning as learning task located in the context of future use – being the keyword "learning design" (Lewin et al., 2018) and the promotion of the role of "teachers as designers" (McKenney et al., 2015; Shamir-Inbal & Kali, 2009) – , and learning by doing as student-active learning approach are relevant pedagogical frameworks for the presented practice (Røkenes & Krumsvik, 2014).

## 3. Method

### 3.1 Basic description of the course

The pre-service teacher training course where the pedagogical design was applied was a face-to-face seminar within the compulsory pedagogical module of the undergraduate programs. Although student teachers can attend the module in a different study year, most of them do it in the ir first year[a]. Within the module, student teachers should attend a lecture and a seminar of their choice, and then deliver the task or examination of the module in the seminar (hereafter, course). The course lasted 14 weeks and took place during the winter semester 2019/2020 at a German university. Although 19 students were officially enrolled to the course, only 10 undergraduate student teachers (6 female and 4 male) following different teacher training itineraries (primary / secondary / vocational school) and various subjects (e.g. English, German, Art, Philosophy, Biology, Mathematics) were active participants. Most of the participants did not have previous experience with the use of technology in the classroom as students at the university.

The focus of the course was on the international view of the concept of digital competence and the educational use of technologies in schools. Therefore, the European Digital Competence frameworks

[a] In Germany, initial teacher training is structured in different pedagogical modules that are to be attended in parallel with two undergraduate studies (two different disciplines / subjects), followed by a Master of Education.

(Redecker & Punie, 2017; Vuorikari et al., 2016) were as much part of the content of the course as the practice in terms of developing digital skills.

The main learning objectives of the course included:

- Identify international relevant research on the topic of digital competence and educational use of technologies in the schools.

- Design and produce an innovative learning scenario for the development of the digital competence of children and young people.

The main element of the course assessment was the design of a technology-enhanced educational proposal aimed at developing school students' digital competence considering one or more of their subjects. Student teachers could choose among different digitally enhanced pedagogical approaches to design their educational proposal (e.g. gamification, flipped learning) (Lai, 2018). A partial DBR process was used (Reeves, 2006), in order to prepare the phases of analysis – identifying the context and working on the literature review – and design – plan their proposal, considering learning activities, strategies, times, groups and resources.

### 3.2 Pedagogical characterisation of the course

To evaluate the degree of learning autonomy and freedom that was given by the RBL course, we considered the model for RBL decision-making (Brew, 2013) to make different pedagogical decisions concerning the educational proposal that student teachers had to prepare within the course. The first one was related to the learning outcome (a design of a technology-enhanced educational proposal aimed at developing school student' digital competence), which was already set but the way to achieved was open (lesson plan, teaching and learning strategies, resources, etc.). On the other hand, students could decide the field of knowledge (different possible subjects), topic (digitally enhanced pedagogical approach), audience (within school educational levels) and output (in terms of digital materials and learning activities) for their proposal and negotiate them with the course instructor.

The learning design of the course considered the digital student learning activities and the resources provided by the teacher to support the performance of the activities, according to the two phases of the design-based research that were embed in the course (analysis and development) and the general process (see Table 1). According to the DBR phases, in this learning design "analysis" would correspond to the first learning objective of the course, and "development" to the second one.

*Table 1: Technology-enhanced Course design.*

| | **Learning objectives of the course** | **Student activities (understood as tasks)** | **Teacher resources** |
|---|---|---|---|
| **Analysis** | Identify international relevant research on the topic of digital competence and educational use of technologies in the schools. | • a) Summarise the EU statistics on digital use of students, teachers and schools in Europe based on the most relevant indicators of different aspects (e.g. students' digital activities and confidence in their digital competence), and b) prepare an infographic to compare the data between two countries based on selected indicators.<br>• a) Find articles or other kind of documentation that explain educational experiences with digital media in schools and b) describe their educational settings and of what the experiences consisted in the course blog.<br>• a) Conduct a literature search on digital competence in schools in using the library databases and the literature recommendations of the course. b) Prepare a concept map to represent the literature review of the proposal. c) Conduct a peer review on the structure of another student's concept map following a rubric (VLE task). | Literature recommendations in the institutional virtual learning environment (VLE).<br><br>Link collection to educational experiences with digital media in schools. |
| **Development** | Design and produce an innovative learning scenario for the development of the digital competence of children and young people. | • Identify learning objectives and activities for a subject matter for each of the levels of the Bloom's taxonomy in an online pinboard, and comment the ones shared by other students.<br>• Use a learning design tool to create an educational scenario, including phases of the activity, resources, tools, support, etc.<br>• a) Try at least two diferent,unfamiliar Web 2.0 tools and Apps and that may be suitable for the chosen digitally enhanced pedagogical approach. b) Analyse their educational uses, advantages and disadvantages for school settings in the course blog.<br>• a) In groups, try out one of the tools introduced to create simple digital educational materials (H5P, Learningapps and Tutory). b) Discuss with the group the advantages and disadvantages of the tool and collect them in the brainstorming tool.<br>• a) Search for open educational resources (OER) in the OER repositories. b) Save potentially interesting OER for the proposal with the social bookmarking tool. | Examples created with learning design tools: provision of structure for the learning design of the proposal.<br><br>Link collection to OER repositories and Web 2.0 tools. |

In the phase of Analysis, student teachers had to identify the context for their educational proposal (school level and subject), as well as their theoretical framework. This latter was based on general information relating schools and technology (statistics of use) and on more concrete information connected to the digitally enhanced pedagogical approach that they had chosen (educational experiences and literature review). Therefore, three technology-enhanced learning activities were carried out in this phase, which aimed at students' understanding of the general state of art in the field of

educational technology and digital competence in schools, and at students' development of the literature review for their educational proposal. Some tools were used both as a teacher resource and as a tool for student learning activities (e.g. the course blog).

The phase of development consisted of preparing the educational scenario of the proposal, based on the previous analysis. Therefore, student teachers had to think about the learning objectives for their proposal and its specific educational settings. In addition, they needed to create their digital educational materials and find OER to reuse for their proposal. For the learning activity consisting of preparing their educational design, examples for modelling student teachers' activity were provided for two digital learning design tools: LDTool[b] and EdCrumble[c] . The teacher resources corresponding to examples of learning designs with those tools refer to two student learning activities listed in Table 1: the LDTool example relates to activity number 1 for Development (see Figure 2), and the EdCrumble example corresponds to activity number 3 for Analysis (see Appendix).

It is worth noting that the learning activities listed in Table 1 put special emphasis on students' investigation, practice and production and, to lesser extent, to collaboration and discussion (Conole, 2007; Laurillard, 2012)[d].

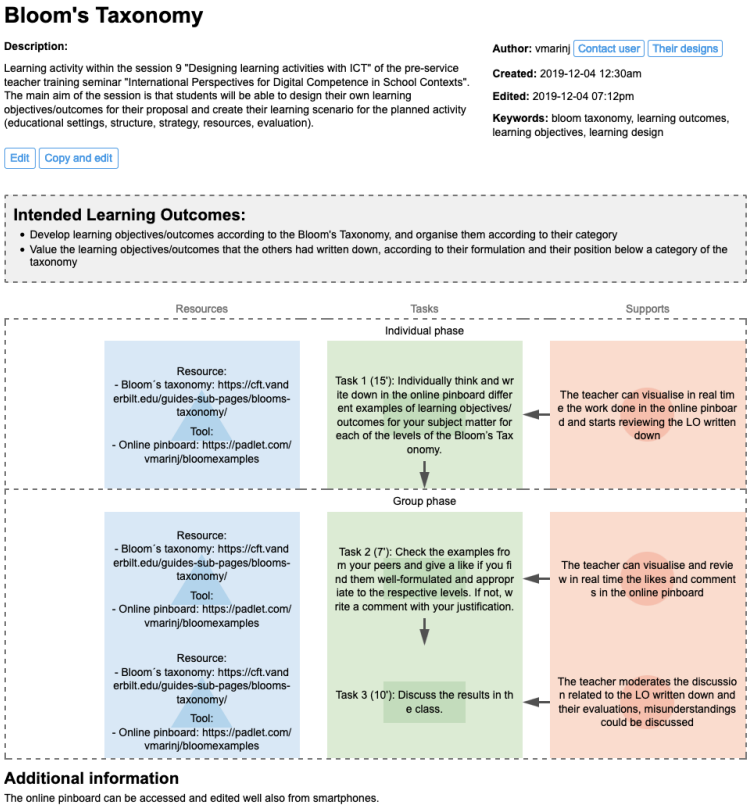


Figure 2. Activity on learning objectives.

On the other hand, three digital tools were used as teacher resources along the complete course. The main one, where all the other resources were integrated, was the course blog. This resource served both as a teacher resource and student tool, since it offered the basic information about the course and its

[b] https://needle.uow.edu.au/ldt/
[c] https://ilde2.upf.edu/edcrumble/
[d] In this course design only the learning activities connected to the use of digital tools are presented. However, other activities that included a stronger focus on discussion and collaboration, as well as on acquisition, were also present to a lesser extent without digital elements.

methodology, and it was also the platform to keep track of the learning activities and to encourage student interaction around their products (peer commenting and feedback). The second one was the concept map of the course, which offered a general overview of the topics addressed in the course, as well as the tools that were going to be used (see Figure 3). In addition, this resource was used in a presentation format at the beginning of each session, showing only the new concepts to address in each class and their connection to concepts from prior sessions. The rest of the map was not visible to the students in the presentation format, but they could see the whole map anytime in the course blog. The last overarching resource was a collection of links that provided useful Internet resources for the learning activities, in particular for identifying empirical practices of the use of technology in schools, finding suitable digital tools to create digital educational materials and searching for OER for the proposal (e.g. see Figure 4).

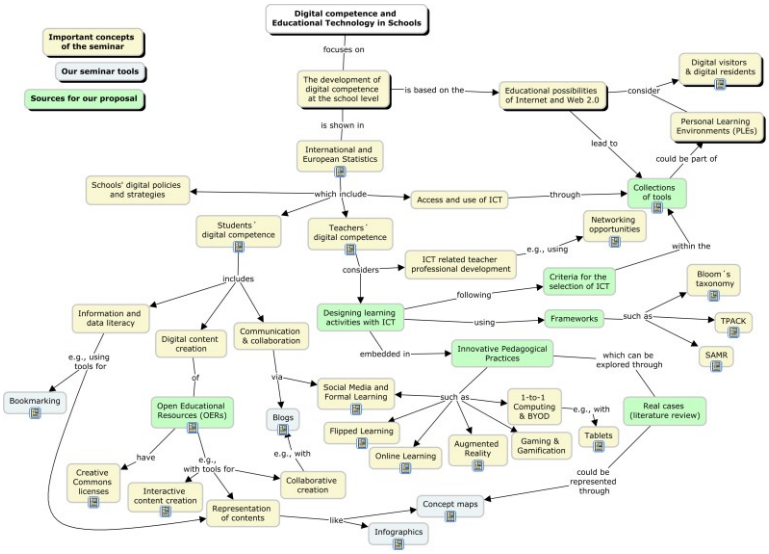


Figure 3. Concept map of the course. Available online at: https://cmapscloud.ihmc.us/viewer/cmap/1V2PNRCP6-1RFMPR2-Q6

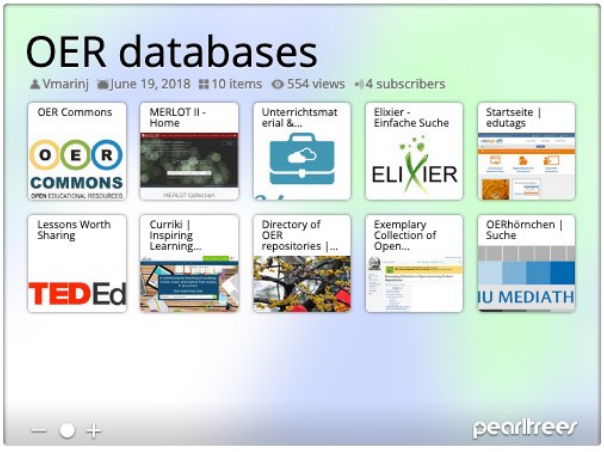


Figure 4. Part of the collection of weblinks (links to OER databases). Available online at: https://www.pearltrees.com/vmarinj/oer-databases/id16604410

Finally, we would like to point out that the educational proposal should be developed in a web format, using the institutional blog system (WordPress), in which the course blog was based on too. Since no student in the course had prior experience using WordPress, an introduction to the tool was provided at the beginning of the course, and regular tasks were carried out in the course blog. Additionally,

students were encouraged to join the institutional online tutorial for students within the VLE, which consists of as self-study learning materials with content and quizzes to do anytime. During the course, students received further suggestions on how to structure their educational proposal in WordPress.

## 4. Results

The results presented in this paper refer to the subjective perceptions of the teacher in charge of the course (also author of this paper), and the students participating in the course in the form of the final official evaluation of the course and informal feedback on the course during the last session.

For the teacher, this course involved an improved designed iteration of the same course from the previous academic year, considering the former student feedback. From this perspective, the course design served well the purposes for what it was planned and covered previous demands. On the other hand, and from a personal perspective, the use of different digital tools to support the RBL processes involved in the course seemed to fit the specific learning activities and brought coherence to the whole preparation of the educational proposal within the frame of RBL. However, some tools were more successful than others in terms of supporting the demands of the learning activities, the student teachers' skills and time planned for the tasks in class. For instance, although the learning design tools were helpful to visualise the learning designs of the proposal, the time in class for the activity was not enough for students to start with it and address it properly. In the case of the activity of the literature review with concept maps, some technical issues were experienced, but structuring the activity in several steps and being flexible with the deadlines were factors of success to ensure that most of the students took part in this formative assessment activity. The importance to adapt the students' learning activities to times, in accordance with student skills as well, is an aspect that is to be taken into higher consideration.

Although not all students answered the course evaluation (6 out of 10 participants did), student teachers' satisfaction with the course was high (1.3 in a scale from 1 ☺ to 4 ☹), and formal and informal feedback was overall very positive, however it cannot be always attributed to the combination of digital tools for the RBL context, instead the conception of the course as a whole needs to be considered. For instance, something that was considered very positive was not connected to the use of digital tools - the invited face-to-face talks by two people from different countries (to listen to first-hand experiences). Nevertheless, the course format was highly appraised in terms of including plenty of hands-on practice – although not specifically for RBL. Additionally, some students were in favour of starting with the practice and later discuss the theory and possibilities in the school at sometimes. Most of the students agreed on the usefulness of having learned many digital tools that could be handy beyond the course and in the school classroom. Examples mentioned were the blog, the online databases, tools for creating digital activities and the concept maps. Something to improve that was pointed out by a student was the inclusion of more dialogue and debate activities. The teacher's thought is that these should be embedded in the RBL context, by encouraging more peer feedback during the learning activities in class and outside the class and incorporating more invited (face-to-face and digital) talks that include conversation with the guests.

On the other hand, this second iteration of the course design has provided the teacher with more elements to work on a third iteration that will be considered in the next academic year, based on student teachers' feedback.

## 5. Conclusions

In this paper we presented a higher education innovative practice in the context of initial teacher training that aims both at developing research skills as educational practitioners and digital competences as future educators. Therefore, the course design is framed within a RBL setting based on a partial DBR approach, supported by digital tools and resources. Apart of this innovative approach, this practice adds a layer of reflection at the level of course design beyond course results in terms of student grades, and provides valuable insights to the RBL practice with the support of digital tools.

Nevertheless, RBL is just one of the possible active teaching and learning approaches that could be supported by digital tools, and others such as project-based learning or problem-based learning have been already researched in the literature (Kokotsaki et al., 2016; Koroneou et al., 2013). Facilitating factors in our case include some that are mentioned in the literature concerning active learning approaches; for instance, providing guidance and support to students and scaffold their learning and well-aligned assessment (Kokotsaki et al., 2016; Marín, 2020). Other challenges are also addressed in this specific case, such as bringing educational research to future educators in a hands-on practice way and using learning design as a key element in the course design.

Apart from recognising the strength of the course design, we should also acknowledge its limitations. One of the most relevant ones is the small number of students participating in the course. Higher number of participants may involve the need to adapt this course design to make it easier to handle. Therefore, future work could also consider this scenario. On the other hand, the course in this case was itself on educational technology and digital competences in schools; hence, it would make sense to explore the use and effectiveness of these educational settings in other initial teacher training courses where the educational use of technology in schools is not the object of the course. Finally, despite in this case was not possible, future work could also explore the whole DBR process with the support of digital tools.

## References

Aditomo, A., Goodyear, P., Bliuc, A. M., & Ellis, R. A. (2013). Inquiry-based learning in higher education: Principal forms, educational objectives, and disciplinary variations. *Studies in Higher Education,* 38(9), 1239–1258. https://doi.org/10.1080/03075079.2011.616584.

Amiel, T., & Reeves, T. C. (2008). Design-Based Research and Educational Technology: Rethinking Technology and the Research Agenda. *Educational Technology & Society*, 11(4), 29–40.

de Benito, B., & Salinas, J. (2016). La Investigación Basada en Diseño en Tecnología Educativa. *Revista Interuniversitaria de Investigación En Tecnología Educativa*, (0), 44–59. https://doi.org/10.6018/riite2016/260631

Brew, A. (2013). Understanding the scope of undergraduate research: A framework for curricular and pedagogical decision-making. *Higher Education*, 66(5), 603–618. https://doi.org/10.1007/s10734-013-9624-x.

Brew, A., & Saunders, C. (2020). Making sense of research-based learning in teacher education. *Teaching and Teacher Education*, 87, 102935. https://doi.org/10.1016/j.tate.2019.102935.

Conole, G. (2007). Describing learning activities: Tools and resources to guide practice. In H. Beetham & R. Sharpe (Eds.), *Rethinking Pedagogy for a Digital Age: Designing and Delivering E-Learning* (pp. 81–91). London: RoutledgeFalmer.

Easterday, M. W., Rees Lewis, D. G., & Gerber, E. M. (2018). The logic of design research. *Learning: Research and Practice*, 4(2), 131–160. https://doi.org/10.1080/23735082.2017.1286367.

Kokotsaki, D., Menzies, V., & Wiggins, A. (2016). Project-based learning: A review of the literature. *Improving Schools*, 19(3), 267–277. https://doi.org/10.1177/1365480216659733.

Koroneou, L., Paraskeva, F., & Alexiou, A. (2013). Designing a Framework Based on Problem-Based Learning for CSCL Environments in Order to Enhance 21st Century Skills. *International Journal of Information and Education Technology*, 3(2), 135–138. https://doi.org/10.7763/IJIET.2013.V3.250.

Lai, K. W. (2018). The Learner and the Learning Process: Research and Practice in Technology-Enhanced Learning. In J. Voogt, G. Knezek, R. Christensen, & K.-W. Lai (Eds.), *Second Handbook of Information Technology in Primary and Secondary Education* (pp. 127–142). Springer, Cham. https://doi.org/10.1007/978-3-319-71054-9_8.

Laurillard, D. (2012). Teaching as a Design Science: *Building Pedagogical Patterns for Learning and Technology*. New York and London: Routledge.

Lewin, C., Cranmer, S., & McNicol, S. (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.

Marín, V. I. (2020). Research-based learning in education studies: Design inquiry using group e-Portfolios based on blogs. *Australasian Journal of Educational Technology*, 36(1), 1–20. https://doi.org/10.14742/ajet.4523.

Marín, V. I. (2019). Research-based Learning enhanced by Technology in Higher Education: a Comparative Analysis of Tools. In E. Vaquero, E. Brescó, J. Coidures, & F. X. Carrera (Eds.), *EDUcación con TECnología: un compromiso social. Iniciativas y resultados de investigaciones y experiencias de innovación educativa* (Edicions d, pp. 459–471). Lleida; Palma de Mallorca. https://doi.org/10.21001/edutec.2019.

Marín, V. I., & Schirmer, C. (2018). Design of a teacher-training workshop to support research-based learning processes with digital media. In N. Neuber, W. Paravicini, & M. Stein (Eds.), *Forschendes Lernen. The Wider View. Eine Tagung des Zentrums für Lehrerbildung der Westfälischen Wilhelms-Universität Münster vom 25. bis 27.09.2017. Schriften zur Allgemeinen Hochschuldidaktik. Band 3.* Münster: WTM-Verlag 2018.

McKenney, S., Kali, Y., Markauskaite, L., & Voogt, J. (2015). Teacher design knowledge for technology enhanced learning: an ecological framework for investigating assets and needs. *Instructional Science*, (43), 181–202. https://doi.org/10.1007/s11251-014-9337-2.

Redecker, C., & Punie, Y. (2017). *European Framework for the Digital Competence of Educators: DigCompEdu. Joint Research Centre (JRC) Science for Policy report.* https://doi.org/10.2760/159770.

Reeves, T. C. (2006). Design research from the technology perspective. In J. van den Akker, K. Gravemeijer, S. McKenney, & N. Nieveen (Eds.), *Educational design research* (pp. 86–109). London: Routledge.

Røkenes, F. M., & Krumsvik, R. J. (2014). Development of Student Teachers' Digital Competence in Teacher Education - A Literature *Review. Nordic Journal Of Digital Literacy*, 9(4).

Saunders, C. (2017). *Research Based Learning in Teacher Education at Humboldt-Universität zu Berlin* (Working Paper No. 1). Deutsche Gesellschaft für Hochschuldidaktik (dghd) and Universität Oldenburg. Retrieved from https://bit.ly/3nrYupA

Schirmer, C., & Marín, V. I. (2020). Die Gestaltung Forschenden Lernens mit digitalen Medien. In C. Wulf, S. Haberstroh, & M. Petersen (Eds.), *Forschendes Lernen: Theorie, Empirie, Praxis* (pp. 283–291). Wiesbaden: Springer Fachmedien Wiesbaden. https://doi.org/10.1007/978-3-658-31489-7_24

Shamir-Inbal, T., & Kali, Y. (2009). Teachers as designers of online activities: The role of socio-constructivist pedagogies in sustaining implementation. *Design Principles & Practices: An International Journal*, 3(1), 89–100.

The Design-Based Research Collective. (2003). Design-Based Research: An Emerging Paradigm for Educational Inquiry. *Educational Researcher*, 32(1), 5–8. https://doi.org/10.3102/0013189X032001005.

Tondeur, J., Van Braak, J., Sang, G., Voogt, J., Fisser, P., & Ottenbreit-Leftwich, A. (2012). Preparing pre-service teachers to integrate technology in education: A synthesis of qualitative evidence. *Computers and Education*, 59(1), 134–144. https://doi.org/10.1016/j.compedu.2011.10.009.

van der Rijst, R. (2017). The Transformative Nature of Research-Based Education: A Thematic Overview of the Literature. In E. Bastiaens, J. van Tilburg, & J. van Merriënboer (Eds.), *Research-Based Learning: Case Studies from Maastricht University* (pp. 3–22). Cham: Springer. https://doi.org/10.1007/978-3-319-50993-8_1.

Vuorikari, R., Punie, Y., Carretero, S., & Van Den Brande, L. (2016). DigComp 2.0: *The Digital Competence Framework for Citizens. Update Phase 1: The Conceptual Reference Model. EU Commission JRC Technical Reports.* Seville, Spain. https://doi.org/10.2791/11517.

Wessels, I., Rueß, J., Gess, C., Deicke, W., & Ziegler, M. (2020). Is research-based learning effective? Evidence from a pre-post analysis in the social sciences. *Studies in Higher* Education, 0(0), 1–15. https://doi.org/10.1080/03075079.2020.1739014.

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# Appendix

Activity of literature review with concept maps in EdCrumble.

## Literature review with concept maps

**Topic:** Education
**Educational level:** Bachelor or equivalent
**Start date:** November 29, 2019
**End date:** December 20, 2019
**Number of students:** 12

### Design description

This learning activity is focused on the literature review for the educational proposal of the pre-service teacher training seminar "International Perspectives for Digital Competence in School Contexts" and it is formed by the Sessions 6-8.

### Learning Objectives

1. Identify meaningful theoretical and empirical scientific literature for the educational proposal
2. Distinguish the most relevant concepts, relationships and results of the chosen literature
3. Develop a visual representation in the form of a concept map to represent the literature of the proposal
4. Appraise others' concept maps according to basic criteria (understanding and structure)

### Evaluation

Summative assessment: Quality of the concept map in terms of reflecting the most important concepts, relationships and results of the literature for the proposal (part of the final assessment)
Formative assessment: Evaluation of others' concept maps in terms of understanding and structure.

**Literature review with concept maps** — 90.45676666666667min

**Start date:** Friday, December 6, 2019 10:15 AM
**End date:** Friday, December 6, 2019 11:45 AM
**Learning Objectives:** 2,3,

15min 2

Remembering previous' session and activity: What did we do last time? Brief round for sharing results of the previous activity (literature review).
**Resources:**

20min 3

Teacher's explanation on concept maps (definition, structure, construction).
**Resources:**
**3,2,**

40min 7

Create a first version of the concept map to represent the literature review of the proposal. Teacher guides in the construction of the concept map in an individualised basis.
**Resources:**
**3,4,**

15min 5

Sum up of the session, revision of the first versions of concept maps.
**Resources:**

**Literature review with concept maps and peer review** — 20040min

**Start date:** Friday, December 6, 2019 12:00 PM
**End date:** Friday, December 20, 2019 10:00 AM
**Learning Objectives:** 3,4,

60min 7

Create an improved version of the concept map to represent the literature review of the proposal.
**Resources:**
**4,3,**

5min 6 x2

Upload the concept map (exported as web page) and resources added as a zip file to Stud.IP (Peer Review Activity) for a first review from another student. Teacher organises the pairings of the assignments for the peer review.
**Resources:**
**5,**

25min 1

Evaluate the structure of another student's concept map following a simple rubric (poor, ok, good) with different criteria in Stud.IP (Peer Review Activity). Include some brief constructive feedback in the last item (General feedback).
**Resources:**
**5,**