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Digital technologies integration in teacher education: the active teacher training model

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Abstract

The objective of this research was to identify the theoretical and practical bases that contribute to a model that will allow the implementation of an innovative teaching-learning model for the integration of digital technologies in teacher education. This model of teacher training, based on identified pedagogical trends, was characterised by a flexible approach to the training process, including active training strategies that encourage the acquisition of diversified skills, including digital. This approach can also transfer to students skills which enable them to take responsibility for their learning and creation of their own knowledge. The research method used was two-fold: i) action research in the development of training workshops in an in-service research training project and ii) a case study in a pre-service teacher education study, in Portugal. It was found in this study that the participating teachers were able to develop skills and integrate digital technologies in their own teaching-learning process and could change their teaching practices, which will support the development of online education in the future.

KEYWORDS: Digital Technologies Integration; Active Teacher Training; Training Model; Teacher Education.

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1. Introduction

Digital technologies have revolutionized practically every aspect of our lives and work, "we live in an exponential time" (Mishra, Koehler & Henriksen, 2011, p. 23), and it is fundamental in this complex digital landscape to face the challenges posed, especially those responsible for education, in order to enable students to participate fully in the economic, social and cultural life (OECD, 2015).

With recent changes in the world, this issue takes on greater relevance, because it is necessary to continue to invest in the teacher education in training for distance learning as an appropriate innovation (COL, 2020).

There is still a long way to go for a more complete integration of Digital Technologies (DTs) in schools and teaching, according to Area, Hernández, & Sosa (2016). They have identified two patterns of pedagogical use of DTs in classes: a weak model, in which DTs are being used simply to transfer knowledge; and an intensive model in which DTs are used every day or several times a week in a variety of individual and group tasks, with research and development of digital resources, content creation and online communication, by teachers and students.

Accepting that "technology can amplify great teaching but great technology cannot replace poor teaching" (OECD, 2015, p.4), it is clear that the adaptation and integration of DTs in the classroom of contemporary society's schools requires the adoption of new roles and forms of work by the teacher. It also requires reflection and analysis of the effects of this new relationship, with the training of teachers as a key factor in the process. See, for example Goeman, Elen, & Pynoo (2015) or

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Johnson, Becker, Estrada, Freeman, Kampylis, Vuorikari, & Punie (2014).

The research described here aimed to contribute to this new kind of work with a proposal for the design of a training model and definition of a specific strategies, named Active Training (AT).

For this purpose, in addition to a literature review, two pieces of empirical work were conducted:

- an in-service research training project, in a given educational community;
- a case study in a pre-service teacher education class of the Masters in Economics and Accounting Education.

Both studies, conducted in Portugal, focused on the construction and development of teachers' skills, especially thinking reflectively, acting autonomously and integration of digital technologies, and active methods and teaching strategies that integrate digital technologies.

2. The integration of digital technologies in the teaching-learning process

2.1 The need for change in the new technological paradigm

The educational use of ICT has imposed fundamental challenges to education researchers and training institutions, which require changes "in both what has to be learned and how this learning is to happen" (Voogt, Erstad, Dede, & Mishra, 2013, p.403).

There is a need to promote transformative learning by emphasizing the roles that transdisciplinary thinking and the latest technologies can play in the creation of 21st century transformative teaching and learning (Mishra et al., 2011).

While not minimizing the importance of the proliferation of computer equipment, "spreading the Internet or putting more computers in schools, by themselves, do not necessarily constitute major social changes" (Castells, 2006, p.19). Integration will depend on how technologies are used. This author considers that one of the key aspects of the network society will be the total reconversion of the education system, with new ways of relating technology, pedagogy, content and organization of the learning process.

Thus, the scope of change clearly requires a new form of learning, amenable to the changing world, allowing the development of diverse skills with an emphasis on higher order cognitive processes, such as critical thinking and creative problem solving (Mishra et al., 2011). These authors also suggest that students engage in technology-rich learning contexts where they work collaboratively to solve complex and multidisciplinary problems.

Although some progress has been made in this direction, the integration of digital technologies is below what is desirable at the present time (Area et al., 2016; Glass & Vrasidas, 2005; Goeman et al., 2015; Mishra et al., 2011; Morris, 2012; OECD, 2015; Voogt et al., 2013).

Voogt et al. (2013) confirm "a lack of integration of 21st century competencies in curriculum and assessment, insufficient preparation of teachers and the absence of any systematic attention for strategies, innovative teaching and learning practices."

Goeman et al. (2015) add that training in the DTs field should promote teachers' thinking reflectively so that they acquire the skills to face the future evolutions of technology in education teaching models. For example, using innovative methods that incorporate collaborative work or project work, related to more active and directed pedagogical approaches to situations and real problems of society.

2.2 Difficulties and challenges of integrating digital technologies

Brown-L'Bahy (2005) argues that there is evidence that technology can improve students' learning and development, but considers that there are also difficulties in its integration. The main problems encountered in integrating DTs were time constraints, inadequate training and the need for rigorous assessment methods. These give compelling reasons for schools to commit to this issue.

In a study on the progress of ICT in education (BECTA, 2005), these problems were jointly identified as obstacles to ICT adoption. In addition to lack of time to learn new technologies, also mentioned were lack of access to computers and technical support, lack of confidence, resistance to change and lack of perceived benefits in their use. With regard to Continuing Professional Development in ICT (BECTA, 2010), external factors with the greatest impact are: the provision of external training actions to meet individual and institutional needs; the need for experienced human resources within institutions; a robust ICT infrastructure and support; and the provision of appropriate training actions in duration and time.

However, according to Morris (2012, p.3), "despite successive government training initiatives, policies and extensive funding over the last 15 years, little has been done to effectively tackle the disparity of ICT skills and the training of the UK teaching workforce".

Based on several studies, Rodrigues (2018) also identified some of the most common difficulties and constraints in the integration of DTs and consequently highlighted as challenges:

- lack of time for teachers to train and use DTs,
- the lack of technological resources for the use of digital technologies with students,
- the need for adequate support and training for the pedagogical integration of DTs in the teaching-learning process,

- the definition of clear objectives and the solid structure of the model of training and evaluation with DTs,
- the overcoming of intrinsic factors, namely those of resistance to change,
- the teacher's low vision of the pedagogical potential of DTs,
- the importance of the role of leadership in the teacher education process (p.369).

Therefore, given the factors that influence the pedagogical integration of DTs, teacher training and the necessary associated strategies and methods must be emphasized.

2.3 Teacher training for the integration of digital technologies

In this context, in order to ensure the integration of digital technologies in schools, teachers need to be trained and supported, so that they feel able to integrate them, both from a perspective of active citizenship and as a prospect of professional development, either in pre-service or in-service training.

In addition, it is intended that the training model used with teachers be used by those teachers with their students. This transfer of skills is called isomorphism (Mialaret, 1990).

Vrasidas and Glass (2005) also claim that efforts to integrate technology must be systematic, with teacher training programs taking place in a collaborative environment resulting from strong research and evaluation. Teacher training models should not be based on one-on-one sessions, but rather on communities that provide ongoing support and the resources that teachers need to integrate DTs.

When teachers with experience in teaching with technology form a community of practice, they provide support for the continuous exploration of technology and the reinforcement of the learning process. However, schools need to analyse their structure, where teachers often work in isolation and react defensively to innovation. It is necessary to develop strong professional communities that promote the habit of research and leadership building to help sustain the impacts of change, because in a community it is easier to integrate educational technology in an ongoing process of learning to teach (Riel, DeWindt, Chase, & Askegreen, 2005).

Thus, it is necessary to learn how to increase participation in communities of practice, focusing on learning in a continuous set of developing relationships (Lave & Wenger, 1991). According to these authors, this concept is broader than learning by doing, since situated learning involves people as full participants in the world and in the construction of meanings, where there is an identity in relation to the group and interaction taking the learning as a social act.

Koehler and Mishra (2009) have designed the TPACK model, in teacher training and professional development. They found it served as the basis of effective teaching with technology integration, resulting from the intersection of three different types of learning contexts:

- curriculum content – Content Knowledge (CK),
- pedagogical methods – Pedagogical Knowledge (PK) and
- technological skills – Technological Knowledge (TK).

They affirm that this model allows one to visualize the process of integration of technology as a whole and to identify what is important in terms of teachers' knowledge in the use of technology for teaching (Mishra & Koehler, 2006).

Active teacher training for the integration of digital technologies

It is clear that change is necessary, that schools need to reflect society and that there is a need to integrate digital technologies into educational practices. In this context an alternative and innovative model of teacher training, named Active Training (AT), was designed (Rodrigues, 2017). The model is based on five structuring principles shown in Table 1.

3.1 Principles of active training

Active Training is used as a cross-curricular method of training (Principle 1). It can be used by students and teachers as a basic skill whenever necessary and considered appropriate to the objectives and syllabus content of any discipline.

The importance of cross-curricular training is reinforced by, and directly related to, the forms of collaborative work adopted. These will have an added value because they allow the sharing of enriching experiences among teachers of different curricular areas and levels of education. At the same time, it strengthens curricular flexibility with a cross-curricular teaching-learning process which bridges theory and practice.

AT is supported by a socio-constructivist approach, derived from Jean Piaget's cognitive constructivism and his main precursor Lev Vygotsky, who valued the social aspect of learning, arguing that it occurs through social interaction with teachers and peers (Arends, 2012). Thus, through social interaction and in response to environmental stimuli, students are pushed towards the zone of proximal development, a zone that represents the level of development where learning of new knowledge occurs (Vygotsky, 2001).

It is proposed that AT should include a face-to-face component and an autonomous work component, to be developed in an authentic social context. This makes it possible for the trainees to learn by doing, in the social context of knowledge production itself, that is, at school, among co-workers.

Structuring Principles of AT	Concepts mobilized
Principle 1 Cross-curricular training with integration into teaching of digital technologies in an authentic social context that supports human development.	Transdisciplinary Socio-constructivism Authentic social context On-the-job training
Principle 2 Training tailored to the needs and interests of trainees, differentiated and focused on skills, with flexible planning and content management.	Needs Analysis Differentiated education Skills Flexible curriculum management
Principle 3 Training based on a democratic and affective pedagogical relationship, with the trainer as a guide, for the critical and isomorphic reproduction of skills for students.	Democratic pedagogical relationship Affectivity Adult Education Isomorphism
Principle 4 Dynamic theoretical-practical training, supported by collaborative and cooperative work in a learning community, using active teaching methods and strategies in synergy with digital technologies.	Collaborative and cooperative work Active methods Project work Group research or peer work Flipped classroom
Principle 5 Training for construction and development of skills of thinking reflectively, acting autonomously, network communication, participatory evaluation and self-regulation, to create a community of practice that allows the social construction of self-knowledge.	Thinking reflectively Acting autonomously Connectivism Evaluation and Self-regulation Community of practice

Table 1 - Structuring Principles of Active Teacher Training
Source: Rodrigues (2017, p. 62)

Training tailored to learners' needs requires differentiated teaching, whether due to the differences in the cognitive stages, knowledge and skills of the trainees, or their different learning styles and preferences. This can be brought about through planning and flexible content management and cooperative learning. A widely used practice is flexible group work, in which each group of students works on different content (Arends, 2012).

Principle 2 argues that training should be tailored to the needs and interests of trainees, with flexible content planning and management.

So, AT is based on flexible management of curriculum and content in which teachers and trainers assume curricular development as a dynamic and reflexive process, associated with collaborative and cooperative practices that seek to build and develop the skills of all students.

In Principle 3, building on cooperation and experimenting with students' values and skills, this democratic relationship also presupposes a cooperative management of content, as well as the use, sharing and communication of information and culture.

Thus, AT considers the trainer as a manager and guide of learning who seeks to create an environment of autonomous, participatory and democratic development. In this, an affective pedagogical relationship assumes particular relevance. Vygotsky (2001) also addresses this aspect, considering that emotional reactions have a substantial influence on our behaviour and the educational process, and that it is easier through the emotions to influence behaviour, seeking activities that are emotionally stimulating.

Mialaret (1990) advances the concept of isomorphism in which the type of education received by the teacher will later be used for educating their students. AT intends that this concept of isomorphism be used.

Principle 4 considers that training should be based on a dynamic theoretical-practical perspective. It uses collaborative and cooperative work and active teaching methods and strategies in synergy with digital technologies. According to Hargreaves (1998), collaboration can foster the professional development of teachers, providing situations of mutual learning and promoting individual reflections.

The intention is to use collaborative work among trainees in which they work to the same objective. Tasks and responsibilities in a group are decided by the members of the group working as a team.

In AT, the following strategies are the most important: project work; problem-based learning; group research or peer work, including Internet research; discussion, with reflection and communication; and flipped classroom.

A flipped classroom involves reversing the teaching-learning process, in which the teacher prepares teaching resources for the students in advance and makes them available in a Learning Management System (LMS). Later, the class discusses the materials presented. Thus, content is transmitted outside the classroom and lesson time is more usefully used by students to apply the content while the teacher guides them, answers questions, and makes suggestions (Baker, 2011).

Lastly, Principle 5 proposes training for the construction and development of the following skills: i) thinking reflectively about pedagogical work carried out; ii)

acting autonomously in the search for new knowledge and new practices; iii) network communication with integration of DT; iv) participatory evaluation and v) self-regulation, in order to create a community of practice that allows the social construction of self-knowledge.

Knowledge, training and the formal and informal experiences of teachers contribute to their identity as a teacher. This is something that they are constantly building and renegotiating throughout their lives (Wenger, 1998). For Fullan and Hargreaves (1992), professional development of teachers takes place within a culture of teaching in a real context. Knowledge and skills develop as teachers interact with each other in a community.

Siemens (2003) says that what we know is less important than our ability to continue to learn more. Thus, we must ensure that the connections we make, especially in specialized communities allow us to maintain the flow of knowledge and to continue learning. In our field, technology is a facilitator of learning and a creator of connections. The more complex the learning needs and the faster the field of knowledge evolves, the greater is the value of a learning community.

The emphasis on increasing skills faces another challenge that is how to carry out their evaluation. In AT it is proposed that evaluation is essentially formative, carried out as a participatory, formative, interactive and differentiated process, in which teaching means helping, managing and orienting, so that the evaluation allows self-regulation by the learner. According to Fernandes (2006), formative evaluation is an essential pedagogical process to "improve what one learns and, more importantly, how one learns" (p. 43), contexts being constituted "by multiple cognitive, metacognitive and social processes which interact with each other such as feedback, teacher and student regulation, self-regulation and self-assessment " (p. 41).

The importance of creating a community of practice is emphasized, where one learns, builds and manages knowledge (Lave & Wenger, 1991).

3.2 Method of Active Training

Active Training is intended to be a model of teacher training in a broader perspective and at the same time a training method, in which it defines a specific way or way of “doing” to organize teaching and learning situations. It can be used not only for a particular content or thematic unit, in a training module during the term, but also for the whole training period or school year.

This method starts from the curriculum or program of the discipline, in which the subjects and contents of work are first presented to the trainees. Groups or work pairs are formed and the thematic areas to be addressed are distributed. These may be similar, complementary or different between working groups depending on the specific subject area or content. Preferably work should be in the form of a project, such as shown in Figure 1.

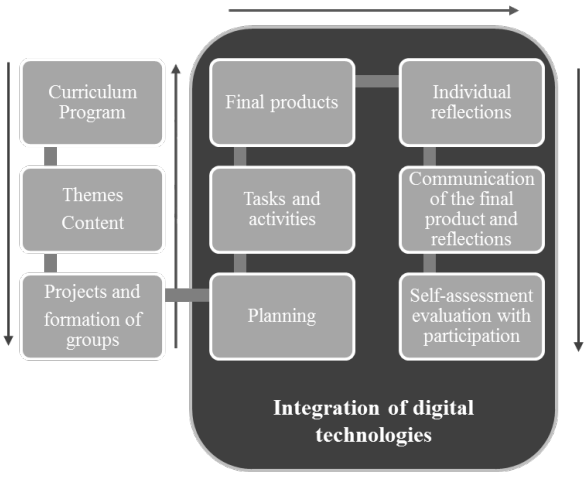

Figure 1 - Method of Active Teacher Training
Source: Rodrigues (2017, p.88)

However, project work can also take other forms, such as using the flipped classroom method and b-learning (online and face-to-face teaching), using a LMS.

After clarifying and negotiating the projects, each group will begin to plan the work, distributing and organizing individual tasks. During practice and while doing the projects, whether in face-to-face or non-face-to-face training sessions, support and guidance is provided by the trainers to each group. Autonomous, non-face-to-face work should be planned and monitored through online teaching using digital technology as a tool to support learning and communication.

The completed projects of each group, the individual reflections and online communication form the basis of the summative evaluation which complements the formative evaluation. The final evaluation should also assign a portion to self-assessment and participatory evaluation, as a way of joint reflection.

3.3 Model under construction

The model of Active Training (AT) arose from an investigation, started in 2014, and developed in workshops of in-service training of teachers that took place during the years 2015 and 2016. It also arose from work done in 2016-2018 in Didactics and Professional Practice of the Master’s Degree in Teaching Economics and Accounting.

After defining and experimenting with the AT model in different contexts, it was restructured to make it a more coherent training model. The main change was a more effective integration of assessment into the teaching-learning process.

Earl (2003) introduced the notion of Assessment as Learning to reinforce and extend the role of formative assessment for learning, emphasizing the learner’s role, not only as a contributor to the process of evaluation and learning, but as the link between them. It is a regulatory process of metacognition, when students monitor what

they are learning and use feedback to make the necessary adaptations and changes.

Black and Wiliam (2003) had already verified that summative assessment should be aligned with formative assessment, since the latter increases attention and long-term retention of information by students. This requires active intervention by the students and also the need for teachers to promote the creation of knowledge through the provision of feedback.

Hattie and Timperley (2007), say that giving and receiving feedback requires skills for both teachers and students. These skills involve stimulus and response routines that require a good control of the classroom environment and the ability to deal with the complexity and diversity of judgments and contents in order to be able to establish relationships between ideas and promote self-regulation of learning. It is also necessary to consider the time required and the importance of managing this time.

Some tasks can lead to more effective feedback and better learning when students share learning objectives, adopt self-assessment and evaluation strategies, develop error-detection procedures, and increase self-efficacy in more challenging tasks. That is, feedback is only effective when students are committed to the learning objectives and when it is related to the learning achievements (Hattie & Timperley, op.cit).

Also, according to Nikou and Economides (2018), with the growth in the use of technologies associated with education, in particular of mobile technologies, there are other fields of study that can bring formal and informal learning opportunities, such as personalization and adaptability, context awareness, interactivity, communication and collaboration among students, the Mobile-Based Assessment (MBA).

Traditional assessment practices are not always appropriate to evaluate skills related to real-world tasks and higher-level skills such as problem solving, creativity and collaboration. However, Nikou and Economides (2018) proposed the development of the use of personal digital mobile devices such as smartphones or tablets to use in assessment. This study presents a review of forty-three articles published between 2009 and 2018 related to evaluation based on mobile devices. It was possible to conclude that the majority of articles analysed had a significant positive impact on students' performance and learning, as well as on the motivation for learning. It reported students' positive attitudes and perceptions about MBA.

Another study of evaluation feedback, Mobile Learning Framework for Assessment (MLFAF), showed the importance of the use of students' personal devices for feedback from evaluation, with the aim of fostering dialogue with students (Bikanga Ada, 2018).

However, for this process to be effective it is fundamental that support and training in technologies, teaching and learning be tailored to individual needs and context. This enables personalized assessment feedback to be given, for these practices to be integrated into the curriculum, and for choices and flexibility to be given to students.

4. Method

This research, based on a predominantly qualitative approach, proposes a training model and a specific strategy, Active Training (AT), that introduces new methods of teaching, assessment and learning integrating digital technology.

Starting from the initial question: What factors, methods and training strategies can influence an effective pedagogical integration of digital technologies? and going beyond the theoretical review of literature, empirical work was developed through i) a research-training project, in-service training; and (ii) a case study in a pre-service training class, both developed in Portugal.

4.1 Research Project in in-service training

In this project in-service training of teachers was used as an Action Research method, which focused on the practices of teachers from a perspective of personal and professional training and development. It aimed to promote the application of AT in the school where the research-training project was developed.

The project consisted of three training workshops each with a duration of 15 hours of face-to-face work and 15 hours of autonomous work. The participants were 35 teachers from a cluster of public schools. They covered various disciplines from pre-school to lower school (KS3). Evaluation questionnaires were given to the participants at the beginning and end of each workshop.

These workshops, following AT principles, included diverse content related to the integration of digital technology. They aimed to stimulate innovative practices designed and tested by the teachers themselves in the school.

4.2 Case study in pre-service training

This study sought to complement the previous one by experimenting with teaching and learning methods, linked to evaluation and integrating digital technology. It was anticipated that this would be effective in incorporating the Active Teacher Training model into pre-service teacher education.

The case study method was applied, in specific Didactics and Professional Practice disciplines, in a class of seven students from a Masters in Teaching. The AT model was used, paying particular attention to the development of formative assessment integrated into the teaching and learning process.

The teaching-assessment-learning strategies developed were: the analysis, presentation and discussion of texts and articles; the construction of learning scenarios; the elaboration of didactic materials and resources; the

simulation of teaching-learning situations with participatory evaluation; observation and teaching of classes in a cooperating school; critical reflection on professional practice; and the performance of group work; using digital technologies for communication. All activities used formative evaluation with feedback.

The case study is a widely adopted method in research in education. It is used particularly when the researcher is confronted with complex situations in which it is difficult to select variables, but in which one tries to describe and analyse phenomena and their interactions (Yin, 1994).

Data collection consisted of a field diary through participant observation, learning scenarios carried out by the students, and photographic and video records. The participant observation, using a systematic record, consistently sought to present a high level of accuracy of the information and its analysis (Bogdan & Biklen, 2007).

5. Results

As well as the quantitative treatment and analysis of the data from the questionnaires, a qualitative approach was also used (Johnson & Christensen, 2004). The analysis of the texts of interviews, field diaries and teachers' reflections were particularly important.

The analysis of content of these instruments was performed through categories and frequencies, according to Bardin (2011), in order to organize information and analyse regularities (Miles & Huberman, 1994).

5.1 Action Research Project

In this research, four questionnaires on the use of digital technology were given to the participants.

The questionnaire applied at the beginning of the project revealed that teachers used digital technology to support the transmission of knowledge and to prepare classes. They had taught themselves to use computers with the help of more experienced colleagues. Their aim was to deepen their knowledge and build teaching materials to support students' autonomous work.

Exploratory studies identified the most common challenges identified in the literature regarding the pedagogical integration of DT in the teaching-learning process, namely: the lack of time or time management of teachers for training and DT use, the need for support and adequate training to pedagogical integration of DT, effective resource management and insufficient technological resources for use by students, and are also highlighted, intrinsic factors, such as resistance to change and the need for information in terms of privacy and security.

The field diaries and reflections of the trainees confirmed that the training workshops generally took place according to plan. Active Training had been applied with very good results, particularly in terms of flexibility in the management of the program and with collaborative work. The trainees were always committed and motivated, having developed projects and activities with their students that integrated digital technologies.

In the Methods and strategies category the use of software with Internet support was emphasized. This enabled the trainees to use diverse work strategies, such as creating online workgroups, viewing videos, creating events and scheduling presentations, promoting a discussion forum and exploring various pieces of software. On-line assessment tools and web quests were developed. Tutorials and micro-classes were provided using video, also synchronous online sessions in chat and a video conference with a guest. There was the possibility of using clarifying questions with students in an extra on-line class.

Concerning the Activities developed by teachers, the ones with the highest frequency were: quiz building, concept maps and flash cards, creating groups and pages on Facebook and websites, preparation of worksheets in Google Forms, creation of e-books with students, and writing and creating characters in Voki. The use of email was mentioned by several teachers. Also mentioned was the use of a closed group on Facebook maintained throughout the entire training project, and aiming to have continuity after its completion.

About Characteristics of the model and training method used, the training was enriched by including teachers from several curricular areas. The importance of differentiation instruction and the flexibility and freedom given to the trainees to choose the activities and projects were confirmed. The support of trainers as consultants was a facilitating factor in the use of digital technology.

The last follow-up questionnaire confirmed the success of the training project and the satisfaction of the respondents with the training workshops. They considered that these had improved their skills in the use of digital technology in teaching, providing them with professional development and allowing to renew and innovate teaching practices, with the creation of a community of practice.

5.2 Case study

In this case study, the teaching-assessment-learning strategies developed in the initial seminars were:

1. group presentations of scientific articles by the masters students with discussion in a large group,
2. the construction of learning scenarios of a curricular unit with materials and educational resources necessary for its development, and
3. evaluation tools.

In the subsequent seminars, the master's students did simulations of parts of classes, with reflection and critical self-analysis on them. A chat session was also developed through Facebook with analysis and debate of a text. In the various activities referred to, the students

were given continuous feedback, either oral, in the discussions, presentations and simulations of classes, or in written form.

In the subjects of Professional Practice, the master's students did coordinated work in the institution of higher education and in the cooperating schools. The field work in these schools involved the teaching of classes or parts of classes by a cooperating tutor. This included the preparation of a field diary describing and reflecting on the activities carried out.

The digital technologies associated to active methods were used in the strategies and the activities developed in the Masters in Teaching. They were integrated in an intensive way, be it in the distribution and organization of the work by the teacher, or in the work developed by the master's students. Different equipment was used, such as laptop, smartphone, and the FTELab room, and also various software and applications, namely Moodle, Facebook, Google Classroom, Prezi, Excel, Kahoot and Padlet.

6. Discussion

In this study, with regard to in-service training research, it was found to be important teachers could see that the use of digital technology is effective, that it increases their freedom of action and allows them to check the progress made by students both inside and outside the classroom. Its use by teachers is also influenced by the motivation shown by their students. This may be a determining factor in the continued integration of digital technology.

It was observed that through experimentation, teachers effectively realized the potential of integrating technologies in the teaching-learning process. Thus, there was an increase in their autonomy in the development of activities with students, which allowed them to verify the advantages and gains with the use of DT in educational practices, including in terms of improving learning.

In addition, the AT model allows pedagogical differentiation, through the proposed active methods, which allows teachers with different levels of proficiency in digital technologies to be covered and that they have acquired experience and autonomy for the integration of DT.

The most significant and constant constraint was the shortage of teachers' time and overwork in general.

In the study of the pre-service teacher education, the trainees did all the work requested.

It was confirmed that:

1. it was possible to differentiate groups according to the needs and interests of the trainees and to carry out the work in an authentic social context;
2. it was appropriate to plan learning scenarios using active methods, based on collaborative work, which allowed the social construction of students' own knowledge;
3. diversified skills, namely digital, reflexive and self-regulation could be developed in teacher education;
4. continuous evaluation supported by feedback could be developed;
5. the isomorphic reproduction of skills for their students, particularly technology skills, was observed in the classes taught by the master's students in the cooperating schools.

In both studies, the issue of building and developing skills proved to be crucial, made possible by the use of active teaching, assessment and learning methods, such as debates, experimentation, project work and cooperative work. An effective increase in technology skills was observed in all participants, with many teachers and future teachers mentioning their intention to continue to use and integrate TD in their classes.

In this way, the development of skills, stood out as an added value of this training method, both digital and also in terms of reflexivity and autonomy. Provided the teachers with the opportunity to create their own knowledge and to reflect on their teaching practices and, simultaneously, to promote the same process among their students, which contributed to the personal and professional development of teachers and to a more digital culture in schools.

7. Conclusion

In this research the main aspects in the design, construction and implementation of the Active Teacher training model for the integration of digital technology into teaching were analysed. This verified the possibility of developing innovative teaching methods and strategies used by teachers.

It was concluded that, in the design of a teacher education program with integration of DT in the teaching-learning process, it will be essential to provide the effective use and experimentation of DT by the trainees, which will facilitate the development of their technology skills.

In turn, this integration of technology requires a relatively complex understanding of the interconnection of technology, pedagogy and content concepts (Koehler & Mishra, 2009), with the use of active teaching, assessment and learning methods. Considering that technology is not only a tool to motivate and assist teachers to implement new methodologies, it has also become a source of knowledge for teachers in providing, sharing and exploring content with students.

For future applications it is essential to note some issues for research particularly in in-service education. There is the need to find time and resources for teachers to develop their skills and to integrate digital technology into their teaching. There is the need to reduce bureaucracy and administrative work. Above all there is

the need to reduce workload or to clarify the definition of hours allocated to training.

The question of the importance of collaborative work is also very relevant, and its development in the teacher education is fundamental, namely for the construction of a community of practice. These, particularly in the use and incorporation of DT in an educational context, have significant added value, especially in a perspective of continuity and professional development, as they allow the sharing of information and knowledge, resources and materials, experiences and pedagogical practices, in a joint reflection and knowledge construction.

A community of practice can be promoted in different ways, for example, by encouraging teachers with greater proficiency in the integration of DT to become consultants of colleagues, in a perspective of coaching and mentoring, in supporting and experimenting activities or projects with technologies and new methodologies and strategies. This type of processes can generate improvement efforts, provide collaboration and cohesion strategies, allowing the change and the development of new knowledge and skills of teachers.

These forms of collaborative work assume considerable relevance in contemporary society, in the sharing of knowledge, in the development of social, interpersonal and higher-level thinking skills, promoting increased motivation and knowledge retention of trainees and students in more meaningful learning.

Other issues that should be addressed at the level of public policies would be certification of training, promotion of free training courses, and consideration of the weight training receives in the performance evaluation of teachers and its contribution to career advancement.

In this way, it is considered that the development of training must be socially binding, projecting a community of democratic and efficient practice that promotes the creation of a digital culture in the school for the integral formation of individuals, where they can get involved in practices cooperative work, with balanced interception of content, pedagogy and technology.

In short, the Active Teacher training model, with its structuring principles and specific methods, confirmed the possibility of developing strategies to integrate digital technology into the teaching-assessment-learning process, which will support the development of online education in the future. It also developed skills associated with pedagogical and didactic knowledge, both in pre-service and in-service teacher training.

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