BABEŞ-BOLYAI UNIVERSITY OF CLUJ-NAPOCA
FACULTY OF PSYCHOLOGY AND EDUCATIONAL SCIENCES
DOCTORAL SCHOOL "EDUCATION, REFLECTION, DEVELOPMENT"

SUMMARY - DOCTORAL THESIS

THE IMPACT OF EDUCATIONAL TECHNOLOGY ADOPTION ON INITIAL TEACHER TRAINING

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List of Abbreviations

PFP – Psycho-pedagogical Training Program
UTCN – CUNBM – Technical University of Cluj-Napoca – North University Centre of Baia Mare
ICT – Information and Communication Technologies
TRA – Theory of Reasoned Action
TPB – Theory of Planned Behaviour
TIB – Theory of Interpersonal Behaviour
UGT – Uses and Gratifications Theory
BAS – Behaviour Activation System
BIS – Behavioural Inhibition System
TAM – Technology Acceptance Model
PEOU – Perceived Ease of Use
PU – Perceived Usefulness
A – Attitude Toward Using
IU – Intention to Use
BI – Behavioural Intention to Use
SN – Subjective Norm
FC – Facilitating Conditions
AT – Technological self-efficacy specific to digital skills
UTAUT – Unified Theory of Acceptance and Use of Technology
AE – Perceived self-efficacy in using educational technologies
GE – Experimental Group
GC – Control Group
VD – Dependent variable
R^2 – Coefficient of determination

Keywords: educational technologies adoption, initial teacher training, teacher professional skills, digital skills, pedagogical practice, Technology Acceptance Model, SAMR model, TPACK model, self-efficacy

Introduction

This research topic started from the consideration that high quality level of education is ensured by the professional teacher training, the digitization of the educational system generating new approaches to initial and continuous training. Nowadays, there is a need to adapt initial training programmes to the reality of the common European space while preserving the nuanced aspects of national contexts. A large part of the new directions of development at the level of educational policies, in the sense of professionalizing the teaching career at European level, aim to reduce the gap between teacher training and the development in diversity and efficiency of digital means of education for education, but above all, to strengthen the bridges between initial training courses and effective teaching practice. In this regard, it is necessary to correlate, as far as possible, the theoretical component with the practical experience, offered through pedagogical practice internships, which would ensure the initiation in the organization of future teachers and their educational activity planning and familiarization with the strategic approaches of the didactic design. The competences for the teaching profession are consolidated and enriched within the pedagogical practice, the student having the opportunity to form his/her professional style from a pedagogical perspective and to capitalize on the theoretical knowledge acquired in the psycho-pedagogical and didactic disciplines of the specialization in the effective practice in the classroom.

The challenge of today's society, of all those involved in the educational process, is to identify the needs of the new generation of students, universities having an essential role in: (i) adapting the educational offer of initial training programs and (ii) preparing students in the sense of developing the analytical and innovative capacity that will allow them to select and make responsible decisions throughout the training and development of the teaching career. For such pedagogical training, the didactic development from a digital perspective is essential, being necessary to train the skills to teach with the use of information and communication technologies (ICT) but also to guide and advise students in the use of these means of education in the classroom activity, in accordance with the current educational requirements. The main argument in choosing the research theme was that the pace of integration of educational technologies was accelerated by: (i) the continuous innovation of pedagogical tools, (ii) the existence of a generation of digital native trainees, (iii) the European directives regarding the digitization of the educational process, (iv) the placing of pedagogical practice in the dominant position of the curricular training programs and (v) the professionalization of the teaching career through the training and development of skills for teaching profession, including digital ones.

The research approach was initiated through an analysis of publications in the field of Educational Sciences, but also in related fields, by selecting those that aimed at accepting the use of educational technologies in the teaching activities of future teachers and the effects on the learning process and on the training and development of skills for the teaching profession. A significant weight in the theoretical substantiation chapters is held by the European Commission's reports on the digitization of the education system. The topic addressed *educational technologies adoption in the initial teacher training* is circumscribed to the field of Education Sciences and outlines the research theme topic - *the impact of the educational technologies' adoption in the initial training of teachers,* the reference field being Didactics / Training Theory and Methodology. Pedagogical practice offers the possibility of applying psycho-pedagogical knowledge and aims at developing skills for the teaching profession. The extent to which the level of students' digital skills, as a constitutive part of the profile of the future graduate of the psycho-pedagogical training program, influences their decision to accept and integrate technology into teaching and learning activities within pedagogical practice, is an aspect that reveals an essential issue of the amplitude of the resistance or openness of future teachers to the digitalization of education. Starting from these considerations, research directions have been identified aimed at: (i) analysing the degree of acceptance and intention to adopt digital technology by students in the didactic design process for the lessons held during the pedagogical internship, (ii) evaluating the impact of technology integration on the effectiveness of the teaching activity and on the results obtained by the students and (iii) investigating the correlation between the level of students' digital skills and the effective use of knowledge, in the context of pedagogical practice. It is necessary for pedagogical practice to create the framework:

- ✓ for didactic design, support and analysis of lessons;
- ✓ for the application of the knowledge acquired within the disciplines of the initial training program;
- ✓ for the generation and development of applied ideas;
- ✓ for the implementation of an innovation in the teaching activity.

The diffusion of technology in pedagogical practice requires a systematic approach, involving both the provision of an adequate technological infrastructure at university and pre-university educational units, as well as the development of an effective tripartite collaboration strategy between the university coordinator, the practicing student and the teacher-mentor. The attitude of the three educational agents towards the integration of technology is significantly influenced by the degree of technological self-efficacy as an essential predictive factor that reflects the perception of one's own ability to use digital tools and determines the openness or resistance to innovation in teaching activities through the integration of digital resources, significantly influencing the adoption of technology. Technological self-efficacy is defined in the literature as confidence in one's own competences to successfully perform a teaching task through the integration of technology (Caprara et al., 2006; McDonald & Siegall, 1992).. The concept was taken from the field of psychology and derives from academic self-efficacy which signifies judgment on one's own ability to organize and carry out actions in order to achieve the intended objectives and to obtain educational performance (Bandura, 1977; Zimmerman, 1995). Bandura (1997) states that the rapid pace of technological development and the accelerated knowledge growth attach particular importance to the capacity for self-directed learning. The same author sets as a major objective of formal education the provision of intellectual tools, beliefs of effectiveness and intrinsic interests to educate themselves, by acquiring new knowledge and cultivating new skills. To ensure quality education, schools require effective educators with cognitive and self-management skills that allow them to master changing technologies throughout their teaching careers and beyond. The pervasive dependence on technologies in education governs the major aspects of the professional career, imposing the dependence on specialized technicians (Bandura, 1997). The perceived power of effectiveness is measured by degrees of certainty in performing the given tasks (Zimmerman, 1995).

Adopting technology in educational practices involves addressing the mental path taken by the student, future teacher, from the moment he or she first heard about an educational innovation to the moment he or she uses it. The purpose of the research was to analyse *the impact of adopting technology in pedagogical practice on the digital skills development—as part of the competencies specific to the teaching profession—among students enrolled in the Psycho-pedagogical Training Program*, with the main objective of the educational research being *to examine the impact of adopting technology in pedagogical practice on the development of digital competencies as dimensions of competencies specific to the teaching profession* *among students*. The present research was built based on multiple research studies of the ascertaining and experimental type, but also applicative of the investigated phenomenon.

Chapter I. Initial Teacher Training in the Context of the Digital Technologies Integration in Education

The first chapter of the thesis addresses the theoretical foundations of preparing future teachers to work in a digitalized educational environment. The structure of the chapter aims to conceptualize the teacher's profile through the perspective of digital skills, the initial training and professional path of teachers, the process of educational technology adoption and the digital education ecosystem configuration. The initial training of teachers contributes significantly to the development of the competence to learn to provide the educational system with graduates ready to adapt to the new. Providing opportunities for learners to be active participants in their own training implies a long-term commitment to the development of the teaching career (Gibson et al., 2021; Papuc & Bocoș, 2017). The knowledge, skills and attitudes that the student possesses in his or her teaching training are consolidated, continuously enriched and reorganized in relation to the dynamics of technology. Nowadays, the structure of competence is influenced by educator's values and the challenges of digitalization. Digital skills are creating new bridges between the teaching skills and 21st-century literacy skills of the. Thus, digital competence is operationalized through frameworks such as DigComp, for citizens, and DigCompEdu, for educators, the professional profile of educators in Romania being organized on a number of 7 areas that can be seen in Figure I.1, including digital technology in education (Ministry of Education, 2024; Redecker, 2017; Vuorikari et al., 2022).

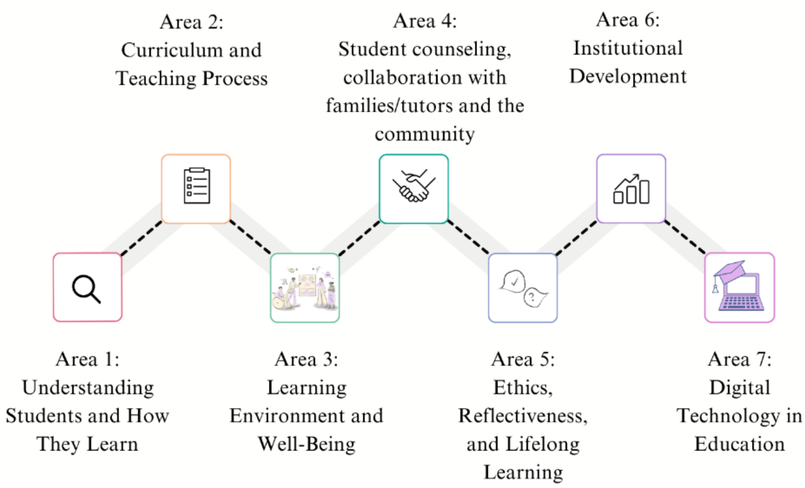

Figure I.1 Areas of competence for the teaching profession specific to pre-university education (translated and adapted from Ministry of Education, 2024)

The initial training of teaching staff is part of an education system oriented towards the formation of competences and based on the principle of cumulative development of the level of professional training of educators (Ministry of Education, Research, Youth and Sport, 2011). In the Figure I.2, four of the laws that constitute the foundations of the initial training for the teaching profession through which the acquisition of the skills and certifications necessary for the exercise of specific duties can be ensured are presented (Guţu & Lefter, 2016).

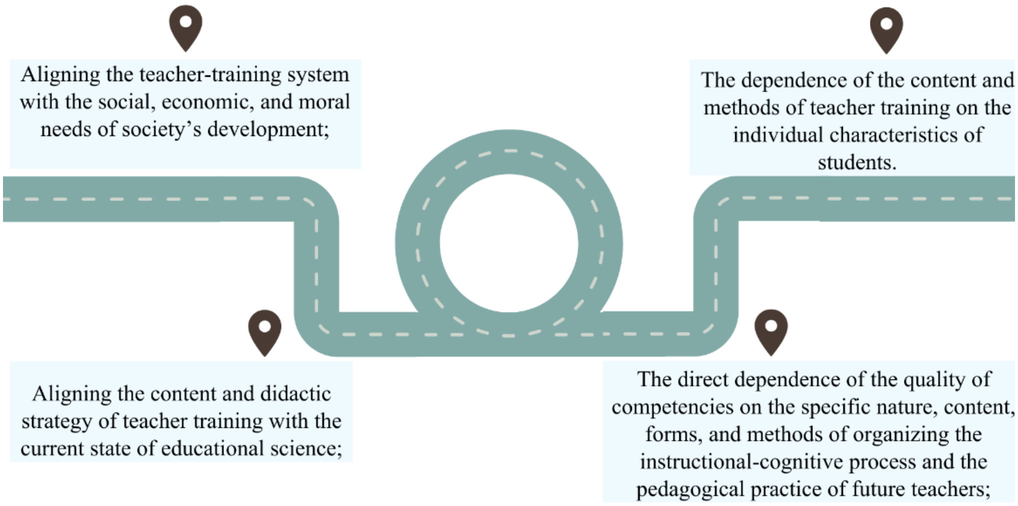

Figure I.2 Laws underlying the initial teacher training (adapted from Guţu & Lefter, 2016)

The European Union policy documents on initial teacher training stress that the profile of future teachers should be built not only from specialist knowledge, but also from professional skills that familiarise them with both pedagogical models and implementation tools due to the new elements (Simion & Chiş, 2019). Educational practices are constantly subject to a continuous process of alignment with technological innovations, aiming at training and developing professional and transversal skills in the field.

Learning involves new technologies, and technological creation becomes a support for learning and the development of new educational environments. The adoption of technology in education is not instantaneous, but a complex mental and social process that, according to Rogers' theory (2003), includes: awareness, arousing interest, evaluating, trying and convincing to adopt. The attitude of teachers, the digital skills already formed and access to infrastructure are factors that influence the integration of digital technologies into the teaching activity.

Nowadays, the education system is integrating areas of the digital ecosystem at an accelerated pace, given that it is necessary to integrate educational technologies, including emerging ones such as robotics, artificial intelligence, 3D printing, etc. Digitalisation alignment involves designing and implementing educational models adapted to new generations of learners within a digital education ecosystem that facilitates: (i) „effective knowledge and know-how development", (ii) obtaining high-performance learning outcomes in the form of professional and transversal skills, (iii) unlimited access to information through the digital infrastructure through which data is stored and processed, (iv) unlimited connectivity between learners and educators, etc. (Miranda et al., 2021, p. 4; Moreno-Charris et al., 2022; Peters, 2019).

The digital educational ecosystem unifies pedagogy with learning spaces and technology, being mentioned in this chapter: (i) models for optimizing learning spaces such as SCALE-UP (flipped classroom), TEAL (technology-enhanced learning) and TILE (inquiry-based learning), (ii) innovative pedagogies identified in the international reports of the Open University, which integrate artificial intelligence, microcredentials, Metaverse and podcasts, and (iii) supporting tools, projects and platforms such as eTwinning, SELFIE and ITELab (Barkoczi et al., 2024; Beichner, 2014; Dori et al., 2003; European Education Area, n.d.; European Schoolnet Academy, 2017; Florman, 2014; Kukulska-Hulme et al., 2020, 2022, 2023; Whiteside et al., 2009).

Pedagogy, space design and technology integration influence each other in the design, implementation, and evaluation of active learning spaces to create an effective pedagogy-space-technology framework (Lee et al., 2018). The digitalization of education is not only about equipping with equipment, but also involves a remodelling of the pedagogical act, requiring teachers trained to design innovative teaching strategies in terms of interactivity and personalization of learning, in a continuous learning process.

Chapter II. Acceptance and Integration of Educational Technologies Models

The second chapter of the thesis represents a theoretical foundation of the way in which educational agents adopt and integrate digital tools in teaching practice and is structured on two main directions: models of acceptance and models of pedagogical integration of technology. Technology acceptance models are based on theories in psychology and related fields that analyse human behaviour. A first theory is the Theory of Reasoned Action (TRA), launched by Fishbein & Ajzen in 1975, according to which a person models behaviour that "should be volitional, systematic, and rational" in relation to attitude toward one or more outcomes and certain perceptions of social pressure (Namoco & Zaharudin, 2021; Taherdoost, 2018, p. 961).

The fact that the educator considers that a certain type or form of assessment is the best way to check the students' learning, if everyone else thinks it is a good idea and if the teacher thinks he can handle it" can be given as an example of the application of this theory (Namoco & Zaharudin, 2021, p. 306). Another theory, which is an extension of TRA, is the Theory of Planned Behaviour (TPB). According to TPB, beliefs are an influencing factor of attitudes and perception of social pressure, ultimately acting on the intentions, for example, of teachers to carry out a behaviour related to their professional practice and of the learners to understand the content transmitted through technological resources and to be motivated to learn (Basnet et al., 2024; Heuckmann et al., 2019). Habits, favourable conditions and emotions are introduced as factors that explain the complexity of adoption behaviour through the Theory of Interpersonal Behaviour (TIB), educational agents facing a dynamic of teacher-student perception reflected by "agreement and contradictions in needs-supporting behaviors" under the pressure of the expansion of the technological educational environment, the level of motivation in learning being the result of this dynamic (Barkoczi et al., 2024; Leroy, 2025, p. 7). The Uses and Gratifications Theory (UGT) focuses on the analysis of the reasons that determine the acceptance or rejection of the use of technology by introducing three constructs that are also widely studied in educational research: motivation, satisfaction and use behaviour (Barkoczi et al., 2024; Hossain et al., 2019; Kircaburun et al., 2020). Another theory of the acceptance of technology describes the Behaviour Activation System (BAS) and analyses the psychological factors of individuals that influence use. BAS is treated as a physiological mechanism that could boost motivation by being sensitive to reward signals and experiencing positive feelings such as euphoria and happiness, as opposed to the adversarial motivational system of the Behaviour Inhibition System (BIS), which is a deterrent (Park et al., 2013). BIS and BAS are the basis *Theory of Sensitivity to Hardening* according to which behaviour and learning are shaped by two major motivations: the desire to receive rewards and the desire to avoid punishment (Corr, 2009; Khoshfetrat et al., 2022). The inner desire of educational agents to obtain rewards can be considered a facilitator of the use of technology in teaching.

Technology acceptance is described as a complex process that depends on educators' critical thinking, openness to new ideas, and self-regulation in the learning process. The Technology Acceptance Model (TAM) is approached through its four constructs: perceived ease of use (PEOU), perceived usefulness (PU), attitude towards use (A) and intention to effectively use educational technologies (IU) (Davis, 1986). The TAM model presents several versions that have been empirically studied because of the variety of variables, the representation of which is illustrated in Figure II.1. If Model 1 represents the initial structure of the model focusing on attitude (A) and behavioural intention (BI) as outcomes, Model 2 expands the TAM by including the actual use of technology (U) in the study. In Models 3 and 4, external variables are introduced, considered predictable to identify perceived usefulness and ease of use: subjective norm (SN), facilitating conditions (FC) and technological self-efficacy (AT) (Scherer et al., 2019).

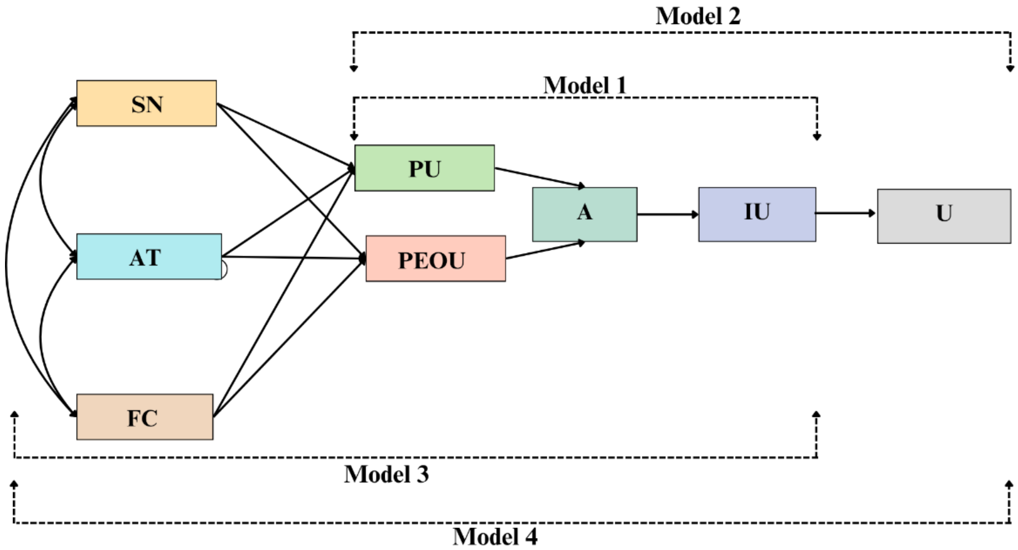

Figure II.1 Types of the technology acceptance model by teachers with and without external variables (adapted from Scherer et al., 2019)

Teo & Schaik (2009) concludes, following a study whose target group was pre-service teachers, that the use of technology in the professional activity is dependent on its effective use during the initial training period by both teachers and themselves, the perceived usefulness being below the impact of the perceived ease of use, and Rad et al. (2023) argue that, although there are findings in the scientific literature that intention and positive attitude are the most impactful factors of the effective use of technology, more research is needed in larger and more complex samples.

An extension of the TAM model is represented by the Unified Theory of Acceptance and Use of Technology, a model identified in the specialized scientific literature with the acronym UTAUT. It focuses on four major factors as determinants of intent: performance expectation, effort expectation, facilitating conditions, and social influence (Balog & Cristescu, 2009). A schematic representation of the model can be seen in Figure II.2.

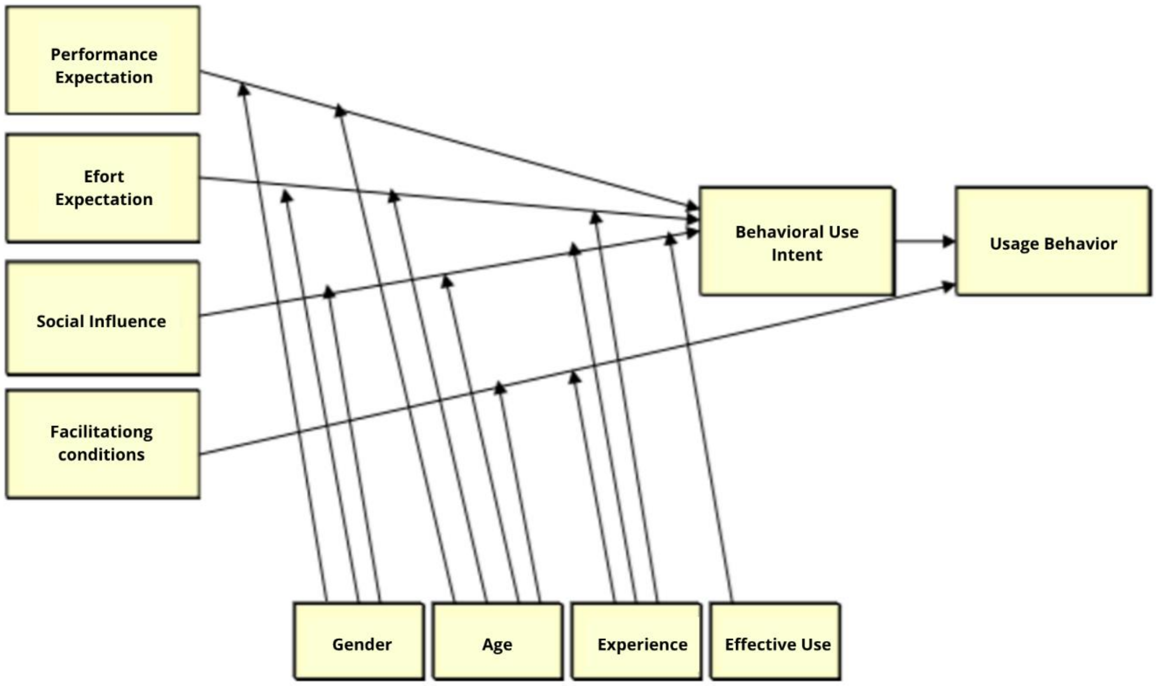

Figure II.2 The UTAUT model (adapted from Balog & Cristescu, 2009)

In the teacher initial training:

- ✓ the expectation of performance is analysed by the degree to which the student, future teacher, believes that the use of technology in classroom instruction is beneficial to teachers in achieving the operational objectives of the lesson and to the learners in improving their learning outcomes (Khlaif, 2018);
- ✓ the expectation of effort can be considered as the degree of difficulty that the student, future teacher, perceives when learning and using digital resources in the design and support of the lesson during the pedagogical practice period;
- ✓ social influence reflects the perception of the student, future teacher, on the importance that mentor teachers, pedagogical practice coordinators, respectively students in the classes in which they hold teaching activities, believe that they could use educational technologies;
- ✓ the facilitating conditions represent the degree to which the student appreciates that he has the organizational infrastructure, resources and technical infrastructure to be supported in the use of technologies in the lesson.

The model is also approached from the perspective of moderating variables such as gender, age and user experience.

The integration of technology is not just about the simple use of devices but involves an intentional redesign of the teaching strategy. From the perspective of this approach, the TPACK models were described through its dimensions - technological, pedagogical and content knowledge, SAMR (substitution, augmentation, modification and redefinition) and TIM (technological integration matrix).

The TPACK model foresees the need for a synergy between three types of knowledge: technological (TK), pedagogical (PK) and content (CK). Effective integration is observed in their intersection areas in which teachers use technology to improve pedagogical practices and convey the content of the discipline (Ilie, 2020). The same author provides a representation of the TPACK model from the perspective of four representative components resulting from the interaction of three types of knowledge: pedagogical knowledge, technological knowledge and content knowledge (Figure II.3). Technological and pedagogical knowledge (TPK) forms the basis for the use of technology in streamlining pedagogical practices within lesson sequences, such as updating knowledge and capturing attention, and formative assessment. Technological and content knowledge (TCK) is the background of knowledge in using technology to transmit the content of the discipline. The knowledge of specialty didactics (PCK) reflects the cognitive preparation of the teacher to teach a school subject. Technological Pedagogical Content Knowledge (TPACK) represents an integrated knowledge base emergent from the interaction of technological, pedagogical, and content knowledge specific to a discipline.

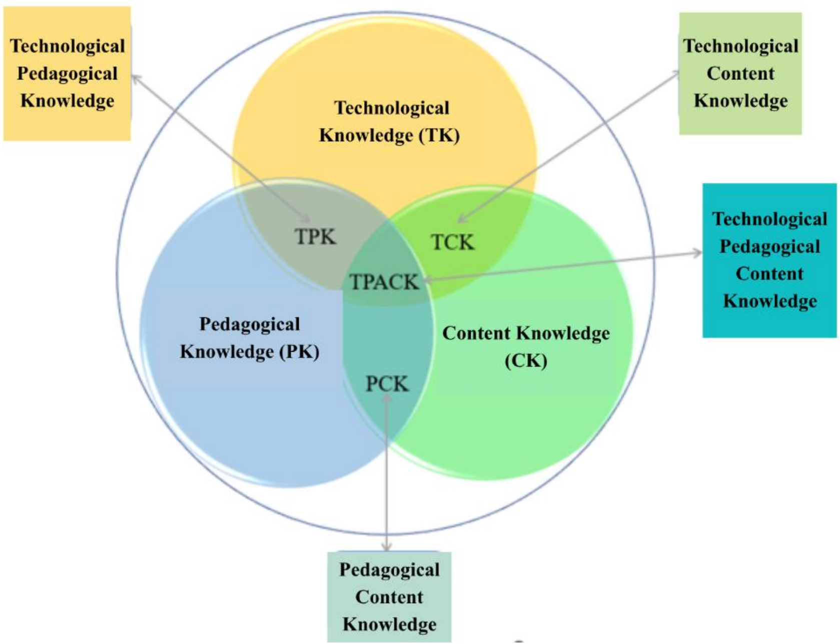

Figure II.3 The TPACK model (adapted from Koehler et al., 2013)

Extensions of the model are XTPACK, which introduces as a variable the importance of context at micro, meso and macro educational levels, and TPACK-G, focused on the use of digital games (Brianza et al., 2022; Villa et al., 2023). XTPACK (Figure II.4) represents an innovative model that includes contextual and networked knowledge, stating that „each educational context is a unique contextual constellation, which leads teachers to develop specialized knowledge for each educational environment" (Brianza et al., 2022, p. 730).

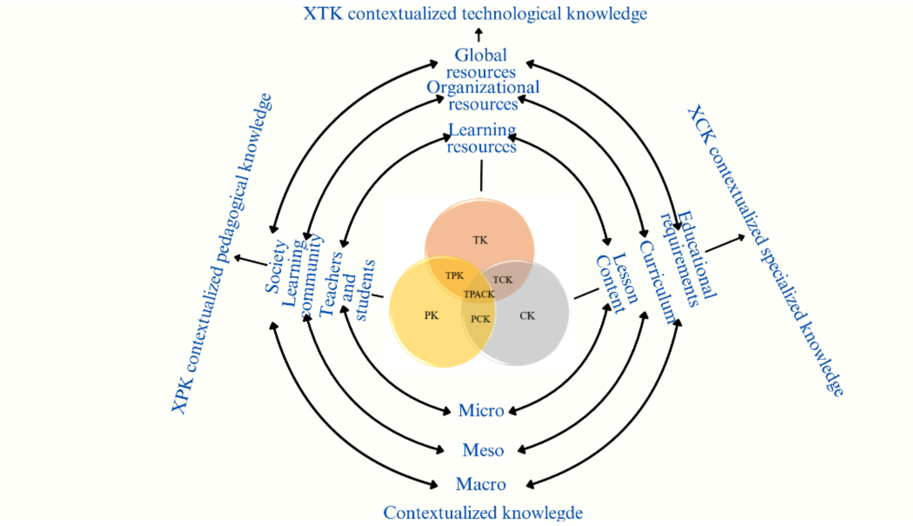

Figure II.4 XTPACK Model Contextual and Contextualized Networked Knowledge (taken and translated from Brianza et al., 2022, p. 730)

The SAMR model classifies educational practices into the following hierarchical levels: substitution and augmentation, which aims to improve educational practices, and modification and redefinition, which aims to transform them (Puentedura, 2006). If the first levels provide for the use of technology as a substitute for traditional means, the transformation area allows the creation of innovative learning tasks. The SAMR model is represented as having four hierarchical levels schematically represented in Figure II.5. The first two stages, substitution (S) and augmentation (A), involve substitutions of the means of learning (e.g. digital textbooks instead of printed textbooks) without changing the functionality of the learning activities. Although augmentation brings a functional plus, the intervention is minor. The modification stage (M) implies that technology is the indispensable teaching medium for carrying out the learning task (e.g. carrying out a collaborative project through a shared document), requiring a significant redesign of the teaching strategy. Redefinition (R) occurs when technology allows the design of new learning activities that transform learners into active participants in their own learning and content creators (Shamir-Inbal et al., 2025).

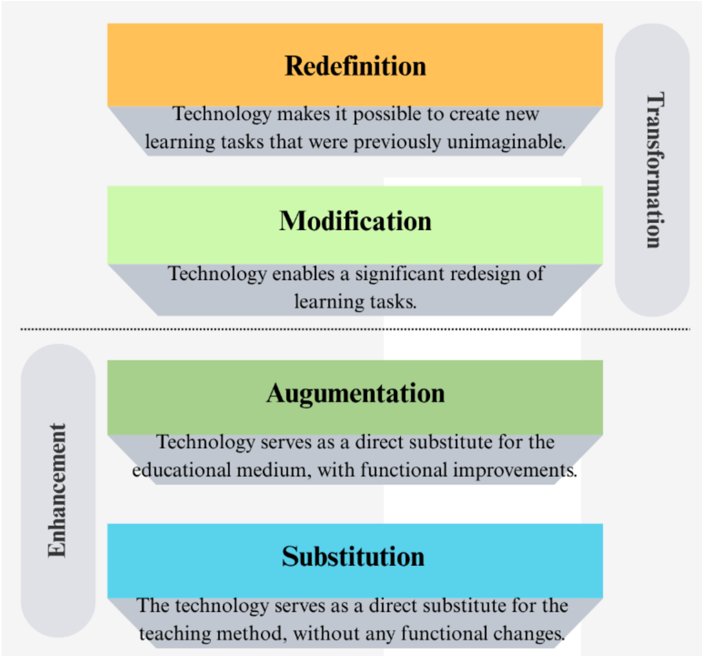

Figure II.5 The SAMR model (adapted from Puentedura, 2013)

The Technological Integration Matrix (TIM) is a dynamic framework that correlates five stages of adoption - entry, adoption, adaptation, infusion, transformation - with five characteristics of the learning environment - active, collaborative, constructive, authentic and goal-oriented (Welsh et al., 2011). The model is closely correlated with Bloom's taxonomy, highlighting the progress from the formation of skills such as remembering, understanding, to higher-order ones, focused on analysis, evaluation and creation, as the use of technology becomes more complex and innovative.

Technology acceptance and integration models are designed to identify the accessibility and limitations of different educational technologies and avoid a replacement of the technology-based educational environment with a non-technological one.

Chapter III. Technology Adoption in Pedagogical Practice Activities

This chapter of the thesis explores the ways in which the practical training of future teachers is reconfigured through the integration of digital resources, emphasizing the harmonization of theory with teaching practice. Pedagogical practice is seen as an essential component, which brings students closer to the real educational environment, facilitating the formation of skills specific to the teaching profession. D. A. Kolb (1984) puts under the magnifying glass the four stages of Experiential Learning Cycle represented by concrete experience (CE), reflective observation (RO), abstract conceptualization (CA) and active experimentation (AE) correlating them with the three forms of pedagogical practice - documentation practice, observational practice and active practice.

Through the pedagogical practice of documentation, the student: (i) is introduced into the organizational, administrative and managerial sphere of the pre-university education unit and (ii) analyses the documents related to the design and conduct of the instructive-educational activities in the pre-university education unit, a large part of which can be seen in Figure III.1.

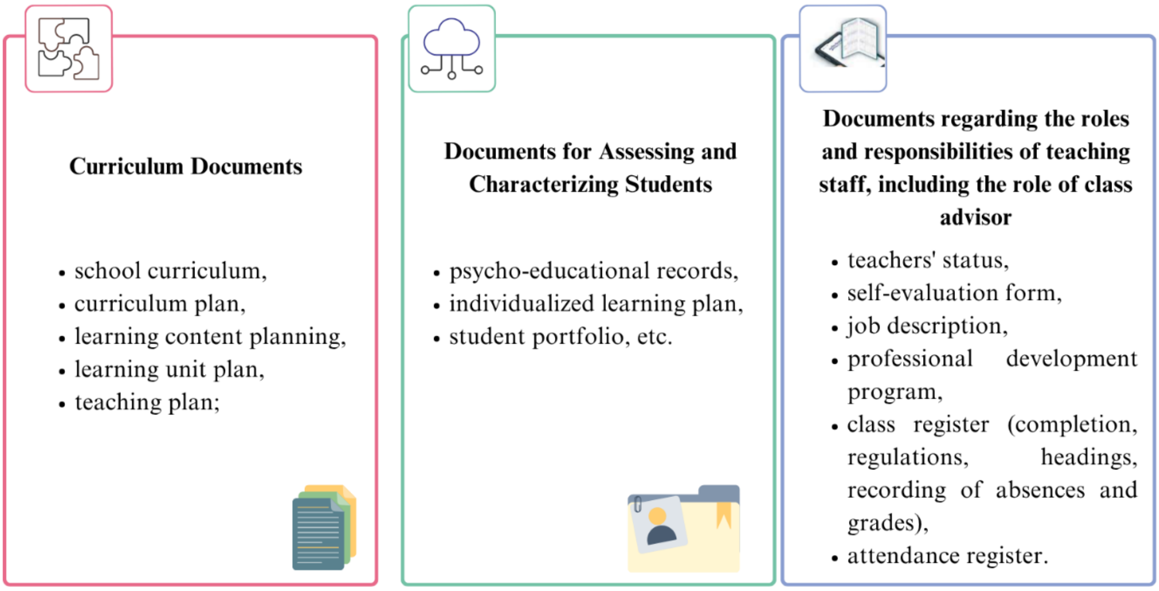

Figure III.1 Documents for the design and conduct of instructional-educational activities in pre-university education units

Observational or passive practice has the role of familiarizing students with: (i) the teaching strategies and teaching styles of teachers, (ii) the organization and conduct of educational, cultural and sports activities, (iii) the organization and conduct of activities such as meetings with parents or counselling and (iv) strategies used in the application of classroom management.

The active teaching practice requires the direct involvement of students in the didactic approach, starting from the lesson design to the preparation of the teaching materials and ending with the lesson support, the evaluation of the students and the self-evaluation of the teaching act, capitalizing on the knowledge acquired in the subjects studied and the awareness, respectively the improvement of one's own teaching style.

Digital resources are educational means that facilitate the constant flow of information and knowledge, the discovery and development of critical thinking being placed at the centre of building and cultivating deep cognitive structures (Mhlongo et al., 2023). Attitudes towards new technologies influence the attitude of future teachers in accepting or rejecting them and, therefore, whether or not to use them in teaching, learning and assessment, given that, within the pedagogical practice activities of the psycho-pedagogical training program, students must carry out teaching activities with digital native students (Barkoczi, 2023). Digital technologies are tools for streamlining: (i) the learning environment, (ii) collaboration between partners, (iii) processes for building the skills base and (iv) professional learning networks.

The success of pedagogical practice depends on effective collaboration within the triad formed by the pedagogical practice coordinator in the higher education unit, the student and the mentor teacher in the pre-university education unit. This collaboration creates a learning space beyond the physical one, in which partnerships are developed: (i) connective, for communication and feedback, (ii) generative, for the co-design of innovative teaching sequences or (iii) transformative, for the design of new learning networks. In truly collaborative partnerships, each of the three partners define their position in relation to learning and contributing to the training and development of skills for the teaching profession (Crooks et al., 2021; Wang, 2010). Mentor teachers simultaneously adopt three roles:

- learners by: (i) stimulating their own professional development within the teaching cycle and (ii) continuous training by participating in programs offered by the university (Farrell, 2023; Wang, 2010),
- mentors in relation to student guidance,
- teachers of the class of students.

The coordinators of pedagogical practice in the university assume and plan the activities in collaboration with the mentor teachers. Students are actively involved in acquiring and developing skills for the teaching profession. The conclusions of the chapter emphasize that the integration of technology into pedagogical practice shapes a more participatory and flexible pedagogy, transforming the student from a mere spectator into a reflective and innovative practitioner.

Chapter IV. Experiment undertaken on the topic of "The Impact of Educational Technologies Adoption on the Formation of Teaching Skills of Students Enrolled in the Psycho-pedagogical Training Program to Certify the Skills for the Teaching Profession"

In the last chapter of the thesis, the research approach based on the need to adapt initial training programs to the dynamics of digitization of the European educational area is presented. The theme of this research was the impact of the adoption of educational technologies in the initial training of teachers in relation to: (i) the technological self-efficacy specific to the digital competence structured on the five areas of the DigComp competence framework, (ii) the constructs of the technology acceptance model (TAM) and (iii) the perceived self-efficacy in relation to the use of educational technologies. The purpose of the research was *to study the impact of the technology adoption in educational practices on the formation of digital competences, dimension of competences for the teaching profession, students enrolled in the Psycho-pedagogical Training Program to certify competences for the teaching profession*.

The research approach was built by correlating the objectives, research questions and established hypotheses. The first research objective, *O1. The determination of the initial level of technological self-efficacy, technology acceptance and perceived self-efficacy in relation to the use of educational technologies of third-year students enrolled in the psycho-pedagogical training program* was operationalized through the first three research questions: *1. What is the level of technological self-efficacy specific to the digital competences of the students of the Psycho-pedagogical Training Program and are there significant differences depending on the faculty and age range, prior to the implementation of the blended learning educational program?, 2. What are the levels of perceived usefulness, perceived ease of use, attitude towards technology and intention to use among students enrolled in the psycho-pedagogical training program, before the implementation of the blended learning educational program?* and 3. *What is the level of perceived self-efficacy in relation to the use of educational technologies of the students of the Psycho-pedagogical Training Program, before the implementation of the blended learning educational program*?, questions that investigate the pre-existing level of self-efficacy specific to digital skills, of the four constructs of the TAM model and of perceived self-efficacy in relation to the use of educational technologies. In this regard, the testing of secondary hypotheses *H 2. There are significant differences between students in terms of technological self-efficacy specific to digital skills according to faculty and age range, prior to the implementation of the educational program, H 3. There are significant* *differences between the levels of perceived usefulness, perceived ease of use, attitude and intention to use technology by students, prior to the implementation of the educational program* and *H 4. The perceived self-efficacy in relation to the use of educational technologies in teaching activities differs significantly depending on the faculty and age range of the students before the implementation of the educational program,* highlighted: (i) the existence of differences in the level of technological self-efficacy specific to digital skills only for the moderating variable the age range of the respondents, not for the moderating variable represented by the faculty at who students are enrolled, (ii) differences between levels of acceptance of technology prior to intervention, and (iii) lack of significant differences in the level of perceived self-efficacy.

Intervention and impact assessment objectives, *O2. Implementation of a blended learning educational program for the integration of technology* and *O3. Establishing the extent to which the blended learning educational program for integrating technology into pedagogical practice influences the analysed variables,* aimed at the development and implementation of the blended learning program, as well as establishing the extent to which it influenced the dependent variables: *technological self-efficacy specific to digital skills, TAM constructs and perceived self-efficacy in relation to the use of educational technologies*. These objectives were directly correlated with research questions *4. To what extent does participation in the blended learning educational program lead to a significant increase in the level of technological self-efficacy specific to digital skills, a dimension of competences for the teaching profession?, 5. To what extent does the educational program influence the levels of perceived usefulness, perceived ease of use, attitude towards technology and intention to use, as constructs of TAM?* and *6. To what extent does participation in the blended learning educational program lead to a significant increase in perceived self-efficacy in relation to the use of educational technologies?*, which analysed progress in technological self-efficacy, level of technology acceptance and perceived self-efficacy in relation to the use of educational technologies following participation in the educational intervention. By testing the main hypothesis *H 1 The systematic adoption of technologies in students' pedagogical practice leads to an increase in the level of technological self-efficacy specific to digital competences, a dimension of competences for the teaching profession*, the lack of a differential effect was confirmed as a result of the initial digital competence profile of the students and the educational context in which the technology is integrated. By testing hypotheses *H 5. Participation in the blended learning educational program determines an increase in the levels of perceived usefulness,* *perceived ease of use, attitude towards technology and intention to use, as constructs of TAM, compared to the control group* and *H 6. Following the implementation of the educational program, the students in the experimental group register significantly higher scores compared to those in the control group in terms of perceived self-efficacy in relation to the use of educational technologies*, it was found that the educational intervention did not determine statistically significant increases in the levels of TAM constructs and perceived self-efficacy in relation to the use of educational technologies related to the TAM group. compared to the experimental group.

The benchmarking objective, *O4. The comparative analysis of the results of the experimental and control groups and of the relationships between the research variables to identify the predictive effects,* followed the relationships between the variables being correlated with the research question *7. To what extent does the level of technological self-efficacy specific to students' digital skills contribute to the variation in perceived usefulness, perceived ease of use, attitude towards technology and intention to use?* and with hypothesis *H 7. The level of technological self-efficacy determines an increase in the level of perceived usefulness, perceived ease of use, attitude towards technology and intention to use.* The results obtained reflected the influence of technological self-efficacy on perceived usefulness, perceived ease of use, attitude and intention to use.

The last objective, *O5. The investigation of how the normative framework prepares and the reality of educational practices reflects the integration of technology in the teaching, learning and assessment process*, focused on the analysis of how the normative framework on educational practices refers to the integration of technology. Research question 8 corresponds to this objective. *What are the predominantly used digital technologies in the teaching practice of teachers and students, future teachers, and to what extent does their functional-pedagogical integration support curricular coherence?*, which aimed to investigate the predominantly mentioned technologies in educational documents and the extent to which their integration supports curricular coherence. Testing the associated hypothesis, *H 8. The integration of educational technology in curricular, institutional and didactic design documents is predominantly instrumental, with a higher share of the substitution and augmentation levels than the levels of modification and redefinition and largely supports curricular coherence*, highlighted that the integration of technology into documents is predominantly instrumental, falling, in most situations, on the substitution and augmentation levels of the SAMR model.

The methodological architecture of the research favoured a holistic approach to the phenomenon of technology adoption, moving from the evaluation of subjective perceptions to the rigorous analysis of the documents supporting pedagogical practice. The blended learning educational program (Annex 2) acted as an independent variable, providing the necessary framework for students to evolve from the role of consumers to that of prosumers of digital content.

The independent variable was represented by *the blended learning educational program for the integration of technology into the pedagogical practice of students enrolled in the Psycho-pedagogical Training Program to certify the competencies for the teaching profession*. The dependent variables analysed were the technological self-efficacy specific to digital competences, defined within DigComp as the competence dimension for the teaching profession of students, the constructs of TAM and the perceived self-efficacy in relation to the use of educational technologies. A quasi-experimental design was applied with an experimental group (73 respondents) and a control group (64 respondents). The research approach was built by correlating the objectives, research questions and established hypotheses. Self-efficacy was approached in the research from a multidimensional perspective: (1) technological self-efficacy specific to digital skills (AT), assessed through items aligned with the DigComp framework and (2) perceived self-efficacy in relation to the use of educational technologies (AE), assessed by the constructs: altruism, freedom, achievement and expression (Masrom, 2007; Redecker, 2017; Shank and Cotten, 2014; Vuorikari et al., 2022).

The research methodology was quasi-experimental, using investigation and experiment as main methods. The selection criteria of the research methods aimed at optimizing the flow created by collecting and processing the data to be in correlation with the research design and the established working hypotheses. The survey method, as a quantitative research method, was used to collect data and identify the established variables over time, the measurements being made: (i) at the end of the first semester of the academic year 2022 – 2023 as a result of completing the disciplines related to the 5 semesters of study within the PFP including Pedagogical Practice 1 and Computer-Assisted Training and (ii) at the end of the second semester of the same academic year, after the introduction of the intervention program and the development of pedagogical practice activities. The purpose of the survey was to identify: (i) the level of technological self-efficacy specific to the digital competences taken from DigComp that complement the framework of competences for the teaching profession of students, future teachers, (ii) the level of perceived usefulness, perceived ease of use, attitude and intention to use technology in teaching as attributes of the technology acceptance model (TAM) and (iii) the level of self-efficacy perceived in the report with the use of educational technologies. The population category was represented by the students of the level I psycho-pedagogical training program within the Technical University of Cluj-Napoca – North University Centre of Baia Mare. The survey we opted for was the cohort survey, the same sample being kept on which repeated measurements are made. The research tool was represented by the electronic questionnaire applied through the Microsoft Forms application. *The experiment method* was applied to track the impact of the independent variable on the dependent variables. The research was carried out between October 2022 and September 2023 and comprised three stages:

a. Pre-experimental stage:
   i. the establishment of the experimental and control groups;
   ii. measurements of dependent variables at the level of participant samples;
b. Experimental stage:
   i. introduction of the independent variable at the level of the experimental group;
   ii. control of dependent variables for each group;
c. Post-experimental stage:
   i. measurements of dependent variables at the level of the experimental group and the control group;
   ii. comparison and analysis of post-experiment differences.

Data collection within the experiment method was achieved by using the questionnaire designed according to the survey research method.

The content sample was represented by the Blended Learning Educational Program for the integration of technology into the pedagogical practice of the students of PFP. The sample of participants was represented by the students of the third year of the PFP to certify the competencies for the teaching profession level I within the Technical University of Cluj-Napoca – North University Centre of Baia Mare (UTCN – CUNBM). The sampling method used in this research study was nonprobabilistic, such as voluntary sampling. This type of sampling involved the inclusion in the study of students who chose to participate on their own initiative in response to the invitation to participate. The criteria for inclusion in the sample were established in accordance with the objectives of the research and were represented by belonging to the target group - third-year students enrolled in the PFP - and expressing informed consent to participate.

To verify that the sample size was adequate, a statistical power analysis was performed after data collection, post-hoc, using the G*Power application, version 3.1.9.4 (Faul et al., 2007). The values used as input data were represented by: (i) sample size, 137 respondents, (ii) the number of respondents of the experimental group, 73 participants, and of the control group, 64 participants, (iii) the level of significance (α) with a value of 0.05 and (iv) effects of medium intensity (Cohen, 1988). In educational research, a minimum level of statistical power of 0.80 is considered adequate for observing significant effects (Field, 2018).

The analysis of the statistical power for the t-test to compare the experimental group with the control group, with an effect of average size (d), i.e. 0.5, indicated a statistical power of 0.826. This value suggested the 82.6% probability of observing significant differences between the two groups, provided that the effect manifested itself in the population. As the reference threshold of 0.80 was exceeded, the sample size was adequate for testing assumptions on differences between groups. Considering the pretest - posttest design of the experimental research, to apply the t-test for paired samples, the statistical power analysis was performed for each group. In the case of the experimental group consisting of 73 respondents, with a mean size effect (dz) with a value of 0.5, a statistical power of 0.988 was recorded, which showed a very high probability of observing the changes generated by the educational intervention. For the control group of 64 respondents, the analysis revealed a statistical power of 0.976, which also highlighted a very high probability of identifying differences between the pretest and posttest measurements. In order to test the differences between the groups based on the moderating variables, faculty or age range, the results of the analysis by the effect values (f) of 0.25, the sample size represented by 137 respondents, and 2 groups, showed a statistical power of 0.828 which confirmed that the sample was adequate to identify the differences between the experimental and control groups based on the analysed variables. The analysis of the statistical power in the case of using the covariance analysis to track the impact of the educational program on the dependent variables, taking into account the scores at the pretest, through the values of the effect (f) of 0.25, of the sample size represented by 137 respondents, 2 groups and 1 covariate, highlighted a value of 0.828 which confirmed the adequate probability of detecting the effect of the intervention, supporting the methodological soundness of statistical analysis. To test the relationships between variables by correlational analysis, provided an average effect (r) of 0.3, the statistical power analysis indicated the value 0.949, which highlighted a very high probability of observing significant relationships, suggesting an excellent suitability of the sample for this analysis. To examine the predictive role of technological self-efficacy on the constructs of the technology acceptance model, the analysis by the effect value (f^2) of 0.15 and a predictor variable indicated a value of 0.994 which signified a very high statistical power and an excellent probability of observing significant predictive effects. The values of the statistical power obtained during the analyses were between 0.826 and 0.994, exceeding the minimum threshold recommended in the specialized scientific literature of 0.80. These results showed that the sample size was adequate to identify effects of moderate intensity.

The content analysis method used the technique of collecting and analysing the content of documents that refer to the use of technology or were available in digital format on educational platforms and was used in the analysis of written and public documents, during the period of pedagogical practice. Content analysis was selected from the systematic research methods due to its usefulness in extracting valid inferences from textual data according to the scientific context, aiming to identify, codify and interpret relevant elements related to the use of technology in education. The research was carried out in the context of the pedagogical practice related to the academic year 2022 – 2023, in an educational context in which: (i) digitalization was accelerated by the previous experience of online education during the pandemic period; (ii) the use of educational platforms in teaching activities has become a trend of European rules on digitalisation in education and (iii) the development of educators' digital skills has become a priority of initial and continuous training. This context has created the favourable framework for conducting a rigorous analysis of the way in which technology is conceptualized, reflected and operationalized in the educational documents in force or developed between September 2022 and September 2025. The content analysis method was used to interpret and compare curricular, institutional and didactic design documents developed as: (i) support of the pedagogical practice of documentation, (ii) as reporting of the educational practices related to the research period and (iii) as products of the pedagogical practice of the students that refer to the integration of technology. The application steps were: (i) extracting representative information from various sources to ensure understanding of the way in which technology is reflected in the normative and operational documents of the education system, (ii) decoding and (iii) interpreting the messages regarding the availability in digital format on educational platforms of curricular and didactic documents and the actual inclusion of technology as a means of education for its use in educational activities teaching within pedagogical practice, (iv) comparing and establishing links between categories and (v) the formulation of the conclusions (Albulescu et al., 2021; Cohen et al., 2017; Ezzy, 2002).

The sample was represented by the corpus of documents relevant to the pedagogical practice carried out in the academic year 2022–2023 that covers all levels of pre-university education related to curricular guidelines, school organization, conducting lessons, but also documents in the form of reports on the use of technology during the research period. The sample was constituted by selecting the relevant documents to highlight the ways in which the use of technology is reflected in the normative and operational documents of pedagogical practice. The analysed documents were divided into three categories: curricular documents, institutional documents and didactic design documents. The selection of the documents was carried out through intentional sampling, aiming at the relevance of the documents for the objectives of the study, involving the structured search and inclusion and exclusion criteria respectively and going through successive stages of selection and evaluation of eligibility. The inclusion criteria were: (i) the type of document, respectively curricular - school curriculum or national curriculum -, institutional and didactic design as an element of the students' pedagogical practice portfolio, (ii) relevance to the field of study of the students enrolled in the PFP, (iii) the inclusion of mentions on educational technology and (iv) the version of the document - in force during the research period. The exclusion criteria concerned the unofficial documents and the lack of mentions on educational technology. The search sources were: the website of the Ministry of Education, the website of the National Centre for Curriculum and Assessment and institutional websites of the Maramureș County School Inspectorate and the partner pre-university education units for the pedagogical practice of the students at the Technical University of Cluj-Napoca – North University Centre of Baia Mare. The search strategy included: (i) defining keywords, such as „curriculum", „curriculum, „managerial documents, „technology, „digital, „ICT, „educational platforms, „open educational resources, „RED", "online", „Power Point, „application", and (ii) the search itself, which was carried out advanced, by using Google and Bing search engines, accessing sites such as edu.ro, legilsație.just.ro, isjmm.ro, websites of pre-university education units and manually, by browsing inside the official websites and by going through the didactic design documents available in electronic format. The screening phase provided, for each identified document, the verification of the title, the issuing institution and the thematic relevance. The evaluation of the eligibility of the document consisted of verifying the competencies or learning outcomes / operational objectives and the contents mentioning the technology, for each document, followed by the decision to include or exclude it.

Following the specialization of the PFP students within UTCN - CUNBM, we adopted a qualitative synthesis approach for the systematic review of the documentary corpus, elaborating the PRISMA diagram, summarized in Figure IV.1, to illustrate the mechanism by which the flow of information was divided into the four different stages: a) identification of documents, b) selection for inclusion, c) evaluation of quality and eligibility, and d) inclusion, data extraction and synthesis.

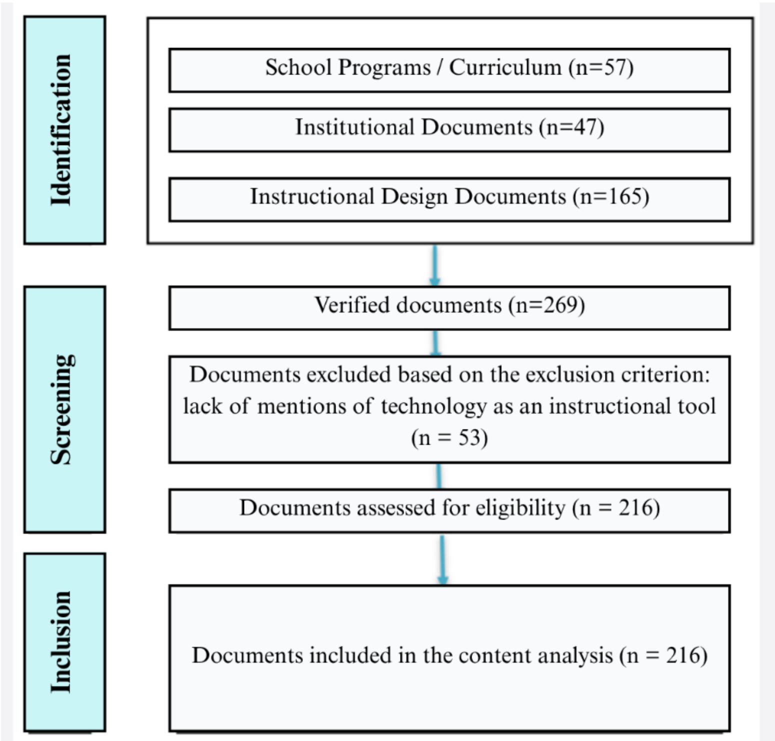

Figure IV.1 PRISMA Diagram

The use of the PRISMA diagram contributed to the clear documentation of the methodological decisions regarding the inclusion or exclusion of documents and to ensuring the traceability of the process of building the final corpus which included 216 documents collected between October 2022 and September 2025. The tool used was the checklist, developed specifically for this research, being based on: (i) the DigCompEdu theoretical framework, for identifying the dimensions of the didactic digital competence reflected in the documents, (ii) the SAMR model, for determining the level of integration of technology in teaching activities and (iii) the TPACK model**,** for analysing the coherence between content, pedagogy and technology in didactic design. Secondary hypothesis 8 of the research - *H 8 The integration of educational technology in curricular, institutional and didactic design documents is predominantly instrumental, with a higher share of the levels of substitution and augmentation than the levels of modification and redefinition and largely supports curricular* *coherence* - it has been divided into 3 derived hypotheses: Hypothesis H8/1 - *The normative and institutional documents present a more general level of integration of educational technology compared to the didactic design documents, which present concrete and applied examples*, Hypothesis H8/2 - *The analysed documents mainly include elements of digital design through the use of technology at the level of substitution and augmentation, without modifying the functionality of the learning activities* and Hypothesis H8/3 - *There is a high coherence between the curricular requirements and the integration of technology in the documents analysed*.

For the analysis of the data obtained by applying the questionnaire, statistical analysis was used to identify the correlations and association and prediction relationships between the investigated variables. Statistical analyses of the data were performed using SPSS software and consisted of descriptive analyses, t tests (paired and independent), ANOVA, ANCOVA, Pearson correlations, linear regression, EFA, reliability testing (Alpha Cronbach), KMO and Bartlett for factor adequacy. The quantitative analysis provided for the division of the sample into the subscale of technological self-efficacy specific to digital skills based on the DigComp framework (24 items), the subscale of TAM constructs (12 items) and the subscale of perceived self-efficacy in relation to the use of educational technologies (4 items). The technological self-efficacy specific to digital competences classified in the five domains established within DigComp reflects: (i) the way in which the student, future teacher, perceives his/her ability to use educational technologies autonomously, efficiently and critically to design and implement teaching strategies and (ii) the student's degree of confidence in the ability to perform on competence levels - from beginner to advanced user - in various contexts specific to the teaching profession. The Digital Competence Specific Technological Self-Efficacy Scale has been established with reference to the components of digital competence – knowledge, skills, attitudes – identified in the European DigComp Framework and adapted so that valid responses can be obtained from respondents (Annex 6).

The results of the application of the methods of the experiment and the survey showed that, in the pre-intervention phase, the students had relatively high levels of technological self-efficacy, TAM constructs and perceived self-efficacy in relation to the use of educational technologies, with variations at the age range and faculty level. The descriptive analysis from the pre-intervention stage and the testing of the initial equivalence between the experimental group and the control group was carried out in a pretest – intervention – posttest design. The distribution of respondents by groups indicated percentages of 53% in the experimental group and 47% in the control group (Figure IV.2).

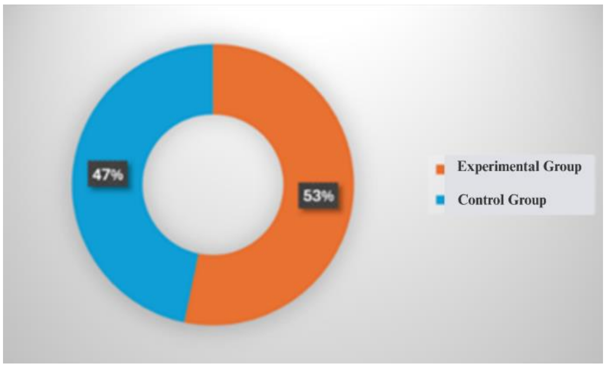

Figure IV.2 Distribution of respondents by experimental group and control group

The results on the initial equivalence of the groups to the pretest (source SPSS) are presented in Table IV.1.

Table IV.1 Results on the initial equivalence of the groups in the pretest (source SPSS)

Variable	**T-Test**	**Degrees of freedom**	**P-value**	**Difference in average values**	**95% confidence interval**
DigComp	-1.08	135	0.28	-0.20	[-0.56; 0.16]
TAM	0.39	135	0.70	0.06	[-0.26; 0.39]
AE	0.34	135	0.73	0.06	[-0.29; 0.41]

The p-values exceeded the materiality threshold $\alpha = 0.05$, and the confidence intervals of the difference in the mean values included the value zero. The absence of statistically significant differences highlighted that the experimental group and the control group were comparable at the pretest, and the internal validity of the experimental design was confirmed.

To assess the impact of the blended learning educational program, the hypotheses formulated in relation to the dependent variables investigated were tested. The analysis was performed on the final sample, N = 137 students, divided into experimental group (n = 73) and control group (n = 64). We have adopted the conventional significance threshold $\alpha = 0.05$. The choice of this threshold reflected the statistical power of the test (Field, 2018; Gravetter & Wallnau, 2014). The intervention generated relatively small increases in the size of the dependent variables, and the post-intervention differences between the experimental and control groups did not show statistical significance for all the variables analysed. Technological self-efficacy confirmed the role of: (i) a strong predictor of TAM constructs and (ii) a pivot in the acceptance and adoption of technology in teaching practice. The analysis of the results obtained from the testing of hypotheses H 1 – H 7 highlighted a coherent structure of the relationships between technological self-efficacy specific to digital competences as dimensions of competences for the teaching profession (TA), TAM constructs and perceived self-efficacy in relation to the use of educational technologies (EE), while providing a nuanced perspective on the impact of the blended learning educational programme. The main hypothesis (H 1), according to which *The systematic adoption of technologies in students' pedagogical practice leads to an increase in the level of technological self-efficacy specific to digital competences, a dimension of competences for the teaching profession*, analysed in an experimental design with an experimental group (GE) and control group (GC), has been partially confirmed. The results showed an increase in scores on technological self-efficacy specific to digital skills over time, but the interaction between Time × Group did not reach the threshold of statistical significance. Figure IV.3 shows the graph of the estimated marginal values of the mean, which shows an increase in scores between the time of pre-intervention and post-intervention in both groups. They increased: on the time axis, from 1 to 2 and on the axis of the values of the adjusted mean of the scores, from ~5.29 to ~5.70 in the experimental group, respectively from ~5.48 to ~5.90 in the control group. Globally, respondents' progress on AT was noted. The lines corresponding to each group are roughly parallel, which confirms the absence of a statistically significant interaction between the time factor and group membership. The representations in Figure IV.3 show that the experimental group maintains an upward trajectory.

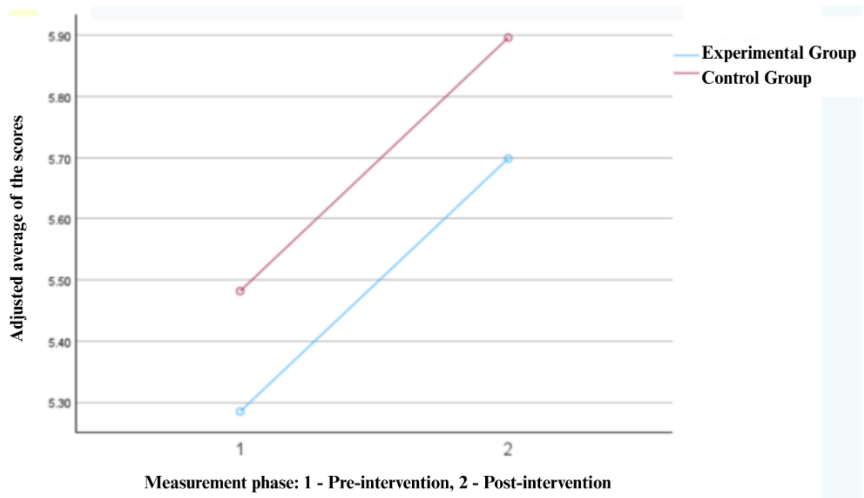

Figure IV.3 Evolution of the adjusted average values of technological self-efficacy specific to digital skills according to pretest and posttest and group membership

The graph of the estimated marginal values of the average highlights:

- increase in scores between pre-intervention and post-intervention in both groups, on the time axis, from 1 to 2 and on the axis of adjusted mean scores, from ~5.29 to ~5.70 in the experimental group, respectively from ~5.48 to ~5.90 in the control group.
- respondents' progress in technological self-efficacy.

The lines corresponding to each group, approximately parallel, confirmed the absence of a statistically significant interaction between the time factor and group membership. The verification of the effect of the intervention in relation to the control group, through the ANCOVA statistical analysis, did not indicate an effect of belonging to the group, which highlighted that the observed improvement cannot be attributed only to the blended learning educational program. The lack of a differential effect did not invalidate the relevance of the intervention but revealed that its effectiveness depended to a very large extent on the students' initial digital skills profile and the educational context in which the technology is integrated. Thus, although a positive development was observed, the clear differentiation of the effect of the intervention on the GE compared to the GC was not statistically supported.

Hypotheses H 2 and H 4 focused on the existence of initial differences in respondents' answers depending on faculty and age range. The ANOVA analyses did not reveal significant differences in the level of technological self-efficacy specific to digital skills or perceived self-efficacy in relation to the use of educational technologies. The results revealed a relative homogeneity of the sample in relation to the level of training and perceptions regarding the use of technology, possibly explainable by the characteristics of the population investigated, namely, students involved in psycho-pedagogical training.

The distribution of respondents according to faculty indicated a majority representation of students from the Faculty of Letters (45%), followed by the Faculty of Sciences (39%) and the Faculty of Engineering (16%) of UTCN – CUNBM. The distribution of participants according to age range indicated a clear predominance of students under 25 years old in the number of 107 respondents, which reflected the specificity of the investigated population, students in initial training for the teaching profession. The age categories 26 - 35 years (17 respondents), 36 - 45 years (7 respondents) and over 46 years (7 respondents) were represented in a significantly lower proportion, which highlighted the unbalanced distribution of the sample from the perspective of the age range. The results presented in Table IV.2 showed that the age range significantly influenced the initial level of technological self-efficacy, the differences between age groups not being random, as students from different age categories did not start from the same level of technological self-efficacy.

Table IV.2 Factorial variance analysis for DigComp_pretest by faculty and age range (source SPSS)

Source of variation	**Degrees of freedom**	**Value of the F indicator**	**P-value**	**Value η²p**
Faculty	2.125	0.267	0.766	0.004
Age range	3.125	4.923	0.003	0.106
Faculty × Age	6.125	1.388	0.225	0.062
Note: R^2 = 0.182				

The high p-value indicated that the differences between students from the three faculties were statistically negligible, demonstrating that the field of study did not significantly influence the initial level of technological self-efficacy. Thus, the initial differences in technological self-efficacy were predominantly associated with the age range of the students and not with the faculty in which they are enrolled. Consequently, Hypothesis H 2, according to which *there are significant differences between students in terms of technological self-efficacy specific to digital skills according to faculty and age range before the implementation of the educational program*, was partially confirmed, the differences being supported only for the age range variable, not for the faculty variable.

Hypothesis H3 concerned the differences between the levels of perceived ease of use, perceived usefulness, attitude and intention to use prior to the implementation of the programme. The descriptive analyses highlighted high initial levels of TAM constructs since the pre-intervention stage, indicating a favourable predisposition towards the integration of the technology but also anticipating the relatively low degree of subsequent variations. The results indicated that students do not perceive the same: (i) how easy it is to use technology, (ii) how useful it is, (iii) what attitude they have, and (iv) how much they intend to use it. The analysis of the differences between the levels of the TAM constructs in the pre-intervention stage highlighted the asymmetric distribution of the degree of acceptance. While perceived usefulness and intention to use had comparable levels and highlighted a close conceptual association between the perception of the advantages of technology and the willingness to integrate it into teaching, perceived ease of use and attitude towards technology had distinct levels and highlighted differences in the way students perceive the usefulness of integrating technology into teaching activities.

The initial differences in perceived self-efficacy in relation to the use of educational technologies by faculty and age were tested by the bifactorial ANOVA analysis, using the composite score of perceived self-efficacy in the pretest (AE_Pretest) as the dependent variable, and faculty and age range as moderating variables. The results indicated that, prior to the intervention, the level of perceived self-efficacy was relatively homogeneous in the sample, regardless of faculty or age range, suggesting both the initial equivalence of participants from the perspective of this variable and the existence of an already high level of confidence in the use of technology among students. Consequently, Hypothesis H 4, according to which *the perceived self-efficacy in relation to the use of educational technologies in teaching activities differs significantly depending on the faculty and age range of the students before the implementation of the educational program*, has not been confirmed. Thus, prior to the implementation of the educational program, there were no significant differences in perceived self-efficacy depending on faculty or age range.

Hypothesis H 5 was based on the premise that *participation in the blended learning educational program leads to an increase in the levels of perceived usefulness, perceived ease of use, attitude towards technology and intention to use, as constructs of TAM, compared to the control group*. The results indicated increases in time for both groups, but without significant interactions in relation to Time × Group for most constructs, suggesting that the positive evolution could be attributed both to the intervention and to other contextual factors to which the students were exposed. Hypothesis H 5 has not been statistically confirmed. The blended learning educational program did not determine statistically significant increases in the levels of TAM constructs in either of the two groups. The result did not invalidate the intervention but explained that the participants already had a high level of acceptance of the technology, which limited the possibility of highlighting a differential effect. Although the mixed ANOVA analysis did not show significant interactions between the time factor and the group factor for TAM constructs, the results reflected the maintenance and consolidation of high levels of technology acceptance in the experimental group. In a university context characterized by an increased level of exposure to technology, the intervention contributed to the consolidation of perceptions and intentions in a positive direction towards the integration of technology.

The H 6 hypothesis investigated whether the experimental group had significantly higher perceived self-efficacy scores in relation to the use of educational technologies compared to the control group. The gross difference between the groups was very small, ~ 0.03, suggesting, even at the descriptive level, the absence of a relevant difference (Table IV.3).

Table IV.3 Average of posttest perceived self-efficacy by groups (source SPSS)

Group	Sample size	Media	Standard deviation
Experimental	73	5,96	1,34
Control	64	5,93	1,42

The H 6 hypothesis has not been confirmed. After controlling for the initial level of perceived self-efficacy in relation to the use of educational technologies, the results from the posttest highlighted the lack of statistically significant differences between the experimental and control groups. The high levels of self-efficacy, since the pre-intervention stage, have highlighted the openness to the integration of technology in the teaching activity, attributing to the educational program a role of stabilization and consolidation.

To test hypothesis H 7 - *The level of technological self-efficacy determines an increase in the level of perceived usefulness, perceived ease of use, attitude towards technology and intention to use*, simple linear regression analysis was performed. The theoretical foundation of this hypothesis is based on the theory of self-efficacy formulated by Bandura (1997), according to which the perception of personal competence influences motivation and subsequent behaviours. In the context of the use of educational technology, a high level of technological self-efficacy (TA) is correlated with high levels of perceived usefulness and perceived ease of use, as well as with a positive attitude and an increased intention to integrate it into the teaching activity (Davis, 1989; Venkatesh et al., 2003). Based on this association, the AT was operationalized through the composite score DigComp_posttest, being used as a predictor variable, and the TAM constructs - UUP_posttest, UP_posttest, A_posttest and IU_posttest - were introduced into the SPSS as criterion variables. Distinct regression models were developed for each dimension, given that the hypothesis aims to examine the structural relationships between variables in their consolidated form, after the implementation of the educational program. Both the predictor variable (DigComp_posttest) and the criterion variables (UUP_posttest, UP_posttest, A_posttest and IU_posttest) were analysed at the posttest, to ensure the internal coherence of the predictive model. Correlational and regression analyses have shown positive relationships between technological self-efficacy specific to digital skills and perceived ease of use, perceived usefulness, attitude towards technology and intention to use. These results attribute to the technological self-efficacy specific to digital skills the role of determinant of the intention to use and validate the coherence of the integrated explanatory model. The simple linear regression analysis used the composite score DigComp_posttest as the predictor variable, and the constructs UUP_posttest, UP_posttest, A_posttest and IU_posttest were introduced as criterion variables in the SPSS. The results highlighted the existence of a positive linear relationship between technological self-efficacy specific to digital skills and attitude towards the use of technology. The coefficient of determination showed that 53.1% of the variation in attitude is explained by technological self-efficacy, which reflects a considerable effect. The level of technological self-efficacy was significantly associated with the attitude towards the use of educational technology. Regression analyses indicated that technological self-efficacy specific to digital skills was significantly associated with all four components of the TAM model investigated: PEOU ($R^2 = 0.618$), UP ($R^2 = 0.558$), A ($R^2 = 0.531$) and UI ($R^2 = 0.516$), where R^2 is the coefficient of determination. The relationship between technological self-efficacy and attitude is illustrated in Figure IV.4.

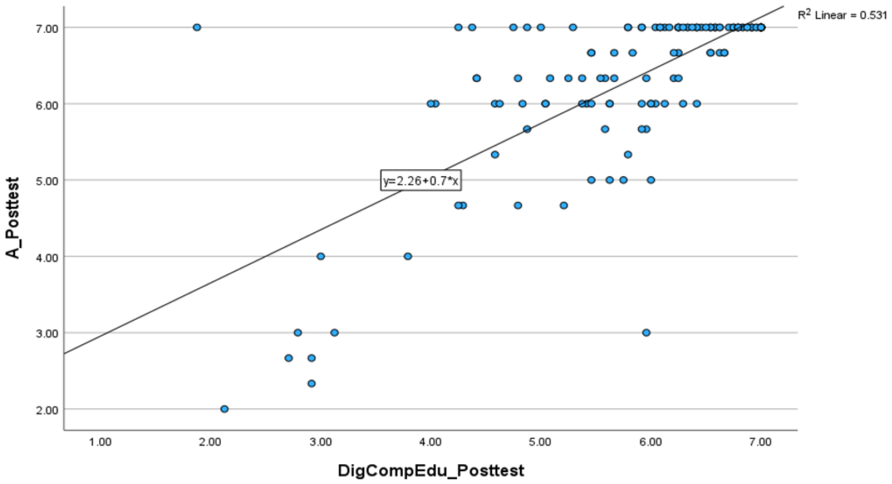

Figure IV.4 The relationship between technological self-efficacy specific to digital skills and the attitude towards the use of technology at the posttest moment

Consequently, Hypothesis H 7, according to which the level of technological self-efficacy leads to an increase in perceived usefulness, perceived ease of use, attitude towards technology and intention to use, has been confirmed.

The results of the research showed that, in the context of initial training for the teaching profession, technological self-efficacy specific to digital competences is the pivotal variable that establishes the architecture of the relationships between perceived ease of use, perceived usefulness, attitude and intention to use educational technology (Figure IV.5). The blended learning educational intervention highlighted a strengthening of the predispositions of respondents who had high initial levels of digital skills and positive perceptions in relation to the use of educational technologies.

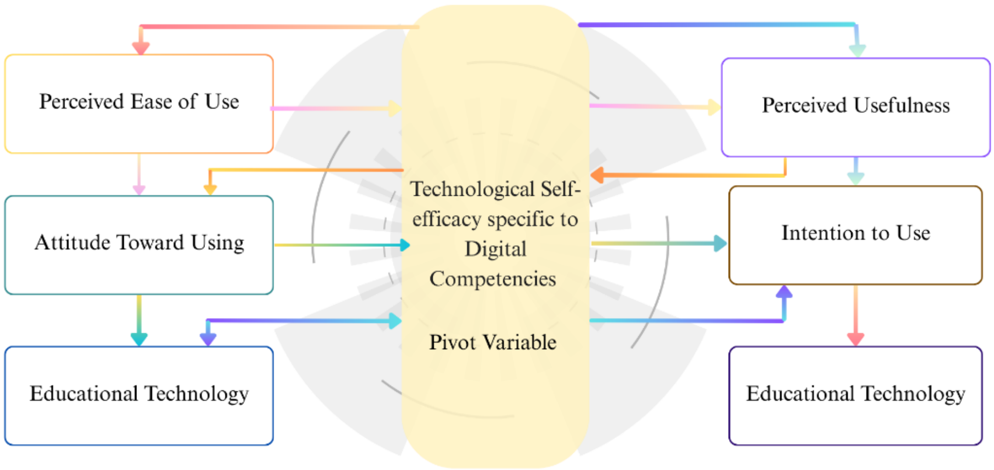

Figure IV.5 Technological self-efficacy specifies digital skills as a pivotal variable of the constructs of Technology Acceptance Model

The integrated model DigComp - TAM - AE proposed an explanatory scheme for understanding technology adoption in initial teacher training, correlating the technological self-efficacy specific to digital competences from the perspective of the DigComp framework, the constructs of TAM and the perceived self-efficacy in relation to the use of educational technologies. DigComp provided the benchmark for the digital skills that future teachers need to acquire, while TAM clarified the role of perceived usefulness and perceived ease of use in determining the attitude and intention to use digital tools as a means of education. The EA strand mediates these relationships by: (i) building confidence in the benefits of using educational technologies, (ii) stimulating their use professionally, and (iii) motivating perseverance in learning using these technologies. The integration of the three frameworks can be achieved simultaneously if: (i) digital skills training increases perceived usefulness, which fosters intent to use, and (ii) technological self-efficacy enhances perceived ease of use and facilitates the shift from intention to actual use. The model provides a coherent framework for the design of initial training programmes aimed at both developing digital skills and improving professional practices.

For the application of the content analysis method, a mixed research design was used, integrating the pragmatic perspective to provide a broad view of the studied phenomenon. The inclusion of Objective O 5 and hypothesis H 8 in the doctoral thesis represented the transition from a purely experimental approach to a methodological triangular one. This blended approach allowed not only to measure the impact of technology adoption, but also to understand the barriers or factors that support its integration into teaching, learning and assessment. The application of content analysis consisted of operating with two types of units: (1) the analysis unit (UA) represented by the entire document - the school curriculum, curriculum, organization and functioning regulations, student status, education status report, institutional development plan, learning unit project, lesson project - and (2) registration unit (UA) represented by relevant text fragments, such as sentences, paragraphs or sections containing references to technology, digital platforms, digital educational resources or technologically mediated teaching activities (Cohen et al., 2017; Krippendorff, 2019). The coding of the data was achieved by associating each fragment (UÎ) with a specific code, according to the coding scheme based on the European theoretical framework DigCompEdu and on models for integrating technology in education, SAMR and TPACK (Mishra and Koehler, 2006; Puentedura, 2013; Redecker, 2017). The coding process combined the deductive approach, based on the conceptual framework, with the inductive one, obtained from the raw data. The documentary corpus was thus made up of 216 units of analysis, 746 units of registration (UÎ) and 2074 coded segments, statistically processed data via MAXQDA software. The content analysis was carried out iteratively on three distinct levels:

- descriptive level: focused on inventorying digital resources and identifying the specific contexts in which the technology appears mentioned in the analysed documents;
- functional-pedagogical level: oriented towards the analysis of the levels of integration of technology in didactic design related to the SAMR model - substitution, augmentation, modification and redefinition;
- interpretative level: focused on the coherence between the integration of technology and the purposes of the teaching act, competences / learning outcomes / operational objectives of the lesson. This stage aimed at articulating content, pedagogy and technology in line with the TPACK model.

The coding scheme included categories and codes as follows: (i) for the descriptive level – category *Presence of educational technology* with *codes RD1 - There are explicit mentions regarding the type of devices and the use of educational technology in the form of digital content* and *RD2 - There are explicit mentions regarding the use of educational technology in the form of educational platforms and open educational resources*, (ii) for the functional-pedagogical level – category *Design of technology-assisted activities* (adaptation according to the SAMR technology integration model) (Puentedura, 2013), with *codes PD1* representing substitution (S) – *Use of educational technology as a direct substitute for traditional tools, without changing the structure of the learning task*, *PD2* representing augmentation (A) – *The use of educational* *technology by adding supporting elements, without transforming the nature of the learning task*, *PD3* representing modification (M) – *Integration of educational technology and didactic redesign, by modifying the learning activity* and *PD4* representing the redefinition (R) – *Carrying out learning tasks impossible to conceive without the use of educational* technology and (iii) for the interpretative level – category *Curricular coherence* with *codes – CC1 Lack of coherence between the use of educational technology, learning activities, competences/learning outcomes provided in the curriculum and operational objectives in the case of didactic projects*, and *CC2 – Coherence between the use of educational technology, learning activities, competences/learning outcomes provided in the curriculum and operational objectives in the case of lesson projects*.

The quantitative analysis aimed to identify the frequency and distribution of the codes applied to the registration units, to highlight the ways of mentioning the integration of educational technology in the analysed documents. The quantitative indicators of the research: (i) were represented by the numerical and/or percentage measurements obtained by quantifying the application of the codes in the content analysis, (ii) included the absolute and relative frequencies of the codes and their distribution by levels of analysis and by document types, (iii) allowed the systematic comparison of the technology integration models and (iv) supported the testing of the hypotheses formulated. The quantitative indicators used were: number of units of record analysed, total number of coded segments, absolute frequencies of codes, relative frequencies of codes, distribution of codes by levels of analysis and distribution of codes by document types. Figure IV.6 shows the relative frequencies of the codes applied to the registration units (source MAXQDA). The relatively high percentage presence of CC1 highlighted the integration of the technology only as a resource without being functionally aligned in an instructional design.

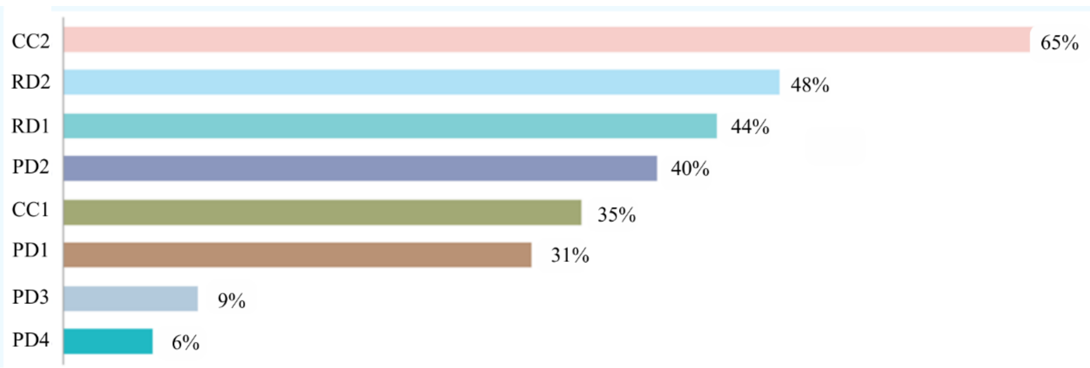

Figure IV.6 Relative frequencies of codes applied to registration units

The data represented in Table IV.4 highlighted the distribution of the frequencies of the registration units according to the type of documents and highlighted the fact that the school curricula and the curriculum represent regulatory documents and strategic orientation, in which technology is mentioned as a support for the development of digital skills and the modernization of educational practices, without systematically detailing didactic scenarios. The close share of text fragments identified in the institutional documents showed that the technology was mentioned in the contexts of reporting, monitoring and internal regulation. The didactic design documents, which highlight the pedagogical space in which the integration of technology should materialize at the operational level, recorded the lowest share of coded fragments. From the perspective of the SAMR and TPACK models, a predominance of lower levels of integration, substitution and augmentation, and alignment between content, pedagogy and technology was observed in a relatively small share. The results obtained confirmed the H8/1 hypothesis, according to which the normative and institutional documents presented a more general level of integration of the technology compared to the didactic design documents, which include fewer mentions, but with a higher potential for practical applicability.

Table IV.4 Distribution of the frequencies of the registration units according to the type of documents

Type of documents	**Absolute frequency of UÎ**	**Relative frequency of UÎ (%)**
Curricular documents	279	37
Institutional documents	269	36
Didactic design documents	198	27
TOTAL	746	100

The qualitative analysis aimed at interpreting the coded text fragments, with emphasis on the pedagogical meanings of the integration of educational technology. The qualitative indicators of the research focused on the presence and typology of educational technology, the functional-pedagogical ways of using it and the degree of curricular coherence between technology, learning activities and operational competences/objectives. The qualitative indicators of the research were: the presence of educational technology in documents, the typology of digital resources, the functional-pedagogical level of technology integration folded on the SAMR model and the degree of curricular coherence folded on the TPACK model (Creswell & Plano Clark, 2018; Krippendorff, 2019; Mishra & Koehler, 2006; Puentedura, 2006; Redecker, 2017). The dominance of the S - substitution and A - augmentation levels of the SAMR model (71%) revealed that the technology is mainly used as a support for the streamlining and optimization of traditional pedagogical practices, without producing changes in the architecture of teaching, learning and assessment. The M - modification and R - redefinition levels were poorly represented, which reflected an integration of technology only as a mediator of pedagogical transformation. Technology has been cited for profoundly reconfiguring learning tasks, facilitating authentic collaboration or building educational experiences impossible in the absence of digital media. Hypothesis H8/2 - *The analysed documents mainly include elements of digital design using technology at the level of substitution and augmentation, without changing the functionality of the learning activities*, has been confirmed.

The majority share of text fragments classified in the CC2 category (65%) reflected situations in which the integration of educational technology is carried out in a coherent way and aligned with the purposes of the educational process. The percentage of 35% of the UI classified in the CC1 category highlights that the technology is not adequately correlated with the specificity of the didactic content (TCK area of the TPACK model) nor with the didactic strategy (TPK area of the TPACK model), which leads to limited educational purposes. The results obtained indicated that the hypothesis H8/3 *There is a high coherence between the curricular requirements and the integration of technology in the analysed documents*, has been partially confirmed. On the one hand, the majority share of fragments coded in the CC2 category (65%) supported the existence of a relatively high level of coherence between the curricular requirements and the use of educational technology, especially in the didactic design documents.

The content analysis reflected that the integration of technology in curricular, institutional and didactic design documents had, to a large extent, an instrumental character in the area of improvement of the SAMR model, the transformative elements and the integration in the core of the TPACK model being insufficiently represented and highlighting a gap between normative intentions and practical application. The analysis in relation to these two integration models, at a descriptive level, highlighted technology as frequently present in the form of open educational resources and educational platforms, reflecting an institutional assumption of the digitization of education. The quantitative indicators confirmed this high visibility, and the qualitative analysis revealed a predominantly enumerative nature of these mentions. The functional-pedagogical analysis of the integration of educational technology, based on the SAMR model, highlighted a dominant profile of instrumental use of technology, characterized by the dominance of the levels of substitution (PD1) and augmentation (PD2). The quantitative indicators showed significantly higher weights for the improvement area than for the transformation area, which was poorly represented in all the documents analysed, as can be seen in Figure IV.7. This distribution has been confirmed by the qualitative analysis of coded fragments, in which technology has frequently emerged as a substitute for traditional educational means, e.g. the use of the digital textbook instead of the printed one, or as a functional support for streamlining existing activities, e.g. multimedia presentation or digital worksheets. At the level of substitution, from a pedagogical perspective, a minimal integration was reflected, with limited impact on the teaching process and on the students' learning experiences. The level of augmentation highlighted an orientation towards efficiency and accessibility, rather than pedagogical innovation. Codes corresponding to the higher levels of the SAMR model, modification and redefinition appeared sporadically. The classification with low shares in the level of redefinition indicated that the potential of technology to support collaborative learning, solving complex problems or producing digital content with high educational value is insufficiently capitalized in the analysed documents.

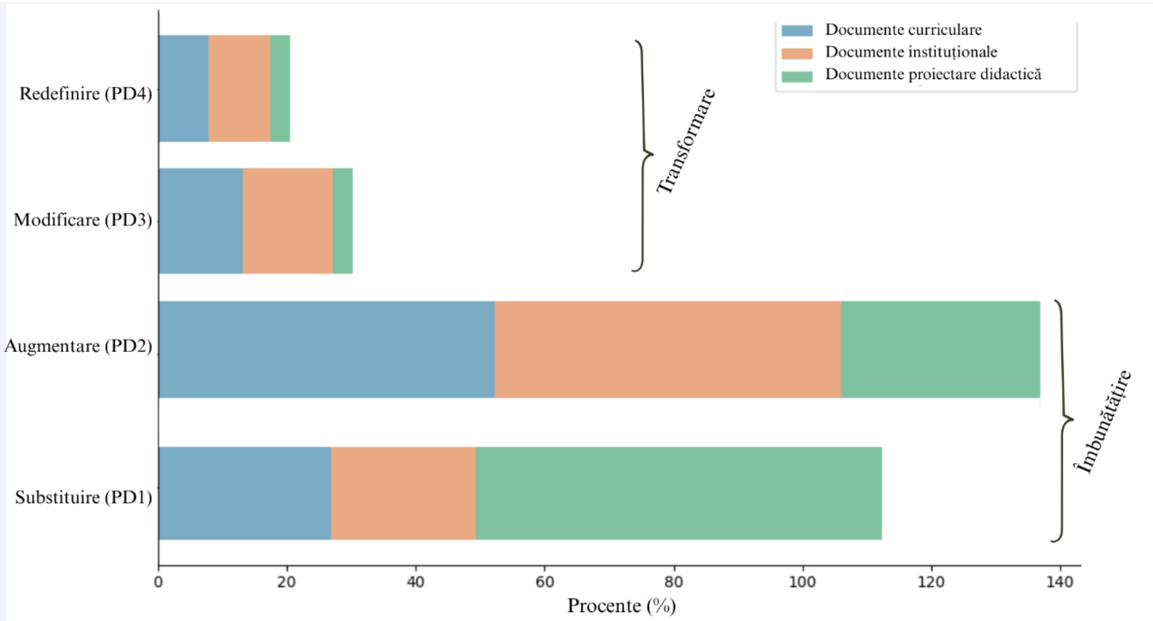

Figure IV.7 Cumulative distributions of SAMR levels by document types

The qualitative analysis of the interpretively coded text fragments highlighted frequent situations in which the technology was mentioned as a complementary element, without being explicitly integrated into the design of the learning activities. In relation to the TPACK model, the qualitative analysis of these fragments indicated:

- predominance of isolated TK, where the technology has been used without a clear pedagogical or curricular justification;
- poor correlation between TCK and competences, the technology not being adapted to the specifics of the disciplinary content;
- the absence of real integration at TPK level, leading to learning activities where technology does not support skills training.

Figure IV.8 visually highlights the difference between pedagogically grounded integration of educational technology and fragmented or only instrumental integration on the structure of the TPACK model. The CC2 category is positioned in the core of TPACK, indicating a balanced and functional integration of the three types of knowledge. This conceptual positioning reflects the situations in which the use of educational technology (TK) is selected and justified in relation to didactic contents (CK), didactic strategies and learning activities (KP) and learning competences/outcomes. The CC1 category is represented in the peripheral areas of the TPACK model, outside the central core, indicating a fragmented or incomplete integration of educational technology. Conceptually, CC1 can be associated with areas where: (i) TK is isolated from CK and PK, (ii) TPK or TCK partially intersect, or (iii) convergence to the TPACK core is absent. If CC2 reflects the coherent integration of technological, pedagogical and content knowledge at the level of the central TPACK integration area, category CC1 indicates imbalances and discontinuities between the components of the model and is in its peripheral areas.

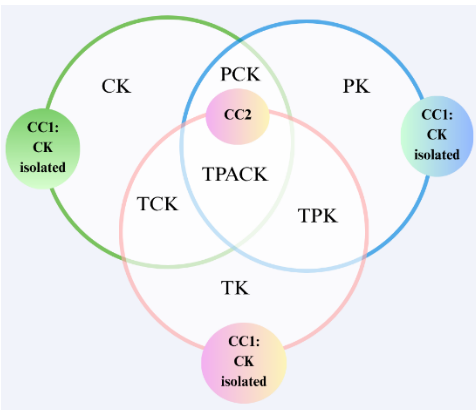

Figure IV.8 Conceptual representation of the categories' curricular coherence and lack of curricular coherence in relation to the TPACK model

The comparative analysis showed that the degree of coherence in relation to the areas of the TPACK model is closely related to the level of contextualisation of the documents. The didactic design documents, which operate with operational objectives, didactic contents and learning activities, have favoured a more coherent integration of technology, as they explicitly require the relationship between the components of the teaching, learning, evaluation process. On the other hand, documents with a normative or strategic role frequently included references to technology without specifying the concrete way of pedagogical use, which led to an integration with a low degree of coherence from the perspective of the TPACK model. This differentiation highlighted that the systematic integration of educational technology was also determined by the degree of pedagogical detail and by the reflections of the document in the real teaching practice.

The results obtained in the research by applying the content analysis method demonstrated that technology occupies a significant place in the analysed educational documents, but the level of integration varied considerably between the different types of documents. The hypotheses of the research were fully or partially confirmed, supporting the idea of a predominantly instrumental technological integration and a persistent gap between normative discourse and pedagogical practice. The conclusions of the research highlight the fact that the integration of educational technology in the analysed documents is in a transition area towards the pedagogical implementation towards the TPACK area. The results obtained can generate a considerable number of practical implications relevant to educational policies, teacher training and curriculum design. In terms of educational policies and institutional documents, the research indicates the need to go beyond approaches focused only on infrastructure and access to technology. Curriculum documents should include clearer guidance on the pedagogical integration of technology, with examples of teaching scenarios and explicit correlations of the level of digital competences in relation to learning activities.

The results highlighted a discrepancy between the three levels of the educational environment addressed in the research study on the TPACK model by Brianza et al. (2022): (i) micro, representing the class, (ii) meso, representing the institution and the community environment, and (iii) macro, representing the social, political, technological and economic environment. As a result of the content analysis, it was found that the integration of technology is more coherent at the micro level of concrete pedagogical practices, where punctual examples of functional and contextualized use appear, while at the macro-institutional level the normative framework reflects a weaker articulated and predominantly declarative integration. These observations indicate that, although pedagogical practice can develop coherent solutions for integrating technology, the regulatory framework does not always succeed in systematically and unitarily supporting these approaches.

Regarding the training through initial and continuous training programs, the results suggested the need for an adjustment at the level of training programs by reconfiguring the competences of using digital tools into digital pedagogical competences, in accordance with the SAMR and TPACK models.

Chapter IV of the thesis completes the theoretical foundation of the previous chapters, supporting the role of the digitization of education as a transformer of pedagogical models. The initial training of teachers is necessary: (i) to strengthen technological self-efficacy through the DigComp and DigCompEdu competences oriented towards digital didactic design, aligning with the TPACK model, (ii) to promote educational interventions that move from the area of improvement to that of transformation of educational practices according to the SAMR model and (iii) to adopt curricular policies and teaching strategies that ensure coherence between normative guidelines and practical technology integration scenarios. The longitudinal validation of the intervention, the extension of the study to several university education institutions and the inclusion of observational indicators of pedagogical practice to verify the transfer of acquired skills in real teaching contexts are part of the future research directions established.

The present research analysed the impact of the systematic adoption of educational technologies through the implementation of a blended learning educational program on the development of digital competences as a dimension of competences for the teaching profession of students within the PFP. The study correlated the results derived from the implementation of the educational program on the technological self-efficacy specific to digital skills, on the constructs of TAM and on the perceived self-efficacy in relation to the use of educational technologies and from the content analysis of curricular, institutional and didactic design documents. The investigative approach was theoretically based on the DigComp European digital competences framework, the DigCompEdu educators' digital competences framework, on the TAM model, the theory of self-efficacy, the theory of diffusion of innovation and the SAMR and TPACK models that were described in detail in the theoretical substantiation chapters (Davis, 1989; Mishra & Koehler, 2006; Puentedura, 2006; Redecker, 2017; Rogers, 2003). The implemented educational program was configured as a mechanism to accelerate the acceptance of technology in the educational practices of students, future teachers, facilitating the rapid transition to integration into teaching activities. In the context of initial teacher training, the results obtained from the research confirmed the validity of the TAM model by consolidating the specialized scientific literature that supports the need for differentiated educational interventions, configured according to the initial digital skills profile of future teachers (Tondeur et al., 2017). According to the diffusion theory of innovation, adoption is facilitated by testability, observability, compatibility, and the perception of relative advantage (Rogers, 2003).

The results of the research indicated an influence of the initial level of technological self-efficacy specific to digital skills on the level in the post-intervention stage. The covariance analysis indicated insignificant differences between the experimental and control groups as a result of the intervention. These two findings underlined a major theoretical implication: the development of digital skills in initial training is a process strongly dependent on the pre-existing cognitive and attitudinal base, confirming the perspective that self-efficacy is progressively strengthened, through repeated and contextualized experiences, going beyond the scope of the impact of punctual interventions (Bandura, 1997). The results were congruent with the scientific literature on the integration of technology in education, which relates the adoption and effective use of technology to previous experiences (Davis, 1989; Venkatesh et al., 2003).

Statistical analyses revealed significant relationships: (i) between perceived ease of use and perceived usefulness, (ii) between perceived usefulness and attitude, and (iii) between attitude and intention to use. These relationships confirmed the cognitive-attitudinal-intentional mechanism described by Davis (1989), according to which perceptions of the ease of use of a technology determine the formation of a favourable attitude, which subsequently influences the intention. Thus, perceived ease of use functioned as a determinant of the reduction of perceived complexity, and perceived usefulness reflected the relative advantage of the technology, in the sense defined by Rogers (2003). The educational program has contributed to reducing the uncertainty associated with the use of technology, with the technological self-efficacy specific to digital skills significantly influencing the four TAM constructs. This finding reinforced the approaches in the scientific literature according to which confidence in one's own ability to use technology is a determinant of adoption (Bandura, 1997; Davis, 1989; Rogers, 2003; Teo & Schaik, 2009; Tondeur et al., 2017; Venkatesh et al., 2003).

The results obtained through the analysis carried out prior to the implementation of the educational program did not show significant variations depending on the faculty or age range. This initial homogeneity highlighted that the educational intervention acted on a comparable level of perceived competence, reinforcing the validity of the experimental design used. The results obtained after the implementation of the educational program reflected that the technological self-efficacy specific to digital skills is not a significant outcome of the intervention, but a catalyst of the technological acceptance process that shapes the evolutionary path towards the intention to use educational technology.

In the comparative analysis, it was observed that the blended learning intervention did not generate strong differences between groups in terms of TAM constructs, but even minimal ones, compared to the time evolutions of the experimental and control groups. This situation revealed that, in a sample with high scores on the scale in the pre-intervention stage, the effect of the intervention can be difficult to statistically highlight without: (i) a longer duration and (ii) teaching tasks more focused on the transformation area.

The content analysis highlighted a coherent picture: the technology is observable in documents, but predominantly at the declarative and instrumental level, and the transition to transformative uses is rare. The results showed a gap between the normative, institutional and operational levels. Curricular and institutional documents have frequently included general formulations regarding digitization, but with reduced pedagogical articulation, and didactic design documents rarely contain mentions, but when they appear, they are contextualized in the lesson sequences as means of education. This distribution supports the conclusion that the education system tends to treat technology, at the macro level, as an object of regulations and administrative modernization, while at the micro level (the lesson), integration becomes dependent on the digital didactic design competence of educators or future educators. The distributions of the codes at the functional-pedagogical level confirmed that the integration of technology is dominant in the area of improvement by substitution and augmentation as components of the SAMR model. Modification and redefinition, the components of the SAMR model in the area of transformation, were observed much less frequently. Therefore, technology has been used mainly to streamline existing teaching routines, not for the systematic redesign of learning experiences. In terms of curricular coherence, the interpretative codes indicated situations of alignment between competences / learning outcomes / operational objectives and the use of technology in documents that address dimensions of didactic design explicitly. The observed results revealed the curricular coherence as being: (i) unevenly distributed, (ii) often declarative in curricular and institutional documents and (iii) dependent on the degree of contextualization and the quality of the didactic scenarios. The interpretation from the perspective of TPACK suggests that the documents reflect the integration of technology at the periphery of the TPK and TCK areas, and only a part of them are located in the core of TPACK, which confirms the need for systematic integration of technology with pedagogy and content.

Through the methodological triangulation of the research, respectively the correlation of the statistical analyses on the relationships between the technological self-efficacy specific to digital skills, the constructs of TAM and the perceived self-efficacy in relation to the use of technology, the evaluation of the impact of the educational intervention and the analysis of the concrete way of integrating technology in the didactic design, it can be concluded that the acceptance and intention to use the technology are significantly correlated with the level of technological self-efficacy specific to digital skills both at declarative and attitudinal level. However, the applicative analysis of the technological integration scenarios reveals a gap between the declarative level of acceptance and the operational level of pedagogically aligned integration. Most of the examples of technological integration identified fell into the first two levels of the SAMR (substitution and augmentation) model, where technology replaces traditional tools or brings limited functional improvements, without fundamentally changing the structure of learning tasks. The situations, which can be associated with the levels of modification and redefinition, characterized by the reconfiguration of teaching activities and the creation of learning experiences impossible in the absence of technology, were relatively low. This discrepancy can be explained in the light of the TPACK model according to which the integration of technology does not only imply isolated technological competence, but the convergence between technological knowledge, pedagogical knowledge and knowledge of teaching content. The results of the research highlighted that, although the technological dimension and confidence in its use have been significantly strengthened, the coherent articulation between technology, pedagogy and content, essential for the transformation area of the SAMR model, is still in the process of development.

The reporting of the results according to the European DigComp framework, in correlation with the conceptual updates in DigCompEdu, indicated that the progress made by respondents was predominantly at the level of competences associated with area 2 – Digital resources aimed at identifying, selecting, adapting and managing digital resources and, partially, in area 3 – Teaching and learning (Redecker, 2017). According to the structure of DigComp, these dimensions correspond to intermediate levels of professional development, characterized by the functional use of technology. In line with the more recent orientations in the field of education addressed in the new theoretical frameworks DigComp and DigCompEdu, the focus shifts from the simple use of digital tools to the integration of emerging technologies, contextualized pedagogical adaptation and the design of personalized learning experiences (Redecker, 2017; Vuorikari et al., 2022). The development of technological self-efficacy specific to digital skills and the strengthening of TAM constructs are necessary conditions for the adoption of technology, but not sufficient to have a significant impact on educational practices. The acceptance of technology facilitates the openness to use, but the authentic curricular transformation involves the integrated development of the TPACK components and the alignment of interventions to the current DigCompEdu standards.

The research approach has the following limitations:

1. High baseline levels of technological self-efficacy specific to digital skills (VD1 - DigComp), TAM variables (VD2a – PEOU, VD2b – UP, VD2c – A, VD2d – IU) and perceived self-efficacy in relation to the use of educational technologies (VD3 – AE) diminished the effect of the educational intervention.
2. The investigated model predominantly emphasized variables such as perceived self-efficacy, without the explicit integration of factors such as social influence or enabling conditions, which are included in extended models of technology adoption such as the UTAUT model as an extension of the TAM model (Venkatesh et al., 2003). This delimitation reduces the explanatory complexity of the model and opens up opportunities for expanding the research area.
3. The operationalisation of technological self-efficacy in relation to the components of digital competence – knowledge, skills and attitudes – was achieved without explicitly capturing the dynamic interactions between them.
4. The dependent variables were assessed by questionnaire, which implies possible distortions generated by the overassessment of competences. Perceptions of digital competence may differ from actual performance (Bandura, 1997).
5. The respondents continued their academic activities in parallel. The increases observed in the control group suggest intervention-independent contextual influences.
6. The sample consists of students enrolled in the psycho-pedagogical training program at a single university, belonging to a single geographical area and a single national context. This particularity limits the degree of generalisation of results, as the adoption of educational technology and the relationships between technological self-efficacy specific to digital competences (DigComp), the dependent variables of the TAM model (PEOU, UP, A, IU) and perceived self-efficacy in relation to the use of educational technologies (AE) can be influenced by specific cultural, institutional and curricular factors.

The identified limitations open up relevant perspectives for the implementation of educational interventions with sustainable impact.

Based on the results obtained and the identified limitations, research development directions can be formulated, such as the development of an integrative model that examines the relationships between knowledge, skills and attitudes in the construction of technological self-efficacy, analysing the mechanisms by which these components influence each other over time. In order to detect clearer cumulative and differential effects on digital competence and perceived self-efficacy, it would be necessary to use an experimental design with a longer intervention period. Medium- or long-term interventions could produce more visible effects on dependent variables such as TAM constructs. To strengthen the technology adoption model, future research should include objective behavioural indicators, such as observational assessments, which would allow the level of self-reported digital skills to be correlated with actual performance, reinforcing the validity of the DigComp construct and the sequence: competence → perceptions → intent → behaviour. Longitudinal research would make it possible to investigate the stability over time of the level of technological self-efficacy specific to digital skills and the intention to use, as well as to assess the transfer of skills into actual teaching practice. To strengthen the external validity of the proposed explanatory model, a direction of research development consists in expanding the investigation to several universities with distinct profiles, at national and/or international level.

Regarding the content analysis, a first limitation derives from the nature of the analyzed corpus, consisting only of curricular, institutional and didactic design educational documents. Content analysis captures how the integration of technology is formulated and conceptualized at the documentary level, without being able to directly evaluate the actual teaching practices in the classroom. Therefore, the results rather reflect the prescriptive and discursive framework of technology integration, not necessarily its concrete implementation in educational activity. A second limitation is related to the method used, namely content analysis, which, although it allows for rigorous investigation, inevitably involves a degree of interpretation on the part of the researcher. Even if clear coding criteria and measures to ensure validity and fidelity have been applied, the analysis remains dependent on the analytical decisions taken in the construction of the coding scheme and in the interpretation of the textual fragments. Another limitation refers to the operationalization of the levels of integration of the technology through the SAMR and TPACK models. These models are validated in the scientific literature and provide conceptual frameworks that can simplify the real complexity of pedagogical practices.

Regarding the identified research directions, a first direction would be the development and validation of operational tools based on the SAMR and TPACK models, which would allow the systematic evaluation of the level of integration of technology in didactic design and educational practice. Another relevant research direction is the longitudinal analysis of educational documents at national and international level, to capture the evolution of technology integration over time, in relation to changes in educational policies, the development of digital infrastructure and the transformations generated by various educational contexts.

This thesis aimed to connect three planes that, in educational theories and practices, are frequently approached fragmented: (i) the cognitive-motivational dimension of the acceptance of educational technology, expressed through self-efficacy and through the perceptions associated with the TAM model, (ii) the normative and institutional framework that regulates training for the teaching profession and (iii) the effective didactic design, materialized in the integration of educational technologies in teaching activities and learning. The plan of perceptions in relation to digital competences aims to combine the psychological and professional dimensions of the future teacher. Research has shown that the mere possession of digital skills does not guarantee their pedagogical integration. Variables such as technological self-efficacy, perceived ease of use and perceived usefulness play a decisive role in shaping attitude and intention to use. By including these variables in the empirical analysis, the research provided a psycho-pedagogical approach to technology adoption. The second plan, the normative and institutional one, refers to the European and national framework that regulates the development of digital skills for future teachers. Strategic documents on digital education, teacher professional profile and competence frameworks such as DigComp and DigCompEdu define standards and directions for development. The thesis critically analysed these landmarks, correlating them with the empirical data obtained. The third plane, that of effective didactic design, represents the applicative level of research. The educational program has been designed in such a way that technology is considered an integrated tool in didactic scenarios that support pedagogical innovation. The originality of the approach lies precisely in the articulation of these three planes in a coherent model of analysis.

A first contribution of the thesis to the development of educational practices consists in the integration of the technological self-efficacy construct specific to digital competences in the explanatory architecture of the technology acceptance model applied to future teachers. Although TAM has been used extensively in research on the acceptance of technology, its application in the context of initial training for the teaching profession and its systematic correlation with technological self-efficacy specific to digital skills is an innovative approach.

Also, the design and validation of a blended learning educational program explicitly designed to operationalize the increase in the level of perceived self-efficacy specific to digital skills through applied teaching experiences is another relevant contribution. The program was not only analysed descriptively but tested through an experimental design with experimental group and control group.

Another significant personal contribution is the correlation of the European regulatory framework on digital competences (DigComp) with the empirical analysis of the perceptions of future teachers. The theoretical frameworks and models of technology integration are operationalized through measurable indicators, creating a bridge between the theoretical foundation and the practical reality of the educational environment.

This doctoral thesis provides an original contribution by validating a systematic intervention model that demonstrates that digital literacy in educational practices is not sufficient on its own without an approach focused on the psycho-pedagogical factors that influence the acceptance of technology in education.

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