

The Pedagogical Integration of Digital Technologies in Initial Teacher Training

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Abstract—The use of Digital Technologies in teaching and learning processes is currently a reality, namely in initial teacher training. This study aims at knowing the digital reality of students in initial teacher training in order to improve training in the educational use of ICT and to promote digital technology integration strategies in an educational context. It is part of the IFITIC Project "Innovate with ICT in Initial Teacher Training to Promote Methodological Renewal in Pre-school Education and in the 1st and 2nd Basic Education Cycle" which involves the School of Education, Polytechnic of Porto and Institute of Education, University of Minho. The Project aims at rethinking educational practice with ICT in the initial training of future teachers in order to promote methodological innovation in Pre-school Education and in the 1st and 2nd Cycles of Basic Education. A qualitative methodology was used, in which a questionnaire survey was applied to teachers in initial training. For data analysis, the techniques of content analysis with the support of *NVivo software* were used. The results point to the following aspects: a) future teachers recognize that they have more technical knowledge about ICT than pedagogical knowledge. This result makes sense if we consider the objective of Basic Education, so that the gaps can be filled in the Master's Course by students who wish to follow the teaching; b) the respondents are aware that the integration of digital resources contributes positively to students' learning and to the life of children and young people, which also promotes preparation in life; c) to be a teacher in the digital age there is a need for the development of digital literacy, lifelong learning and the adoption of new ways of teaching how to learn. Thus, this study aims to contribute to a reflection on the teaching profession in the digital age.

Keywords—Digital technologies, initial teacher training, pedagogical use of ICT, skills.

I. INTRODUCTION

THE integration of digital technologies in teaching-learning processes is currently a reality responding to social, economic, scientific and technological changes in societies. In fact, the changes and transformation of educational practices that they promote in an internship situation necessarily involve the availability of technological devices, the opportunity they offer through pedagogical strategies that sustain active practice, but also require professional knowledge of a technical and pedagogical nature specific to the different disciplinary areas [26]. In this context, initial teacher training presents a unique responsibility in training teachers capable of intervening critically and creatively in pedagogical renewal in the context of a multicultural, technological and knowledge

society [27]. In fact, students, future teachers, must leave equipped with scientific, technical, deontological and pedagogical knowledge and skills appropriate to the use of digital technologies in a conscious and appropriate way, in order to eradicate with an excessively theoretical training and out of step with the reality of schools and classrooms [3], [4], [8], [10], [12].

This study is part of the IFITIC Project "Innovate with ICT in Initial Teacher Education to Promote Methodological Renewal in Pre-school Education and in the 1st and 2nd Cycles of Basic Education" which involves the School of Education, Polytechnic of Porto and Institute of Education, University of Minho, and aims to rethink educational practice with ICT in the initial training of future teachers in order to promote methodological renewal in Pre-school Education and the 1st and 2nd Cycles of Basic Education.

It is a qualitative research with the main purpose of knowing the digital reality of students to better manage and train their ICT training and promote integrated digital technology strategies in an educational context. For data collection, a questionnaire with open and closed answers was used applied to students in initial teacher training. In this article we treat some of the open answers through content analysis, with support from *NVivo software*.

II. THEORETICAL FRAMEWORK

Initial Teacher Training

The inclusion of Information and Communication Technologies (ICT) has opened very interesting perspectives for education [21], leading to the reconstruction of the professional teaching identity. It is therefore important to reflect on the implications for the ways of teaching, understanding how schools are responding to ICT integration, and how teachers have renewed their practices. These changes, to which teachers in initial training are exposed, involve processes of maturation and integration in contexts, so that in the educational framework and in the initial training of teachers disruptive innovation is avoided [9].

According to [21], teacher training institutions must be consistent in building institutional programs that link discourse to practice and vice versa. It is in this sense that the university must (re)organize its pedagogical activities in such a way as to replace the traditional classes with orientation, tutoring and supervision activities, as well as building work and research groups dedicated to the critical reflection of knowledge and its continuous reconstruction.

In [22], the issue of teacher training is a worldwide reality and, from his perspective, should be thought with the five axes

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shown in Fig. 1 as guidelines. In this way, the author reinforces that the teacher training must privilege a strong practical component in a real intervention context. It should also be based on the construction of a professional culture, which designates *moving into* the profession, promoting an exchange of experiences and knowledge between the most experienced teachers and the youngest teachers who are training as teachers. Reference [22] also states that there should be the development of personal dimensions that involve the ability to relate and communicate, which he calls *pedagogical tact*. It also emphasizes the idea that in the process of teacher training, teamwork that leads to the collective exercise of the profession should be stimulated and implies a *social responsibility* that stimulates communication, collaboration and participation among teachers in the educational space. Besides these principles, [22] believes that new technologies are a constant challenge in the development of educational practices in the initial and continuous training of teachers and that training institutions must be prepared to accompany these changes. In this way, the institutional supervisor, an experienced professional, must create the conditions for students to understand the technology and its educational use in order to incorporate it into their teaching practice. In this way, he will be mitigating the main problem of integrating ICT in pedagogical practices, which is not so much limited to the difficulty of appropriation of the technique, today almost overcome, but above all, according to [1], to the difficulty of designing strategic plans on how to integrate them in order to promote significant practices to be an added value in the learning. It is also expected that the institutional supervisor will value the person he learns, fostering in his students a critical and creative attitude towards the great issues of society [24]. This professional and personal development also materializes in the workplace through the experiences made in real contexts and reflected in an environment of dialogue with peers in training, in order to improve the process of teaching and learning [13]. It is therefore essential to instigate specific training that links teaching practices to technology, building a technological didactic and accompanying the *digital revolution* we are witnessing [17], [20].

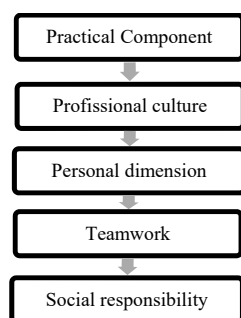


Fig. 1 The five axes that guide the formation of the teacher (Own Authorship, based on [22])

III. METHODOLOGY

In this study, a qualitative methodology was used. Qualitative research focuses on understanding the phenomena, exploring them from the perspective of the participants in a natural environment and in relation to their context [28]. A questionnaire survey was applied to 38 students of the Basic Education Degree in order to collect their thoughts and opinions on the subject under study [29]. The characteristics of the sample and the time at which the investigation takes place influence the value of the information collected. Thus, it should be noted that the questionnaire was applied at the end of the school year, the universe of study being students of the Degree in Basic Education.

For data analysis, the content analysis techniques were used [7]. Its proper use will depend on advance planning that takes place in three stages [2]: pre-analysis; data exploration; and data processing. The data processing phase includes the coding and categorization of the data. The organization of the codification comprises three moments: a) the choice of the registration units; b) the enumeration: choice of the counting rules; and c) the classification and aggregation: choice of the categories [2]. According to the same author, the selection of the registration units to be coded is an extremely delicate and important operation in the analysis process. It is important in this type of technique to define the registration units, context units and enumeration units. The registration unit, still according to [7], refers to the element of meaning to be codified, to be classified and to which it is assigned to a certain category. There are two types of registration units: semantic or thematic registration units and formal registration units. As far as context units are concerned, they refer to a message segment that is more comprehensive than the registration unit. Finally, enumeration units appear when the researcher deems it appropriate to make some quantification of occurrences [7].

The categorization is considered an operation of classification of constituent elements of an ensemble, by differentiation and then by regrouping according to gender (analogy), with the criteria previously defined [2]. Reference [7] states that categorization integrates two inverse processes: on the one hand, a closed procedure in which one has a pre-defined system of categories from the literature or hypothetical theoretical workings; on the other hand, an open procedure, in which the categories of analysis are created as data are analyzed. In the case of this analysis, the open procedure was chosen, since the name of each category was only defined during the data analysis process, that is, the categories of analysis were created as the data were being analyzed [2].

In this work, only a few questions from the questionnaire will be analyzed (Table I). It should be noted that question 3.1 follows on from this previous question *Do you feel prepared to use digital technologies with children in a formal (at school, for example) or informal (at home, for example) context?* whose scale of response was: *Yes formal*; *Yes informal*; *No formal* and *No informal*. This question was subject to a quantitative analysis, we only refer to it for the

purpose of contextualizing question 3.1.1 below.

TABLE I
ANALYZED QUESTIONS

Q. 3.1 Please justify indicating:
Q. 3.1.1 the knowledge you have and that would facilitate this use.
Q. 3.1.2 or it doesn't and would make it difficult.
Q. 4 What contribution can technology provide to:
Q. 4.1 students' learning.
Q. 4.2 the lives of children and young people.
Q. 6 Tell us what it is like for you to be a teacher in the digital age.

IV. DATA ANALYSIS AND DISCUSSION

According to the above analysis techniques, it was possible to identify three categories (Table II).

TABLE II
CATEGORIES AND SUBCATEGORIES OF ANALYSIS

CATEGORY A- Preparation for ICT use
A1- Knowledge that possesses and facilitates the use
A1.1- Didactic-pedagogical knowledge: It refers to the knowledge related to the teaching process, such as the selection of the content to be taught, the intentionality of this content, the resources adopted in class, as well as the selection of methods and strategies geared to the needs of students.
A1.2- Computer knowledge: It refers to capabilities developed through a digital device, such as working with Windows tools, as well as the use of <i>software</i> and <i>hardware</i> .
A2- Knowledge that does not have and makes it difficult to use
A2.1- Didactic-pedagogical knowledge: It refers to the knowledge related to the teaching process, such as the selection of the content to be taught, the intentionality of this content, the resources adopted in class, as well as the selection of methods and strategies geared to the needs of students.
A2.2- Computer knowledge: It refers to capabilities developed through a digital device, such as working with Windows tools, as well as the use of <i>software</i> and <i>hardware</i> .
CATEGORY B- Positive contribution of ICT usage
B1- In the students' learning process
B1.1- Cognitive effects: It refers to issues that fall under the process of knowledge acquisition, and that arise from the use of ICT by students.
B1.2- Socio-emotional effects: It refers to social and emotional issues, namely the management of emotions in the relationship with others, caused by the use of ICT.
B2- In the lives of children and youth
B2.1- Development of your digital literacy: It refers to the effective use of digital technology by children and young people, whether related to the operation of technological equipment or programs.
B2.2- Socio-emotional effects: It refers to social and emotional issues, namely the management of emotions in the relationship with others, caused by the use of ICT.
B2.3- Responding to current challenges: It refers to the challenges faced by the information society that can be met through the use of ICT.
CATEGORY C- Being a teacher in the digital age
C1- Development of digital teaching literacy: It refers to the effective use of digital technology by teachers, whether related to the operation of technological equipment or programs.
C2- In-service training of teachers: It refers to the constant development of teaching skills, in which teachers must be open to new ideas, decisions, skills or behaviors.
C3- New ways of teaching: Refers to new teaching strategies and activities that pedagogically integrate the use of ICT and that promote significant learning in students.

To support the data analysis, the *NVivo software* was used. *NVivo* is a qualitative data analysis software, which helps to

organize and analyze multimodal data, that is, text, audio, video, image, tables, online surveys, information from websites and social networks, among others.

A. Preparation for the Use of ICT

With regard to the first issue analyzed, it was intended, on the one hand, to understand what knowledge students in initial teacher training had and that would facilitate the use of ICT and, on the other hand, what knowledge they did not have and that would hinder the use of ICT. For the analysis of this issue, the *project's map* functionality was used, Fig. 2, built using *NVivo software*. The figure shows the *project map* of the analysis of the questions, associating the subcategories to the sources (context units) of the 38 respondents. There are context units that are not linked to any subcategory such as "I02"; "I25"; "I27"; "I33" and "I38", which shows that the students did not answer any of the questions posed.

It is found that computer knowledge is the most evident in the subcategory Knowledge it has and facilitates its use. In fact, students say they know *Windows* tools like "*the PowerPoint, the Word...*" (I03) "*Prezi, Excel, Audacity, Movie Maker*" (I11). Others reveal computer knowledge of *hardware* and *software* "*Ability to use, in general, computer, speakers, projector and (a little) interactive whiteboard*". (I16) "*Basic knowledge learned from the regular use of computers, software and applications*". (I19) "*Domain of specific programs*." (I20).

We also point out that one of the respondents states that he has this knowledge due to the fact that he learned it in previous school levels, namely in the 1st cycle of basic education, in secondary education and in higher education "*The basic knowledge, acquired with the frequent use of the computer, with the computer classes that I had until the 4th year, with a computer course that I had in the 12th year and with the ICT class that I had in the 1st year of this course*". (I18), which reveals an attempt by educational institutions to develop knowledge and digital skills in students from an early age. As for didactic-pedagogical knowledge, these appear with only 6 registration units, which shows that students still have little knowledge related to the pedagogical use of ICT, namely the selection of digital media according to the contents to be treated and the skills to be developed in the classroom. However, some of the students show an interconnection between technical and pedagogical competence [1], visible in the adequacy of technological tools for learning "*exploration of applications/games allusive to the contents addressed*" (I06), namely digital resources related to the teaching of mathematics as "*geogebra*" (I09) or teaching platforms as "*virtual school*" (I09). This little didactic-pedagogical knowledge would be expected, since they are students attending the Degree in Basic Education, a common core of studies not specifically directed to teaching, which does not include any Curricular Unit in its study plan regarding the pedagogical use of ICT nor any didactic curricular component. This situation may be mitigated when attending the Master's Degree, the next degree and indispensable for teaching professionalization in Portugal.

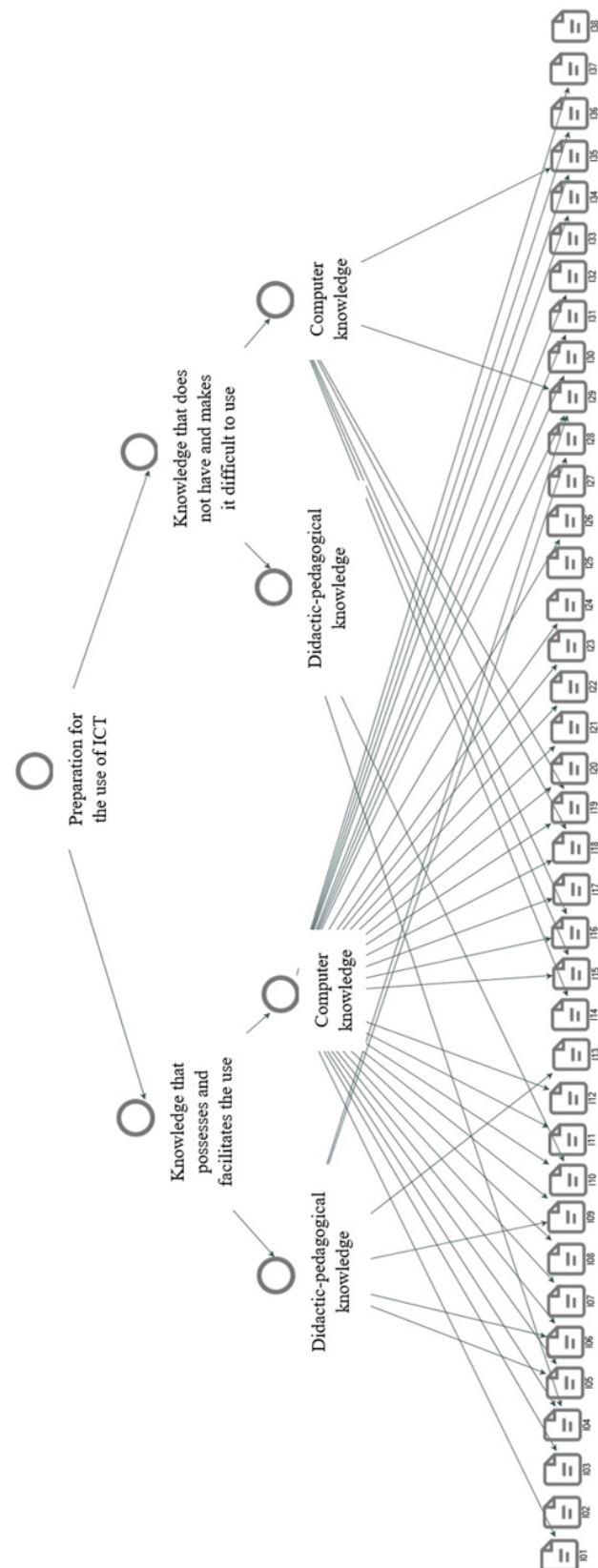


Fig. 2 *Project's map* of the knowledge that the students have and do not have

The subcategory Knowledge that do not have and make it difficult to use, presents again the predominance of the subcategory Computer knowledge, revealing that despite dominating certain tools of *Windows, hardware and software*, some difficulties still persist, namely "*Knowledge about the operation of the interactive whiteboard and some specific programs*". (I15); "*Certain programs more difficult to work*". Students consider that they have more instrumental knowledge of using technology than didactic-pedagogical knowledge; however, they state that they still need more computer knowledge. This situation can be justified by the fact that the study plan of these students in the Basic Education Degree does not have any didactic curricular unit or the pedagogical use of ICT, as mentioned before. It is then up to the

universities to reflect in order to align the formation of future teachers with social and technological evolution, knowing that the learning process is continuous [25].

As for didactic-pedagogical knowledge, which was mentioned in smaller numbers, with only 2 registration units, and which reveal that effectively one of the main barriers to the pedagogical integration of ICT in the classroom is not so much the mastery of technology, but mainly the difficulty in understanding the countless potentialities it may have if pedagogically integrated in the classroom [1]. The same information can be seen in Fig. 3 as a *tree map*, in which the relative frequency with which a certain subcategory appears in each context unit is perceptible.

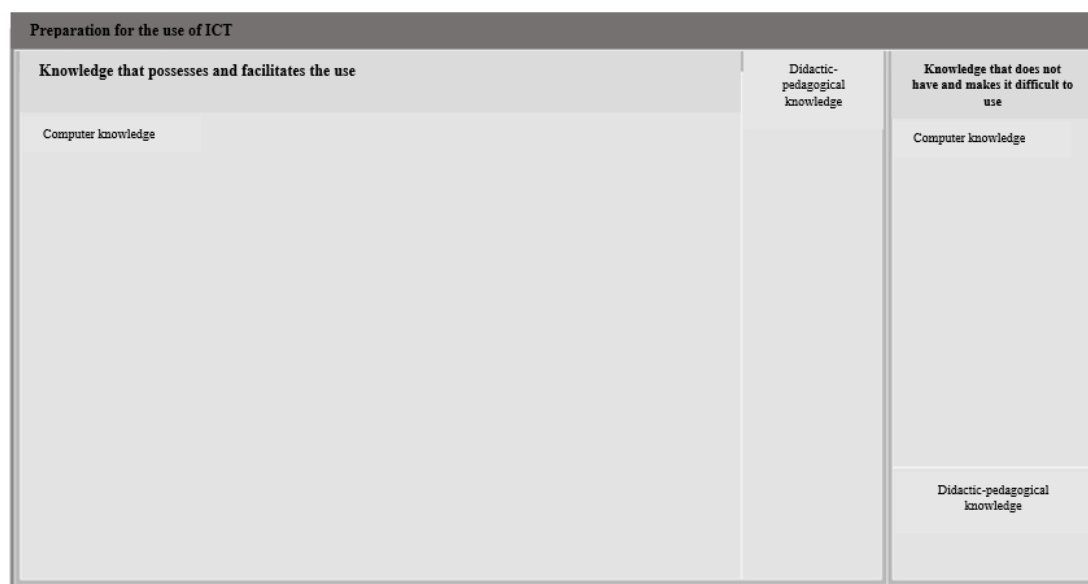


Fig. 3 Tree map of the knowledge that students have and do not have

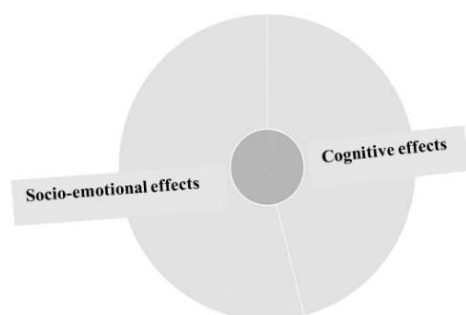


Fig. 4 Circular chart on the contribution of ICT to student learning

The sum of the relative frequency per subcategory reveals the amount of coded registration units, evidenced by the area of each rectangle in each subcategory.

B. Positive Contribution of ICT Use

The second issue is to understand the positive contribution that students in initial teacher training make to the use of ICT in student learning and in the lives of children and young

people. For the analysis of the subcategory In the process of student learning, a circular graph was used, built in *NVivo software* (Fig. 4).

Fig. 4, within *NVivo*, is interactive, and you can see not only this subcategory but also the rest, as well as the units of record present in each of them. As we can see in Fig. 4, the subcategory *Social-emotional effects* is the most evidenced in the students' responses, with 27 registration units. There are responses that refer to emotions caused by the use of ICT in student learning "*technology can help motivate children*" (I10); "*It can encourage, captivate students*". (I25); "*produces greater attention, motivation and curiosity*". (I03), but also for more social issues such as "*More interaction*" (I19); "*Being more critical, having your own opinion*" (I38); "*Communicating*" (I38).

With 23 registration units, we find the subcategory Cognitive Effects, highlighting the idea that ICT enables a change in the way students learn the curricular contents in the classroom "*promotion of significant learning*". (I23); "*We can create and give much more productive and meaningful classes*

to students, using the new technologies" (I27); "It makes learning interactive, stimulating and more appealing, because the visual stimuli attract students' attention". (I28); "Can provide more meaningful and didactic learning". (I29). These students also consider that technologies can enhance learning in which the student is an active agent in this process, possible with active teaching methodologies [18] "Hold their attention more, allowing them to be active in their learning process" (I36).

Clearly, the socio-emotional and cognitive effects are

articulated, because "... the use of ICT in school helps in the social promotion of culture, norms and traditions of the group, at the same time, a personal process is developed that involves style, aptitude, motivation. The exploration of images, sounds and simultaneous movements provides students and teachers with opportunities for interaction and production of knowledge". [12, p.13]. To complement the analysis carried out, a word tree (Fig. 5) was constructed, having as central word *learning*, showing the different contexts in which it appears in the registration units.

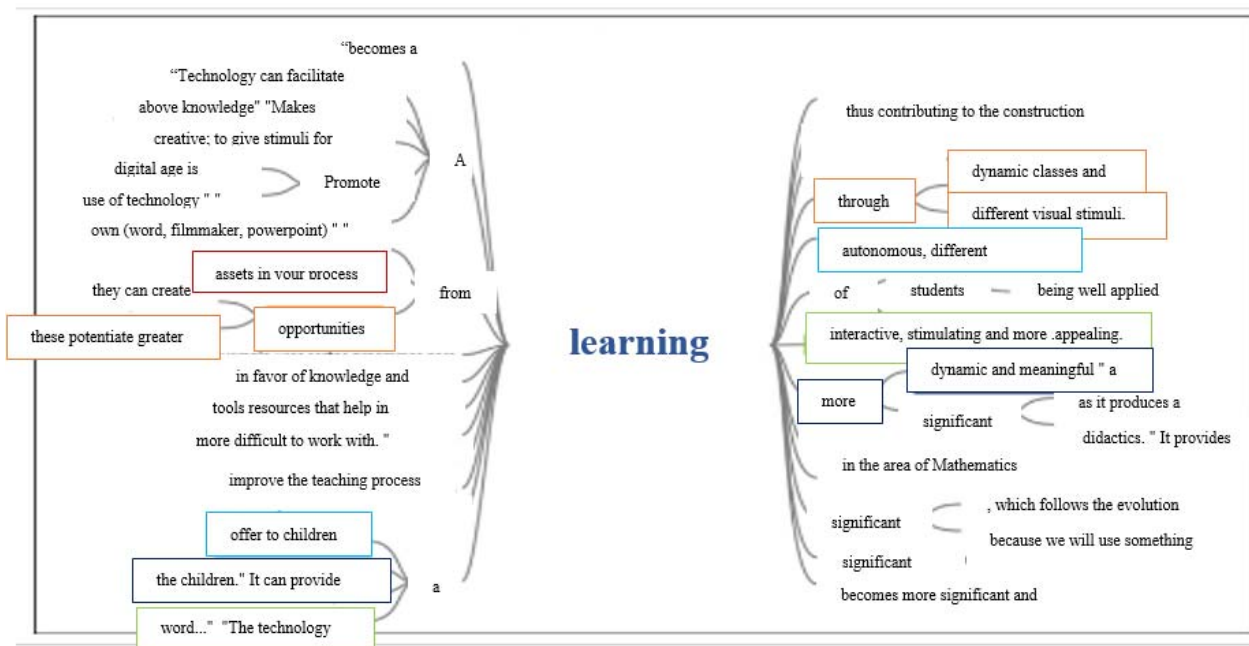


Fig. 5 Tree of words with the word learning

Through its analysis, it is possible to verify the reinforcement of the idea that ICT effectively contributes to the learning of students, "active in their learning process"; "they enhance learning opportunities through dynamic classes and different visual stimuli"; "to offer children autonomous, different learning"; "it can provide more dynamic and meaningful learning" and "technology allows interactive, stimulating and more appealing learning" [19] (taken from the word tree), and therefore it is necessary to enhance ICT in the planning and implementation of teaching-learning activities, integrating them in a coherent curricular perspective [24].

For the analysis of the subcategory in the life of children and young people, the construction of a mental map (Fig. 6) was used in the NVivo software. In this mental map we find the subcategory positive contribution of ICTs in the lives of children and young people, the 3 subcategories built and the key words we identify in the respective registration units.

It can be seen that students have referred to socio-emotional effects as one of the positive contributions of ICT use, integrating aspects such as motivation, creativity, autonomy and attractiveness "Allows them to become motivated, creative and autonomous". (I23); "They become more motivated,

creative and interested children/young people". (I22), as well as the interaction "Easier to communicate" (I37). Students also mention that the use of ICTs contributes to the development of digital literacy of children and young people because it allows them to learn by themselves, making their daily lives easier "It can make them learn by themselves and makes their daily lives easier". (I04); they state that it is important to develop digital skills that allow them to understand and master the language underlying cyberculture and the digital age in which we find ourselves [16] "Knowing how to contact and develop projects using a computer and making their lives easier because everything revolves around new technologies." (I36); "In their professional future they will have to use the technologies in their daily lives and, therefore, it is very important to learn from an early age" (I08). It is clear that the subcategory responding to current challenges is closely related to the one previously exposed, since it is important to foster in young people the development of key skills for the world in which they live [11], which requires the development of digital literacy, stimulating skills that can help to give answers to challenges that enter the day-to-day life of each one and that require constant updating of information about the world,

using ICT as a means of responding to these demands: "They have become better able to meet the demands of today's world with regard to technology." (I13); "To have greater, faster and more varied access to information" (I02), to have greater

contact with the world "technology allows children and young people to know the world around them better" (I09), "Greater contact with the world and the different existing realities". (I14); "To be in contact with everyone at any time". (I18).

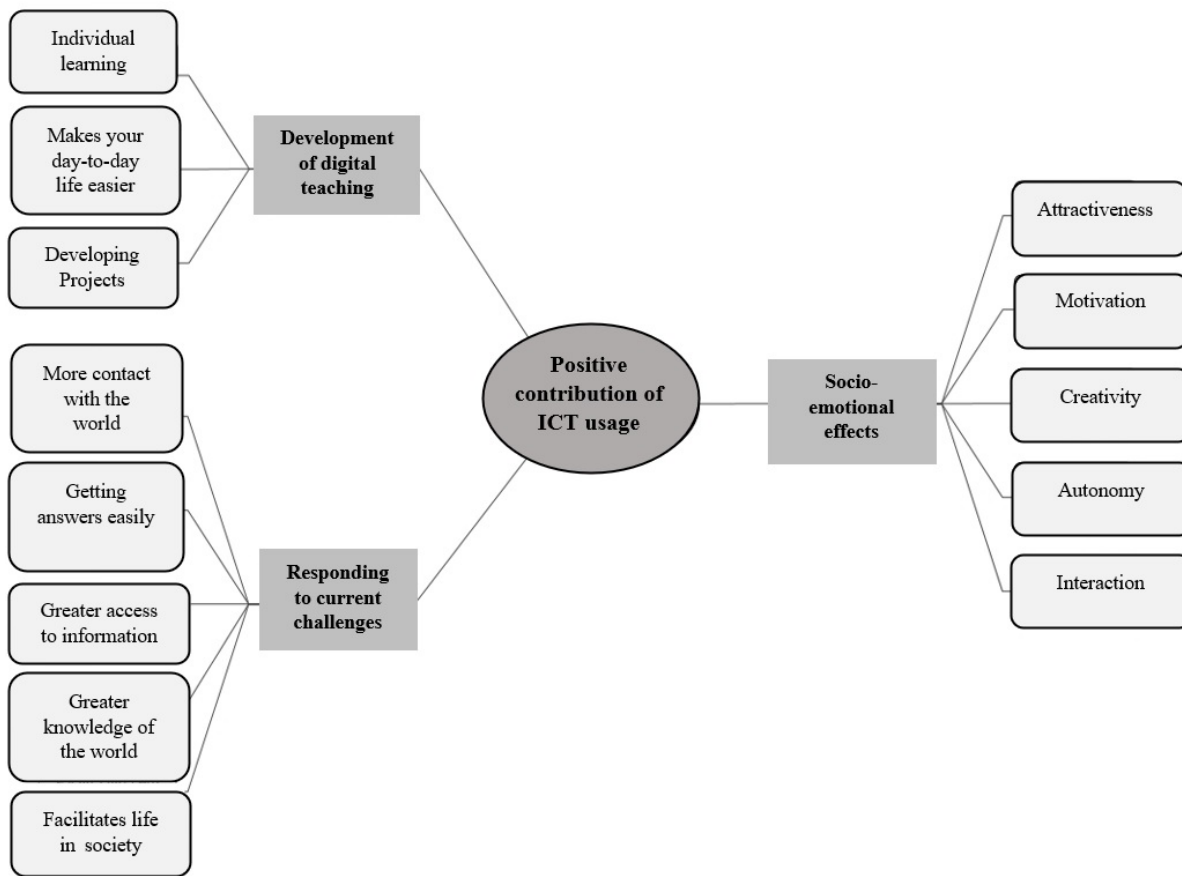


Fig. 6 Mental map on the contribution of ICT in the lives of children and young people



Fig. 7 Cloud of words about teacher profile conceptions in the digital age

C. Being a Teacher in the Digital Age

Finally, it was intended to understand what the profile defined by these students for the teacher in the digital age. To

this end, a *cloud of words* from the categorized registration units was used (Fig. 7). In the word cloud, the size of the word is directly proportional to the frequency of that word in the registration units.

Through the observation of the word cloud, it is possible to verify that there is more emphasis on the words classes, technologies and resources. A possible justification for this may be that students consider that the teacher in the digital age has to appropriate the new technologies and digital resources, "It is knowing how to bring the technologies to class" (I04); "it is knowing how to make use of the technologies" (I11); "being a creator of innovative resources" (I05); "to explore technological resources for research and exploration" (I09); "to know how to use digital resources and technologies" (I27), thus developing your digital literacy, and integrating them pedagogically in your classes, promoting "learning through dynamic classes making your classes more productive and meaningful" (I27). It is therefore crucial that teachers develop skills that allow them to intentionally and didactically use ICT in their educational practices in order to prepare students for

future challenges [5], [6], [14], [15], [23]. It is also noted that the students' discourse shows a high frequency of the words *tools, learning, use, digital, updated* and *different*, which may mean that they consider that the teacher in the digital age must be constantly updated, making use in a didactic-pedagogical way of different digital tools for their educational practices *"be always updated to provide good resources to students"* (I17) *"a teacher in change and "updated", who knows how to use the resources"* (I27); *"improve the process of teaching and learning"*. (I04). This evidence of the analyzed data may indicate that students consider that more time is needed for the creation, selection and knowledge of technological materials in order to provide answers, leading to a continuous training that is desired constant [11].

It is also important to note, on the one hand, the presence of some verbs present in the cloud of words that, although they have a lower frequency compared to other words, deserve attention because they refer to essential skills that a teacher in the digital age must have, namely to know how to adapt *"having the ability to adapt and innovate"*. (I15), to adapt *"is to be able to adapt the contents to the tools"* (I06), to teach *"is to know how to teach in a different, attractive way"* (I02), to innovate *"is to be creative and to know how to innovate"* (I06), to create *"more dynamic classes"*. (I37). On the other hand, some captivating, productive, dynamic adjectives that characterize new ways of teaching that are necessary in this new teacher profile in the digital age, *"thus making the classes captivating."* (I17), *"more interesting, productive and meaningful for students"* (I28) *"Providing dynamic classes to students"* (I36).

To finish this analysis, we carry out a data cross-check, namely between the subcategories *In-service training of teachers, Development of digital teaching literacy, New ways of teaching* and the subcategories *Computer knowledge and didactic-pedagogical knowledge* that students possess, with the aim of understanding what the relationship between the knowledge that students possess and their conceptions of what it is to be a teacher in the digital age. A graph (Fig. 8) was used to illustrate this relationship. It is possible to verify in the chart, that the *New Ways of teaching* demonstrate a greater relationship with computer knowledge, with 23 registration units, which reinforces the need to mobilize this knowledge to provide new ways of teaching students, with new and varied resources *"adapting the contents to the tools"* (I06), but leaving them *"also to explore technological resources for research and exploration of themes of each discipline"* (I09).

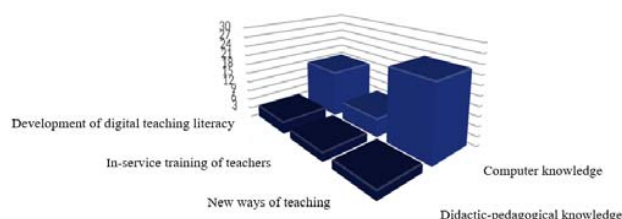


Fig. 8 Graphic on students' knowledge and teacher profile conceptions in the digital era

There is also a high relationship between the development of digital literacy in teaching and computer literacy, which can be explained by the fact that it is considered very important that teachers have computer skills to be able to use technology in the classroom in order to provide *"captivating"* (I17) and *"more interactive"* (I34) classes, since *"new technologies drive new ways of teaching and learning and have initiated new forms of dissemination and democratization of learning"* [11, p.405]. However, it is found that *didactic-pedagogical knowledge* has little to do with the different conceptions of what it is to be a teacher in the digital era, presenting few units of context, which may mean that students consider that computer knowledge is more relevant in the profile of a teacher in the digital era, there is a *theory-practical disarticulation*, rather than the creation of a hybrid space of *border crossings* where various types of knowledge are articulated and converge [8]. Thus, it is important to have a balance between technical computer knowledge and didactic-pedagogical knowledge so that new methodologies emerge that enhance the learning process, that favor the understanding of reality, that stimulate the development of personal and social skills responding to the interests, needs and difficulties of students, but also to social challenges [9], thus building *technological didactics* [17].

V.CONCLUSION

In the present analysis, it was possible to know the digital reality of the students surveyed in initial teacher training, namely: a) the knowledge they possess that facilitates their use of ICT is more technical than didactic-pedagogical. However, the technical computer knowledge is not enough, because the students say they need more information and other skills that allow them to mobilize effectively the technical and pedagogical, as [1] says.

In the study it was found that students consider that ICTs are indeed enhancers of student learning and also positively influence that of children's lives. In fact, they recognize the importance of fostering in young people the development of key competences for today's world by developing, on one hand, socio-emotional competences, related to social issues and management of emotions in the relationship with others (motivation, interaction, communication...) and cognitive effects, linked to significant learning. They also allow the development of their digital literacy, stimulating digital skills that allow understanding and mastering the language underlying the current cyberculture.

As for the teacher's profile in the digital age, students emphasize the ways of teaching and the development of digital teaching literacy, two dimensions that effectively change the teaching profession. They also mention that the initial and continuing training of teachers are important and should be seen as opportunities to (re)build the professional teaching identity, taking as a presupposition the digital revolution we are witnessing, which has profound consequences on learning processes.

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