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Research Article

Digital skills and ethical knowledge of teachers with TPACK in higher education

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ABSTRACT

This paper analyzes the professional ethical knowledge of teachers in the use of technologies by teachers in training. Based on the disciplinary pedagogical technological knowledge (TPACK) model, it is intended to measure the correct inclusion of technologies in the classroom. For this, a descriptive exploratory methodological design study was carried out. The instruments used have been the Likert scale questionnaire and the personal interview, organized into four dimensions in which the self-perception of professional ethical knowledge, ethical knowledge of technology, pedagogical technological ethical knowledge and disciplinary technological ethical knowledge of the future teachers. The questionnaire has been applied to a sample of 1.051 trainee teachers from a European university in the context of COVID-19 and 822 students participated in the interview.

The results show the scarce training in professional ethical knowledge of teachers in training and the importance of addressing this knowledge in the 21st century, a post-pandemic context. Another of the conclusions is the need to include the ethical component in the TPACK model to achieve a correct and ethical use of digital resources in the classroom.

Keywords: professional ethics, teaching digital competence, technology, teachers in training, TPACK

INTRODUCTION

World Health Organization (WHO) classified the outbreak of the disease caused by the new virus of the coronaviridae family known internationally as COVID-19 in March 2020 as a global pandemic (WHO, 2020). It was a public emergency, in view of the rapid evolution of infections on a national and international scale. The international health authorities prepared a guide as a strategic plan for preparation and response to the pandemic. This document included the necessary guidelines to act in the generalized state of alarm. These indications were subsequently updated, incorporating others aimed at alleviating humanitarian, social, economic and educational problems.

Schools were forced to move from face-to-face education to distance education based, almost exclusively, on the inclusion of technologies as learning tools. This situation has given rise to the fact that the two key elements of teaching and learning process (T-LP), students and teachers, have verified the negative consequences of little or no interaction between them, which has endangered the formation of citizenship, as well as the importance of ethical aspects in the educational process.

TPACK Model and Teacher Digital Skills

The adaptation to virtual teaching has been different in relation to the educational level. Universities are the educational institutions that have suffered the least from face-to-face education to virtual education, but this transformation has not been the same for all of them or for all of its members. Some universities had digital platforms before the pandemic. These universities used these digital resources as a complement to

traditional face-to-face teaching (Zhu & Liu, 2020). Other universities had to try to be able to adapt to the new 100% virtual situation (Gómez-Trigueros et al., 2021).

There is no doubt that this pandemic has generated an innovative movement in education, helping to find educational solutions in times of confinement. Even so, the new educational situation has put on the table the importance of training in the proper use of technologies, promoting a correct digital competence of the student. Also, a lack of training in digital skills for active teachers has been detected (Ortega-Sánchez et al., 2020). This is not something new, many investigations related to the digital training of teachers confirm the need for adequate preparation of teachers for the 21st century. For this training to be correct, it is necessary to have knowledge of the subject to be taught and to have pedagogical knowledge (Shulman, 1986), as well as adequate instruction in technological skills (Mishra & Koehler, 2006).

Disciplinary pedagogical technological knowledge (TPACK) teaching and learning model includes the components and knowledge of teachers for the information technology era. In a virtual world, where technology is of key importance in all aspects of life, this model provides an instructional framework for: students to develop 21st century skills through the use of technology and teachers to plan and implement strategies that make the T-L process more successful (Atun & Usta, 2019; Gómez-Trigueros, 2020; Gómez-Trigueros & Yáñez de Aldecoa, 2021).

Ethics of Technologies in the Classroom

The concept of ethics is a key factor in higher education, and it is important to study the attitude of teachers towards the ethical use of tools and digital knowledge. Universities have played, throughout time, the role of being transmitters of social, cultural, academic and ethical values. This training maxim cannot be omitted or left for another time, much less in teacher training.

Ethical teacher behavior includes responsibilities related to justice, respect, empathy, attention, student care and commitment, among other virtues, during the teaching process, recognizing the consequences of this ethical behavior and the transmission of those values-virtues (Gao et al., 2008) and what is known as pedagogical ethical knowledge (Anderson, 2005; Ganote & Longo, 2015; Gómez-Trigueros & Ortega-Sánchez, 2022). It includes the understanding of the responsibilities, rights and obligations during the educational process, the knowledge of the possible impact and the consequences of an appropriate or inappropriate behavior in the teaching process and the knowledge of ethical inferences involved.

There are many investigations on the use of technologies in education but without considering the ethical considerations of their inclusion in the classroom. This is an issue of great importance since teachers must face the ethical challenges that the use of new modalities of access to information with technology can pose (Ghiațău & Mâță, 2019).

Official bodies and legal texts on priority digital skills in which teachers should be trained (UNESCO, 2018) ICT competence framework; European framework for teacher digital competence (DigCompEdu); common framework for teacher digital competence of the National Institute of Educational Technology and Teacher Training (INTEF) seek to recognize the way in which ICT should be used and integrated into teaching, showing different training itineraries and identifying the needs of teachers for a correct inclusion of such tools in the classroom. In all these documents, there is already talk of the importance of the ethical dimension in the use of technological resources (Cabero-Almenara et al., 2020).

When research related to the correct inclusion of technologies in education is observed, ethics is highlighted as one more factor, to be considered in educational and training processes. For this reason, it must be borne in mind that ethical awareness is present in the teachers' approaches in relation to the right of access to technologies or to address issues of technology-based intellectual property. Also, the veracity of the information used and extracted with technology and to achieve the security and privacy of students when they use technological resources is a priority (Asamoah, 2019).

The new post-pandemic scenario increases the importance of applying ethics in the use of educational technology in the classroom and in instructional design, presented as an added challenge to the educational context of the 21st century. The purpose of this research has been to analyze the ethical knowledge of teachers in training for the correct incorporation of technologies in the classroom through the TPACK model. For this, the ethical component has been included in the model and it has been assessed, through a questionnaire

and personal interviews, adapted to the pandemic context, with bimodal teaching, in a faculty of education of a European university. The objectives can be specified in the following questions or study variables:

1. What training in ethics and professional ethics (PEK) in the use of technological resources (PTEK) do trainee teachers have?
2. What importance do future teachers attach to the ethical component in the use of knowledge (PEK) that is extracted through technological resources (PEK, EKDT, and PTEK)?
3. What are the relationships between teachers' ethical knowledge and technological ethical knowledge (TEK)?

Characteristics of the Context and the Sample Participating in the Study

The research has been developed during four academic years: 2019-2020, 2020-2021, 2021-2022, and 2022-2023, in the learning context of a faculty of education of a European university. It should be noted that the research is located at a time of pandemic in which educational centers had opted for one hundred percent remote teaching. In the specific case of the university where the study was carried out, the students received their training in the bimodal modality consisting of 50% of the students attending the classroom in person while the other 50% of the group received teaching virtually, through the platforms created by the institution for this purpose. Although this situation has been maintained over time throughout the first two academic years studied, in the 2021-2022 academic year, teaching has returned to being fully face-to-face, which has allowed personal interviews with the participants in the study the investigation. This circumstance has meant having the direct and qualitative opinion of the teachers in training, enriching the results of the study carried out.

The sample object of the study has been selected in a non-probabilistic, directed and intentional way (Argibay, 2009). It consists of 1.051 participants, teachers in training, undergraduate (895 students) and postgraduate (156 students). The sample is considered significant with respect to the total existing population and is made up of 840 women (80%), 740 graduate (88%) and 100 postgraduate (12%) and 211 men (20%), 155 graduate (73%) and 56 postgraduate (27%). The age range is between 19 years and over 40 years.

METHODOLOGY

Design of the Investigation

The work has been proposed from a descriptive approach, with a mixed methodology (Sánchez-Gómez et al., 2018). For its development, an exploratory research design has been used, based on the use of the questionnaire as an instrument for collecting information and the personal interview (Pardo et al., 2015). The study process has been configured through different phases: firstly, a theoretical review was carried out on the disciplinary pedagogical technological knowledge model, reviewing research on the measurement of said T-L model, the concept of professional ethics for teachers (pedagogical ethics and measurements of ethical knowledge), virtual teaching and previously developed studies on teacher digital competence (TDC); secondly, the instruments were designed and subsequently validated based on the collaboration of teachers from other national and international universities with experience in pedagogical ethics and teaching technological pedagogical competences; thirdly, based on the suggestions and qualifications of these experts, the research team carried out revisions of the items (modifications in the questions for a better understanding of the issues raised; unification of some items and the like); fourthly, the collection of information was carried out through the questionnaire, research instrument and interviews; finally, the information collected was emptied and analyzed.

Data Collection Instruments

In this research, a cross-sectional quantitative methodological design of descriptive and inferential nature has been chosen. On the one hand, the questionnaire has been applied, adapted to the objectives of the study and designed ad hoc, based on the one used by Gómez-Trigueros (2020) and Yurdakul et al. (2012) whose content has been validated by 21 experts from Spanish and international public universities, from categories ranging from professors to doctoral assistants.

Each researcher was asked to rate the importance and operability of each question using a 5-point scale (1, strongly disagree to 5, strongly agree). They were also encouraged to provide suggestions for each question. Based on the comments received from the experts, the instrument was redesigned, which was made up of 17 items measured on a five-point Likert scale (1, strongly disagree; 2, disagree; 3, neither agree nor disagree; 4, agree; 5, totally agree), and organized into four dimensions or study variables:

1. Knowledge professional ethical (PEK) (items 4-6),
2. Technological ethical knowledge (TEK) (7-9),
3. Pedagogical technological ethical knowledge (PTEK) (items 10-13), and
4. Disciplinary technology ethical knowledge (EKDT) (items 14-17).

In addition, the first part includes aspects related to the sociodemographic characteristics of the sample (items 1-3).

On the other hand, the interview, equally validated and made up from the same dimensions, with a different wording so as not to condition the answers or provide training for the participants. The information obtained was subjected to an exploratory-comparative reading based on the available content, in order to identify the thematic lines and the possibilities of saturation of the different emerging categories (*f*) (Corbin & Strauss, 2015). Next, from the constant comparison of the data, an open coding process of the transcripts was carried out. The codes obtained were grouped and organized, based on their connections, into study variables or subcategories and their selective, group coding was carried out, integrated around four central analysis dimensions: professional-teacher ethical knowledge dimension; dimension of ethical knowledge of the use of technology; dimension of knowledge of the implementation of technology in the pedagogical task; and dimension of ethical knowledge of technology in disciplinary development.

Finally, after identifying the partial existence of more than one study variable in the statements expressed by the students, the analysis variables were coded and quantified using an ordinal scale from 1 to 3, where 1 represents a low level of approximation and 3 a high level of approximation level of approximation to the variable under study. This procedure made it possible to quantitatively adjust the explanatory trends of each emerging variable. Analyzed variables are as follows:

1. **Sociodemographic dimension**: item 1: sex (woman, man); item 2: age (between 18 and over 40 years); Item 3: studies that I carry out (undergraduate or postgraduate).
2. **PEK dimension:** item 4: I know what ethics and morality are applied to teaching; item 5: I am able to implement ethical and moral principles in the classroom, with my future students; item 6: I know how to act ethically in situations related to teaching and learning.
3. **TEK dimension:** item 7: I know the problems of personal security, copyright and access to information in the use of technologies; item 8: I believe that ICTs allow all citizens access to information, promoting equity among all; item 9: I pay attention to the problems related to the copyright of digital sources and I make an ethical use of the information that appears on the Internet.
4. **PTEK dimension:** item 10: I am able to guide students to use technologies and online educational resources ethically; item 11: I am capable of protecting the right of students to use ICT and Internet knowledge in an ethical manner; item 12: I am able to use ICT resources to perform my task as a future teacher in a safe and respectful manner; item 13: I am capable of transmitting ethical values related to the proper use of ICTs and content hosted on the Internet to my future students.
5. **EKDT dimension:** item 14: I know that I must take into account and respect intellectual property when adapting content hosted on the Internet to create teaching materials; item 15: I know the ethical principles in relation to the use of digital resources for teaching; item 16: I will always use digital content and resources for the classroom that are not sexist, discriminatory or that include violence; item 17: I will transmit ethical values and concepts related to justice, truth and respect for diverse opinions.

In order to verify the reliability of the questionnaire, Cronbach's Alpha coefficient has been calculated (Raykov & Marcoulides, 2017). The results obtained (questionnaire α=.921) confirm the existence of a high and adequate internal consistency for the proposed study. In the same way, the Pearson Chi-square index was found with results of p-value<1=Sig. 0.001 (Cohen et al., 2008), indicative of the high correlation of the questions posed, illustrative of the validity of the items and the structure of the implemented instrument.

The second research instrument, the interview, has also been validated. For this, the Delphi method (Landeta, 2002) was used. The stability of the results was achieved, after their consensus, after the administration of the evaluation instrument in two rounds and obtaining statistically reliable results. To use this method, two groups were formed: a coordinating group, which was made up of the researchers of the present study and those responsible for the design of the instrument, and an evaluator group of experts, the same ones that were used for the first instrument. In their analysis, the following were evaluated: the relevance and adequacy, the internal coherence and the importance of the questions that they intended to formulate, and their general assessment of the construct on a scale of 1 to 10 points. Also, a reliability and internal consistency analysis of the total scale (α=.901) was carried out.

Procedure

In relation to the procedure, the questionnaire was administered to the entire sample through a link that is hosted in the free Google Forms application, during the first quarter of each of the academic courses analyzed (from September to December). The students received the questionnaire through their institutional mail from the university and were informed of objective of research, as well as confidentiality of responses.

For their part, semi-structured personal interviews have been carried out. The selection and application of the interview technique had the objective of obtaining personalized information on the attitudes and representations of the components on professional ethics and ethics with technology and pedagogy of the participants. The application of this technique was complemented with the completion of the above meaning questionnaire, in order to construct meanings and deepen the interpretation of the individual perceptions of the students (Zohrabi, 2013). The interviewees were summoned by institutional email; they were carried out in the Faculty of Education of the same university institution throughout the third and fourth week of November of all the school years of the study. For the first two academic years analyzed (2019-2020 and 2020-2021), the interviews were conducted through the Google Meet program; In the case of the 2021-2022 and 2022-2023 academic years, the latter still under development, the interviews have been carried out in person. Both in the emails and at the beginning of the interview, the participants were informed about the conditions in which it would take place, the research objectives and its duration: 55 minutes. After the explanation of the research purpose, the participants were reminded of the confidentiality and anonymity with which the data obtained would be processed and interpreted and that, in addition, they would be recorded in audio. A total of 822 students out of the total 1,051 called (n=1,051) participated in the interviews.

In order to respond to the research objectives, both descriptive analyzes (M=Mean and SD=Standard Deviation) have been carried out, using the statistical program statistical package for social sciences (SPSS statistics) in its version 25 for Windows as a tool.

RESULTS

Descriptive Analysis

The results of the descriptive statistics (M=Mean; SD=Standard Deviation) of each one of the dimensions (**Table 1**) underline, in the first place, the weak training of the participants in relation to key concepts, related to professional teaching ethics. Thus, in the dimension on PEK, the response values show little or no training of the participants and little preparation to apply ethical principles in educational processes; with mean values around 2 (disagree) ($M \leq 2.33$) and a mean dispersion of the responses issued low ($SD \leq 0.58$).

The results of the descriptive statistics (M; SD) of each of the dimensions analyzed (**Table 1**) show a weak training of teachers in training on key concepts related to professional teaching ethics. In the dimension on PEK, responses very close to value 2 of the Likert scale "disagree" ($M \leq 2.31$) are obtained. This result indicates the poor preparation of teachers in training on ethical principles in T-LP.

The values obtained in the TEK dimension related to the participants' perception of their ethical knowledge in the use of technologies, present responses close to value 5 (strongly agree) ($M \geq 4.94$; $SD \leq 0.50$). These results indicate the high perception of teachers in training on ethical issues related to safety in the use of ICT resources (item 7); copyright in relation to content hosted on the Internet (item 9) and the importance of technological resources for the development of society in the context of the 21st century (item 8).

Table 1. Descriptive statistics (*M*, *SD*) of the research questionnaire

Item and dimension	*M*[1]	*SD*[2]
PEK[3]		
4. I know what ethics and morality are applied to teaching.	2.09	0.68
5. I am capable of implementing ethical & moral principles in classroom with my future students.	2.24	0.65
6. I know how to act ethically in situations related to teaching and learning.	2.31	0.66
TEK[4]		
7. I know problems of personal security, copyright, & access to information in use of technologies.	4.98	0.48
8. I believe that ICTs allow all citizens access to information, promoting equity among all.	4.96	0.41
9. I pay attention to copyright issues related to digital sources and make ethical use of information that appears on the Internet.	4.94	0.50
PTEK[5]		
10. I am able to guide students in the ethical use of online educational resources and technologies.	3.02	0.79
11. I am capable of protecting the right of students to use ICT and Internet knowledge in an ethical manner.	3.11	0.76
12. I am able to use ICT resources to perform my task as a future teacher in a safe and respectful manner.	4.88	0.53
13. I am capable of transmitting ethical values related to the proper use of ICTs and content hosted on the Internet to my future students.	3.10	0.81
EKDT[6]		
14. I know that I must consider and respect intellectual property when adapting content hosted on the Internet to create teaching materials.	4.94	0.52
15. I know the ethical principles in relation to the use of digital resources for teaching.	3.03	0.88
16. I will always use digital content & resources for classroom that are not sexist, discriminatory or include violence.	4.96	0.52
17. I will transmit ethical values and concepts related to justice, truth, and respect for diverse opinions.	4.97	0.49

In PTEK dimension, the values show the negative perception of the participants about their ability to guide students in the ethical use of technologies; in the protection of their rights and in the transmission of ethical values in the T-L process ($M \leq 3.11$; $SD \geq 0.76$). For its part, this same dimension yields positive values, which are close to response option 5 (strongly agree) when asked about your capacity for the ethical use of ICT resources, as a teacher (item 12, $M=4.88$; $SD=0.53$).

The values obtained for the fourth dimension EKDT, the sample considers that it has sufficient knowledge about respect for the intellectual property of digital content and resources; and that it has the capacity to discriminate non-sexist, discriminatory or violent materials. In the same way, he perceives himself with the capacity to transmit values such as justice, truth and respect for diverse opinions with his teaching practice ($M \geq 4.83$; $SD \leq 0.58$).

It is important to highlight the answers obtained in item 15 "I know the ethical principles in relation to the use of digital resources for teaching". Their responses show that teachers in training do not recognize ethical principles in the use of technology for teaching with response values close to 3 "neither agree nor disagree" ($M=3.03$; $SD=0.88$) indicative of the need to address this training in future teachers.

DISCUSSION AND CONCLUSIONS

The current educational context offers challenges and possibilities for teachers. The post-pandemic situation has given the green light for the massive inclusion of technologies in training. Universities and training centers for future teachers have the challenge of offering a level of instruction that educates in disciplinary, pedagogical, and technological content. The researchers found that the TPACK teaching and learning model offers ample possibilities to develop training in teacher digital competences; It helps the correct inclusion of technologies in the classroom and a better understanding of ICT resources for teaching.

It is therefore a priority to harmonize education systems and guidelines for action related to the principles of ethics. In the specific case of technologies, the use of these tools in an equitable, fair and responsible manner is proposed as a measure to achieve an improvement in the quality of world education. It is a priority to pay special attention to ethical knowledge in teacher training, understood as behavior based on values of justice, equity, truth and responsibility in the use of technology in teaching and learning environments (Gómez-Trigueros & Yáñez de Aldecoa, 2021).

The results of this research confirm the lack of training in the professional ethical knowledge of the students at the analyzed university. These values indicate the need for training in the understanding of ethics in the classroom (Mâță et al., 2020) and coincide with the other research by Yurdakul et al. (2012), where it is pointed out that teachers must have, in addition to knowledge of the subject, pedagogical and technological, with a preparation in teaching ethics.

The need to resolve issues related to aspects related to how the teacher guides the use of digital resources in the classroom is highlighted. The data obtained in this work show that teachers in training are aware of the importance of the safe use of content hosted on the Internet; of the importance of respecting the authorship of the contents; and the need to make responsible use of these contents, but they are unaware of the pedagogy to carry out this task in their professional activity. These results coincide with other studies on technology and teaching (Asamoah, 2019; Cabero-Almenara, 2020), where the importance of ethical use of ICT tools is emphasized.

Finally, this research wants to point out the importance of teacher training in issues related to teaching ethics in the use of technologies, in the new post-pandemic context. It is urgent to carry out a correct preparation of our teachers in order to generate an ethical use of digital tools, which allow a formation of citizens of the information society and communication competent in ICT.

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Ethics declaration: Authors declared that the instruments used and the procedure designed in this study have been approved by the Ethics Committee of University of Alicante, where the research was carried out (File UA-2021-08-27).

Declaration of interest: The author declares no competing interest.

Data availability: Data generated or analyzed during this study are available from the author on request.

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