

# What Can AI Learn from Teachers and Students? A Contribution to Build the Research Gap Between AI Technologies and Pedagogical Knowledge

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## ABSTRACT

Artificial Intelligence and related technologies represent a major advance in the human capacity to produce knowledge from different areas of knowledge. The application of these technologies in repetitive human activities that can be learned by a machine is already a constant in society, but their use in education still needs research, especially pedagogical research, which can make it clear how AI can contribute effectively to teaching and learning processes, since these processes are marked not only by cognitive characteristics, but also by cultural and emotional aspects. Having identified this gap, we conducted a qualitative study with students and teachers from four EU countries in order to find out what they know about the use of technologies and AI in education, what are their concrete needs and the recommendations of teachers on the pedagogical use of AI in education. This is a contribution to the gap identified by other authors in research on AI and education. This study gives voice to the participants and addresses the issue from the perspective of education. The results point to (1) A knowledge of the topic only from the perspective of users, (2) High expectations of the impact of AI on education (3) Recommendations of adapting AI to learning purposes, (4) Attention to guarantees of inclusion, citizenship, and democracy.

**Keywords:** artificial intelligence, education, pedagogy, 21<sup>st</sup> century skills.

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## I. INTRODUCTION

The use of Artificial Intelligence in Education (AIEd) is a recent and productive issue due to its potential to contribute with some old educational challenges such as personalized learning and the instructor's role (Baker, 2016; Holmes *et al.*, 2018). AIEd techniques as natural language processing, artificial neural networks, machine learning and deep learning have been used to create intelligent learning environment (Chen *et al.*, 2020; Rowe, 2019) with potential to transform the way we face knowledge, cognition, and culture (Hwang *et al.*, 2020).

This paper presents the results of research carried out within the scope of the ERASMUS+ project TASK 21 EdTech and AI for Essential Skills in the 21<sup>st</sup> century. The project aims to help modernize formal educational curricula and create teaching material that meets the needs of the 21<sup>st</sup> century through the use of technologies in education and, in particular, Artificial Intelligence. To this end, it brings together institutions from 6 countries-France, Finland, Italy, Norway, Portugal and Sweden-in the areas of Technologies and Educational Sciences to gather its expertise in the planning, creation, testing and implementation of a transdisciplinary university course, whose public targets are future teachers and curriculum developers and future developers of e-learning courses.

This work draws on the first task of the project with the aim of identifying the knowledge of students and teachers about the use of technologies and Artificial Intelligence in education, the motivations of students for the course and the pedagogical recommendations of teachers, in order to enable the creation of a course both centered on the concrete needs of future participants and solid pedagogical knowledge. The results can contribute to the debate on the topic, specifically on the lack of pedagogical knowledge in the literature on AI and education (Chen *et al.*, 2020).

Our contributions are as follows:

- (1) This paper is one of the first papers to consider students' and teachers' needs for MOOC.
- (2) This paper builds the research gap to combine educational research with AI technology.
- (3) This paper gives pedagogical recommendations in creating MOOC with AI technology.

## II. LITERATURE REVIEW

This section reviews brief literature on Artificial Intelligence in education, educational technologies and innovative learning, and Massive Open Online Courses. We found a research gap in the previous literature.

### A. Artificial Intelligence in Education

From the early days of systematic use of instructional design, educational scientists hope to use the results of Artificial Intelligence to support the teaching work of educators, developers, and researchers to create automatic curriculum design machines or to make built-in processes more reasonable (Ahmad *et al.*, 2020). The development of this discipline is still in the emerging stage. The problem of not knowing how we learn and the limitations of theoretically describing any learning content have led us to find specific solutions to specific problems (Chen *et al.*, 2020).

Researchers mainly adopt AI technologies such as machine learning (Thomaz & Breazeal, 2008; Pierre-Yves, 2003), intelligent tutoring system (Cetintas *et al.*, 2009), neural network-related algorithms (Delen, 2010; Muldner *et al.*, 2011), Natural Language Processing techniques (Nye *et al.*, 2014; Cambria & White, 2014) to solve problems of AI in education. However, few educational theories have been adopted, along with the novel theories or theoretical frameworks. Therefore, after reviewing 45 papers on AI in education, Chen *et al.* (2020) suggest that AI technology should closely integrate with educational theory. Such research can promote AI development in education and become an essential and promising subfield in educational technology. This paper builds the research gap to combine educational research and innovation with AI technology.

### B. Educational Technologies and Innovative Learning

Innovation is a concept with deeper roots in science or industry rather than in education. O'Sullivan and Dooley (2008, p. 5) considered innovation "as the process of making changes, large and small, radical and incremental, in products, processes and services that result in the introduction of something new for the organization that adds value to customers and contributes to the organization's knowledge storage." This conceptualization brings into discussion the ideas of new and imitation and, according to Rogers (2003), to be considered an innovation, an idea does not necessarily need to be totally new, since it is considered as a practice or idea that is perceived as new by the person or unit that adopts it.

From the nineties onwards, innovation and its rationality have asserted themselves on educational changing processes, although its conceptual complexity makes it difficult to reach a consensus around its definition. Due to its highly contextual character, innovation in education must include the loan aspect, therefore imitation is included in the definition because contextually it appears as something new (Kovacs, 2017). In addition, innovation in education takes on a different character when viewed as a process that shapes the educational offer and when researched as a desirable result.

Canário (1992) assumes educational innovation as instituting changes, produced in organizational contexts, from the action and interaction of the respective social actors. Also, Gonzalez and Muñoz (1987, p. 16) assume the concept of innovation associated with "explicit dynamics that intend to change school ideas, conceptions, goals, contents and practices, in a renewing direction from the existing one" and distinguish it from the change, designed as a deliberately designed process for making improvements. Educational innovation is, then, understood as a process of definition,

construction, and social participation (Muñoz, 1988, p. 86), produced not in a desert of meanings, previously expanded, and concretized in school cultures with the objective of transposing the "thick cover meanings found in the current culture of educational groups and establish new meanings" (Angulo, 1994, p. 359).

This perspective implies, according to Canário (1992), an increase in the internal complexity of the educational establishment and a change in the organizational paradigm, breaking definitively with the Taylorist paradigm. This multidimensional character of innovation and its procedural aspect is also materialized in the different roles that teachers assume in each curricular paradigm, as well as in correspondent pedagogical approaches that do not always follow the introduction of novelties in education, namely in terms of technologies.

When new digital tools are introduced in higher education, traditional practices tend to adapt instead of contributing to innovations (Salmon, 2005). Academics need technological know-how and support, and professional training courses should emphasize pedagogy over technology (Niess, 2005). Educational technicians no longer consider computers as a device or equipment (O'Shea & Self, 1983). Assuming that education technologies pay attention to teaching and learning seriously, they can contribute regardless of whether they use computer technology as a means of implementation because the design of a computer-based learning environment provides us with a new perspective (Issroff & Scanlon, 2002).

Some scholars have studied educational technologies and innovative learning in different views. Istance and Kools (2013) analyze multiple ways of integrating technology into education through Innovative Learning Environments (ILE) and as a design framework. Learning science plays a vital role in educational AI design by providing actionable and advanced theories (Luckin & Cukurova, 2019). Luckin and Cukurova (2019) prove through a case study that appropriate data analysis in interdisciplinary learning science research can promote AI education technology development. The cloud teaching framework can promote personal and collaborative, synchronous, and asynchronous active learning in the classroom and outdoors (Barak, 2017). Although currently no accepted guidelines on using educational technology theory, Issroff and Scanlon (2002) propose that the use of theory in educational technology should be at least descriptive; it must consider the students' learning experience. Various educational technologies have improved certain aspects of education (Yang & Liu, 2007; Davies *et al.*, 2013), such as more information access (Liu *et al.*, 2020), more content creation tools (Koehler & Mishra, 2005), comprehensive instruction access (Earle, 2002), automatic data collection and behavior management tools (Lefever & Matthiasdottir, 2007), teaching design, teaching methods, seamless integration with technical tools is challenging to achieve (Ding *et al.*, 2020). Therefore, to ensure that the AI technology used for education and training reflects this wise analysis and learns scientifically, there must be established stakeholder relationships among AI developers, educators, and researchers.

### C. Massive Open Online Course

Massive Open Online Courses (MOOC) at all levels

includes the use of tools such as Coursera ([www.coursera.org](http://www.coursera.org)), Wikipedia, Khan Academy (<https://www.khanacademy.org>), and other advanced learning methods. The number of Stanford MOOC registrations reached 160,000 in the 2011 artificial intelligence online course (Rodriguez, 2012). With the explosive growth of MOOC, the research on MOOC has gradually become the subject of academic research (Hone & El Said, 2016) and is the research product transferred from the boundary between the education field and artificial intelligence (Paviotti *et al.*, 2012).

MOOC is suitable for advanced learners who need less academic support to pass courses and materials successfully. However, less than 10% of registered students can complete the course (Alraimi *et al.*, 2015). There are challenges and gaps in finding new teaching methods and organizational mechanisms in MOOC to provide high-level teaching. Specific teaching issues and challenges include: how much MOOC can support in-depth exploration and creation of advanced knowledge (Eriksson *et al.*, 2017); the breadth and depth of participation (Zheng *et al.*, 2015); under what conditions, successful participation can go beyond broadband access and complexity (Hew, 2016); participants of social networking skills (McAuley *et al.*, 2010); specific strategies to maximize the effective contribution of the coordinator (De Freitas & Da Silva, 2020). No literature focuses on teachers' and students' needs for MOOC. Methodologically, MOOC literature relies heavily on introductory and case studies (Raffaghelli *et al.*, 2015; Liyanagunawardena *et al.*, 2013; Greene *et al.*, 2015; Littenberg-Tobias & Reich, 2020). This paper considers the needs of teachers and students in a MOOC using qualitative analysis.

### III. METHOD

A qualitative approach focused on understanding social phenomena (Gonzales *et al.*, 2008) and giving voice to educational main actors-teachers and students (Cohen *et al.*, 2017). 104 subjects participated in this research: 60 Masters students in the areas of Education and Technologies from 3 countries (Portugal, Italy, and Norway); and 44 teachers of basic, secondary, and higher education from 3 countries (Portugal, Italy, and Sweden). The option for Education and Technologies is justified as the curricular unit to be built under the project will be within those areas. The option to listen to teachers both from higher and non-higher education is due to the fact that their professional needs are different as well as their knowledge and pedagogical recommendations. The participating countries are part of the project consortium and are among the countries in which the final curricular unit will be built, tested, and implemented in 2021 onward.

The three used instruments were previously pre-tested and validated by consortium partners. The research applied to two questionnaires (Cohen *et al.*, 2017) and a semi-structured interview (Warren, 2002; Brinkmann & Kvale, 2015). Students were asked a questionnaire consisting of 10 items, of which 5 were closed, using the Likert scale (1932) and 5 open. The main objective was to have a better understanding of students' knowledge about the use of technologies and Artificial Intelligence (AI) in education and their motivations

for their higher education studies.

Teachers were given a questionnaire, consisting of 9 questions, of which 3 were open and 6 closed, using the Likert scale (1932) for 5 of them. A semi-structured interview, consisting of 6 questions, was also applied. All instruments were applied via the internet (Buchanan & Zimmer, 2012; Farrimond, 2013), due to the contingencies imposed by the Covid-19 pandemic and followed by an Informed Consent Term (Buchanan & Zimmer, 2012). In Italy, the instruments were applied in person, before schools closed due to the Covid-19 pandemic.

Students from Italy are part of the profile of Science of Education students. Respondents are on average 25 years old. They are mostly female (88%) and 12% are male. Norwegian participants are part of the IT student profile-Technologies Sciences. 60% are male and 40% female. Their average age is 33 years. Participants from Portugal also integrate the profile of students of Educational Sciences. Respondents have an average age of 38 years. 23% are male and 77% female. It is notable the greater presence of women in the courses of Educational Sciences (82%) in relation to men (18%). In the profile of IT students, this proportion is 60% men and 40% women. The average age of the participants as a whole is 32 years, with a difference that we cannot fail to highlight: 25 years (Italy), 33 and 38 years (Norway and Portugal, respectively).

The Italian teachers who answered the questionnaire within the scope of this research are composed of a total of 29 divided into two levels: 13 from Higher Education and 16 from Non-Higher Education (Basic Education and High School). Question number four was not answered by the teachers. As for the interviews, a total of 6 were conducted by 2 teachers from Higher Education and 4 from non-Higher Education (Basic and Secondary Education).

The Swedish respondents to the questionnaire were three teachers of Basic Education. There is no teacher interview.

The Portuguese teachers who answered the questionnaire are composed of a total of 12 divided into two levels: 3 from Higher Education and 9 from Non-Higher Education (Secondary Education). Regarding the interviews, they were carried out by a total of 6 teachers, 3 teachers from Higher Education and 3 from Non-Higher Education.

Content analysis (Flick, 2009) was applied both to questionnaires and interviews results according to the following categories:

- 1) The use of technologies.
- 2) Technologies, education, and skills development.
- 3) Contribution and recommendations for the use of technologies in education.

In the case of closed questions, statistical analysis was used only as a summary of the answers.

### IV. RESULTS

The results are going to be presented by category. Nevertheless, each country's results will be identified due to the need to assume the specificities of each social, cultural, and educational context.

TABLE I: STUDENT'S USE OF TECHNOLOGY

| Time per activity<br>Week/Country | Cell phone | Computer | Chat with<br>friends | Access Social<br>networks | Listening to music | Reading and<br>sending email |
|-----------------------------------|------------|----------|----------------------|---------------------------|--------------------|------------------------------|
| Italy                             | 46 h       | 24 h     | 23 h                 | 12 h                      | 9 h                | 4 h                          |
| Norway                            | 8 h        | 54 h     | 2 h                  | 9 h                       | 13 h               | 5 h                          |
| Portugal                          | 20 h       | 24 h     | 17 h                 | 16 h                      | 20 h               | 20 h                         |

### A. The Use of Technologies

Table I summarizes the personal use of technologies by students, namely the used equipment, the activities carried out and time spent.

Summarizing all the students' results, the most used technological equipment is the mobile phone and the computer, with more time spent on the mobile phone (26 hours per week) than on the computer (18 hours per week). However, when we look at the age differences, we noticed a clear preference of the youngest for the use of the mobile phone (46 hours per week) compared to the computer (24 hours per week), while the participants of a higher age group indicated a similar time of use of the two types of equipment (8 hours per week for mobile phones and computers-Norway) and (23 hours per week for mobile phones and 24 hours for computers-Portugal).

The main activities developed by all students through the technologies, presented here following an order of time spent, are talking with friends and listening to music (14 hours per week), researching general information (13 hours per week), accessing to the social networks (12 hours per week), reading, and sending emails (10 hours per week). Also, in the activities developed, we observed differences according to the average age of the participants. Among the youngest, there are more hours devoted to conversation with friends and social networks (23 and 12 hours per week respectively), while among older people the time is more dedicated to listening (20 and 13 hours per week), researching general information (20 and 9 hours per week), reading, and sending emails (20 and 5.5 hours per week).

In general, students use technologies essentially for communication and information search purposes, which can give important clues for the pedagogical and methodological principles to be guaranteed in the elaboration of the MOOC curricular unit.

Regarding the teachers, the questionnaires reveal that Italian teachers have different attitudes towards the use of technologies according to the profile they assume, using the technologies more often for personnel use than in professional context. Within the scope of the user profile, teachers use technologies with higher frequency to seek information, communicate with others and share information as education professionals, with a difference between the use of technologies for entertainment or information sharing between the two profiles since the frequency of response is always higher when it comes to non-higher education teachers. As professionals, they use technologies mainly to provide content to students, with a significant difference in the frequency of response between the two levels of teachers. That is, non-higher education teachers use, except to communicate with students, more technologies than higher education teachers.

The interviews showed teachers use computer lab activities to support the understanding of concepts, considering that

they are a contribution to learning. On the other hand, they also use technology as a resource for experimenting with new teaching methods that give the student an active role in building their knowledge, facilitating collaborative learning.

Swedish teachers use technologies with higher frequency either to communicate with others, or as a means of entertainment and seeking and sharing information, or, in this case, to communicate with students, to provide them with content, to promote activities in the classroom and outside the classroom (3.6).

The questionnaires showed that Portuguese teachers assume a higher frequency in the use of technologies both in their private and professional use. The two dimensions that have the lowest frequency of response are entertainment, as users, and the promotion of activities outside the classroom, as teachers. There is also a difference between the use of technologies as users, whose frequency of response is lower in the case of non-higher education teachers, with an approximation in the dimension of information demand. Regarding the profile of teachers, the frequency of response is higher in the case of teachers in non-higher education, except in the case of the dimension of promoting activities outside the classroom.

In the context of the interviews carried out, the perspective of Portuguese teachers can be summarized in the sentences: "the use of technologies in teaching is a resource to be taken into account in the set of available resources. It requires smart and effective, but moderate use, because there are skills that you do not develop."

It seems that, in Italy and Portugal, non-higher education teachers use technologies more frequently than higher education teachers. Italian teachers use technologies more as users than professionals, unlike Portuguese and Swedish teachers whose use is similar.

Whether in Italy or Portugal, teachers take technologies as a support and complement to other learning resources, giving them an instrumental perspective, which cannot be interpreted from the data of Swedish teachers.

Teachers also revealed training models using technology they already know or used. For the Italians, e-learning is the training model they have experienced, verifying that b-learning was only experienced by a small number. As for MOOCs and others, not specified, only non-higher education teachers declared to have had contact with these training models.

Only one teacher in non-higher education knows the four models presented (e-learning, b-learning, MOOCs, another model) and four know two. Regarding higher education, only two contacted two models. In their perspective, these training models are evaluated positively in relation to all the dimensions presented, highlighting the dimension of easier navigation. However, this question also reveals differences between the responses of teachers in higher education and non-higher education, with a higher frequency of response in the second.

For the Swedish teachers, the training models they have experienced are e-learning and MOOCs. Only one teacher knows the four models presented and the remaining two participated in only one. In their perspective, these training models are evaluated very positively in terms of the learning developed, the technical resources available, the easier navigation, the quality of the content and the adequacy of their professional needs.

Portuguese teachers have experienced other training models than those mentioned and not identified and e-learning, verifying that non-higher education teachers did not experience the model b-learning and only one teacher knows the MOOC. Only one teacher in higher education contacted more than one training model using technologies, in this case with three models. In their perspective, these training models provided a moderate contribution in relation to all identified dimensions, registering, however, a more positive perspective of higher education teachers.

### B. Technologies, Education and Skill Development

To identify the students' level of knowledge about the topic, we asked them a series of questions, starting by asking them to rate, on a scale of 1 to 5, how their course prepares them for the development of a set of skills. The responses of the participants show slight variations in the level of preparation for the development of each of the skills, as follows in Table II.

TABLE II: PERCEPTION OF STUDENTS ABOUT THE CONTRIBUTION OF THEIR COURSE IN THE DEVELOPMENT OF SKILLS

| Skill                              | Contribution from the course |       |        |          |
|------------------------------------|------------------------------|-------|--------|----------|
|                                    | General                      | Italy | Norway | Portugal |
| Learning in innovative environment | 3.3                          | 2.8   | 3.6    | 3.5      |
| Work in innovative environment     | 3.3                          | 2.5   | 4.2    | 3.3      |
| Work collaboratively               | 3.7                          | 3.7   | 4      | 3.6      |
| Develop creativity                 | 3.4                          | 3.6   | 3.2    | 3.4      |
| Develop autonomous learning        | 3.6                          | 3.5   | 3.5    | 3.8      |
| React critically to information    | 3.5                          | 3.5   | 3.5    | 3.6      |
| Learning through problem solving   | 3.5                          | 3.4   | 3.8    | 3.4      |

As shown in Table II, participants give their current course a median level of contribution to the development of the skills mentioned. Collaborative work and the development of autonomous learning, indicated as the skills with the greatest contribution from the course, may be indications of the methodologies commonly used in the courses under analysis, such as group work and individual research. Remember that the search for general information was one of the activities mentioned by the participants with a high number of weekly hours attributed to it (13 hours).

The skills with the least indication of contribution attributed have the aspect of innovation in common-learning in innovative environments and work in innovative environments-and are indicative of the difficulties of the programs and the methodologies of the courses in working on this aspect. However, they are also indicative of the possibilities of using technologies and AI in their development.

Regarding the two profiles of the participants, it should be noted that respondents from Educational Sciences, in general, attribute less contribution from their course in the development of skills than respondents from the Technologies profile.

When asked about the level of influence of the use of technologies in motivating for the classes and in the learning content, Italian students indicated the level 4, on a scale of 1 to 5 for both categories. Norwegian students consider that the level of influence on motivation is 3.4 and on content learning is 4.4. The Portuguese participants, in turn, rated 3.9 the influence of the use of technologies on the motivation for classes and 4 the influence on learning.

These results seem to contribute to understand the potentials of use and the impact of technologies on effective learning, as well as to undo an idea that may still figure in the imagination of some educators that technologies are just an appealing resource in the motivation of student and learning should be relegated to other more traditional methodological dimensions.

When asked about the use of technologies for educational purposes, all students responded affirmatively and presented their justifications, which we summarize in the following categories by country.

Italian students advocate the use of technology in education for two main reasons: (1) Approach to students' real-life needs; (2) Improvement in learning. Norway participants present similar justifications for the use of technologies in education: (1) Possibility of improving the quality of several learning factors; (2) Preparing students for the needs of the world of work. Portuguese students, for their part, also defend the use of technologies in education and justify their opinion for the following reasons: (1) Promotion of the teaching and learning process; (2) Adequacy of teachers' pedagogical training.

*"Yes, because technologies are part of our daily life and if well used, they are a valid support to improve teaching and increase our skills."*

(Italian student)

*"Of course. Using the new technologies will help the students to prepare for their future careers. Also, the new ICT devices engage the students and create an interactive environment which can increase their motivation."*

(Norwegian student)

*"Technologies allow future teachers to learn to teach their students in an interactive way, using, for example, educational games in which the whole class participates. There are many teachers who know little about using a computer and today it is the fundamental technological means for communication between teachers and students (given the situation of the COVID-19 pandemic)."*

(Portuguese student)

Learning appeared among the categories most indicated by students, along with the adequacy of what is taught to the current social and historical context and to the demands of the world of work. About learning, students point out the use of different audiovisual resources, the environment of creativity, the search and sharing of scientific information as favorable

elements for improving this process.

The adequacy of what is taught to the social and historical context is settled in an increasingly digital society students live in, with direct impacts in various areas of social life, including in education. The adequacy of what is taught to the world of work is based on the need for better preparation of future professionals in both profiles through the use of technologies.

Regarding their knowledge about Artificial Intelligence, Italian students have an average level of knowledge of 3.3 on a scale of 1 to 5. This reported level of knowledge is reflected in their perception of the impact of AI on education, that is, when asked about the level of impact of AI on learning, the average response was 3.4. Norwegian students indicated a level of AI knowledge of 3 and a level of AI implications for learning of 4.4. Portuguese students, in turn, indicated an average level of knowledge of 2.8 and their perception of the impact of AI on learning was 3.8.

Regarding the teachers, they were asked to indicate the level of contribution of the syllabus of their subject to the development of the same set of skills, on a scale of 1 to 5. Table III summarizes the results.

TABLE III: PERCEPTION OF TEACHERS ABOUT THE CONTRIBUTION OF THEIR SYLLABUS TO THE DEVELOPMENT OF SKILLS

| Skill                              | Contribution from the course |       |        |          |
|------------------------------------|------------------------------|-------|--------|----------|
|                                    | General                      | Italy | Norway | Portugal |
| Learning in innovative environment | 4.1                          | 3.5   | 4.6    | 4.3      |
| Work in innovative environment     | 4.0                          | 3.5   | 4.6    | 4.1      |
| Work collaboratively               | 4.3                          | 3.8   | 5      | 4.1      |
| Develop creativity                 | 4.3                          | 3.8   | 5      | 4.2      |
| Develop autonomous learning        | 4.3                          | 4.0   | 5      | 4.1      |
| React critically to information    | 4.2                          | 3.8   | 5      | 3.9      |
| Learning through problem solving   | 4.2                          | 3.7   | 5      | 3.9      |

Italian teachers reveal that the syllabus content of their subject lead students to autonomy more frequently and on average, with the remaining dimensions having a very close frequency of response. The differences between the responses of teachers at the two levels in question are significant since, while the responses of teachers in higher education are always below average, on the contrary, the responses of teachers in non-higher education are always situated above average, identifying four skills as the most developed within the scope of the syllabus of their subject, namely: working collaboratively, developing creativity, developing autonomous learning and reacting critically to the information they receive.

Swedish teachers reveal that the syllabus of their subject leads students more often to learning in innovative environments, as well as to learning through problem solving. However, the remaining skills presented also present a high level of development. Regarding the contribution of technologies to the development of skills in students, teachers identify a high contribution to the development of all the skills presented.

For Portuguese teachers, the syllabus content of their subject lead students, with high frequency and on average, to

the development of all the skills identified. We note only a difference between the average responses of teachers in higher education and non-higher education in relation to the dimension of reacting critically to the information they receive, which is lower in non-higher education.

In the interviews, the teachers underlined the contributions of their subjects to the development of critical sense and creativity, as well as the promotion of decision-making capacity, the resolution of problems centered on themselves and on team and group work to achieve individual and group success.

Regarding the contribution of technologies to the development of skills in students, teachers identify a high contribution to the development of most of the skills presented, except for the ability to react critically to the information they receive and learn by solving problems they present, on average and in non-higher education teachers, a moderate frequency.

Again, there are differences between higher and non-higher education teachers in Italy and Portugal: in the first case, non-higher education teachers present a higher frequency of response; in the second case, the difference in relation to the development of critical thinking may be related to the existence of a highly segmented, hierarchical and standardized curriculum in non-higher education, which has favored reproduction and not the production of knowledge, contrary to what may happen in higher education.

### C. Needs And Suggestions for the Use of Technologies in Education

The participants were asked to indicate suggestions for educational activities that could be carried out with the effective use of technology.

Italian students suggested, for example: make learning more meaningful; expand the perspectives for analyzing a certain content; and develop a more active posture in students. For participants from Norway, suggestions for the use of technologies in education are related to access to contents and information, collaborative work. Portuguese students, in turn, suggest the use of technologies for purposes such as: development of a more active student profile; diversification of means and ways of presenting content; means of searching, sharing, and presenting information.

*“With new technologies, more innovative and captivating activities can be carried out in the classroom. above all it is possible to experience objects, phenomena and situations that are difficult to replicate in class in a real way, using for example augmented reality (AR) or simulators.”*

(Italian Student)

*“Video streaming online, discussion, blogging social media, 3D printing, VR.”*

(Norwegian student)

*“In the classroom, it is interesting to use interactive whiteboards to approach various program contents, software, interactive keyboards. Outside the classroom didactic games on tablet or computer.”*

(Portuguese student)

The answers presented show not only what they need, but their creativity and an underlying request for methodological changes in educational practice. In the general set of responses, the suggestions relate to learning, the student's role in the process and the methodologies used.

Learning in this dimension, the suggestions mainly point out a process of bringing the content closer to the real and concrete needs of the students' historical and cultural context. For this purpose, they suggest the use of augmented virtual reality, videos and tools that make what is being studied more concrete.

Role of the student-the participants indicates in their suggestions the need for a more proactive and participative attitude of the students in the educational process, from the possibility of giving an opinion on the choice of content, preparation of classes, teamwork, debates in online groups and creating blogs.

Methodologies-in this dimension, we highlight the suggestions for greater diversification in the form of content presentation, using various image, audio, and video tools as well as suggestions for expanding the perspectives of content analysis through consultation with different sources.

Regarding teachers' suggestions, Italian non-higher education teachers reinforce the contribution of technologies to the development of digital and information literacy, creativity, autonomy, communication, collaboration, involvement, retention of knowledge, useful skills for life, digital citizenship, problem solving problems and critical thinking, as well as the contribution to student motivation.

Although higher education teachers identified the same contributions, there is the presence of other relevant dimensions, namely: distance work, personalized learning and its consolidation, preparation for the world of work, the collection, treatment and classification of data, and their interpretation, as well as the relationship between cultures. It seems that the global emphasis is placed both on contributions to autonomy and collaboration, and on digital literacy. These perspectives are corroborated by the analysis of the interviews that show that teachers establish a strong relationship between school and society, although they identify weak basic knowledge and lack of study methods.

Teachers in non-higher education express the need to deepen their knowledge, especially in software, applications, tools, resources, systems, and platforms that allow them to personalize teaching and build classes that include all students.

As for higher education teachers, they reveal two levels of needs: tangible, in terms of knowledge of tools, software and platforms for work and classroom management, but also for collaborative work. On the other hand, they reveal the need to know how to build original tasks, how to implement feedback, work in networks, prepare exams or how to work with children with special educational needs. Regarding intangible needs, teachers identify the need to know the efficiency of distance education compared to the face-to-face model, to assess their safety conditions and to establish contacts with foreign teachers to compare experiences regarding the use of technologies in education.

Regarding the recommendations with a view to creating a MOOC that can contribute to the development of the skills identified in the questionnaire, non-higher education teachers

identify various types of needs, both at the technical level, in terms of the learner or training of teachers. On the one hand, teachers recognize the need to create a safe, accessible, collaborative learning environment with digital tools appropriate to the goals where learning is challenging and flexible. On the other hand, teachers identify the need to meet the needs of students, the relevance of the curriculum for their lives, the need to include values that allow students to choose and adapt technology by teachers to their students. Finally, they recognize the need for a deeper knowledge of technologies on the part of teachers in order to design and create courses, share resources and improve their use.

Given the content of the interviews, we can say that Italian teachers, in general, recommend learning through discovery, the promotion of critical thinking, collaborative work and the use of current technologies.

Swedish teachers reinforced that the technologies contribute strongly to the development of programming, creativity, autonomy, and lifelong learning skills, highlighting as obstacles the constraints placed by the General Data Protection Regulation (GDPR) and the inefficiency of some unspecified tools chosen by the experts in ICT. They believe that a relationship should be established between ICT and research on pedagogy and didactics to help them teach better or establish links between technical and educational decisions.

To create a MOOC that can contribute to the development of the skills identified in the questionnaire, the teachers finally provide technical recommendations, such as the need for quality of the Wifi network or the digital platforms that allow the interface between various applications and respect the GDPR, but also of a pedagogical scope, such as the existence of a flexible ICT system and knowledge of the students' needs.

Portuguese teachers at both levels reinforce the contribution of technologies to the development of digital literacy, creativity, autonomy, communication, collaboration, critical thinking, and responsibility. Both also emphasize the conception of technology as a tool to facilitate learning, seek solutions, stimulate curiosity, and develop culture, and not as the main protagonist of the teaching-learning process that students will have as their main actors. In this context, the interviewees consider that teachers are in a permanent learning process and that current technologies are stimulating in the continuous process of preparing students to work in society, stimulating non-conformism and developing skills within the scope of citizenship.

Both groups of teachers express the need to learn how to assess distance or, in the case of higher education, to create instruments and strategies for summative assessment avoiding fraud. These also refer to innovative and creative methodologies, while non-higher education teachers identify the need for training, improving knowledge about digital tools and applications, examples of their application in diverse and current contexts, as well as process management distance learning.

Regarding the recommendations with a view to creating a MOOC that can contribute to the development of the skills identified in the questionnaire, both teacher profiles identify the need for technical resources, namely tools, individual equipment, in the case of teachers of non-higher education,

and internet network in the classroom space. Both groups also refer to the need for teacher training, appropriate to the context of each school, in the case of non-higher education. The emphasis on teacher training is accentuated in the interviews in which they consider that training in current technologies must be constant and carried out throughout their training process, namely in terms of the construction of technological environments, their use and management, as well as communication. Some even stress the need for training in equality, differentiation, accountability, individuality as the fundamental principles for education.

## V. DISCUSSION

In general, both students and teachers participating in this study use technologies in their activities, both personally and professionally, mainly to communicate. For this reason, it seems pertinent to recommend, in creating a MOOC, a close look at the basic elements of communication systems - sender, receiver, message, channel and code-and ensure the specificities of each one, to provide the necessary conditions for the effectiveness of communication in a formative context. If the technologies work so well for communication, it seems that it should be asked why and from there consider the elements that can be applied in a context of formative use, as it will be done in the units to be developed.

The group of participants shows basic knowledge about the use of technologies in education and even less knowledge about Artificial Intelligence, recognizing, however, the potential for use in their professional activities and the possible contributions both as methodologies and for the effectiveness of learning. Among students, this potential for use is higher than among teachers, namely in terms of impact on learning. Among the teachers, there is a greater possibility for the contribution of technologies while providing new methodologies, that is, these are seen as a complementary resource in the teaching and learning process.

Regarding the contribution of the course to the development of the set of skills indicated, it should underline a clear difference between the perception of students and teachers. For teachers, there is a strong contribution from the content of their subjects, but for students this impact is considerably less, and, for some skills, it is even very low. Among the skills mentioned in the study, those that referred to innovation were evaluated as those with the lowest contribution of the course to their development. Those who referred to collaborative work, autonomous learning and problem solving appear as the most outstanding as a contribution of courses / content. This difference in the attribution of the contribution of courses and content may be related to the methodologies used, but it also draws our attention to the profile of professionals that our courses are training and to the context in which they will work professionally, marked by the need for adaptation, flexibility, and innovation.

In the area of expectations, we highlight two fundamental aspects of the students' data: the adaptation of curricula to the context of current needs and the adaptation of methodologies to a more active role for students.

Regarding recommendations, teachers pointed especially

of a technical and pedagogical nature, regarding the role of the student and teacher training. They consider fundamental technical issues, such as security, internet connection quality, the existence of individual equipment for students, the mastery of different technological tools to allow the selection by the teacher or the flexibility of the technological systems to use.

These conditions are essential not only for teachers to develop a pedagogical model that is truly student-centered, which allows the development of values and skills identified as fundamental, but also a safe, accessible, collaborative learning environment with digital tools appropriate to students' goals where learning is challenging and flexible. The pedagogical models to be adopted presuppose an active student, focused on his learning, curious and in search of knowledge together with their peers and their teachers. For this construction to be possible, teachers recommend investment in training that is not only related to the user's perspective, but also to build learning environments, in which the teacher makes decisions, builds, organizes, and adapts the digital tools to the objectives pedagogical factors underlying their work.

From the perspective of the teachers, there are some principles to be considered when organizing a course that can contribute to the development of the identified skills, namely:

- 1) The instrumental dimension of the technologies-the technologies is not considered an end in themselves, but a means for the development of the abilities of the students considered fundamental for the current and future world.
- 2) Student-centered teaching-learning process-based on the concept of co-creation that assumes the student as an active participant in their learning process.
- 3) The need to incorporate technologies in education appropriate to the defined pedagogical principles-inclusion, customization, citizenship, democracy is the pedagogical model that determines the technologies to be used.

## VI. CONCLUSION

The research has highlighted both students' and teachers' need for online and distance learning, considering their knowledge and experience. In fact, there are high expectations about the use of technologies in an educational context and a clear understanding of these needs to meet the pedagogical purposes of the teaching and learning process. The second highlight is related to an explicit need for learning more focused on the active role of students. Therefore, the paper also shows the relevance of changing curriculum to the needs of the current historical context and the world of work, considering that it includes knowledge, pedagogy, and assessment. Finally, the research confirms the requirement of a humanized approach to an issue usually worked from a technical point of view.

A conclusion section is not required. Although a conclusion may review the main points of the paper, do not replicate the abstract as the conclusion. A conclusion might elaborate on the importance of the work or suggest applications and extensions.

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## CONFLICT OF INTEREST

Authors declare that they do not have any conflict of interest.

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