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DIGITAL COMPETENCIES OF TEACHERS AND STUDENTS IN THE FIELD OF SECURITY AND DEFENCE

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***Abstract**: Digital technology has become an integral part of teaching and learning. Teachers and students need to possess digital competencies to be effective in their activity. The aim of this paper is to investigate how to design training activities that can help teachers and students develop digital competencies. It is crucial to assess the current level of digital competencies of the people involved. The training objectives should be aligned with the actual frameworks on digital competencies. The activities themselves should be interactive, engaging, and practical, without forgetting theoretical components. It is essential to use a variety of training methods, such as workshops, online training, and coaching, to cater to the different learning styles of the teachers. This paper discusses the systematic approach adopted in the context of the European project DIGICODE. The aim of the DIGICODE project is to improve the security and defence education quality by using digital tools in the didactic activities and by developing digital competences of teachers. Project partners are European Universities and Military Institutions that deal with the training of officers. Results will focus on the data collected in a school "Systems for Command and Control in Security and Defence Field", which involved teachers and engaged students on the topics of the project. Findings connect various dimensions: (P) Pedagogical, (H) Human, (T) Technological and (I) Institutional. The discussion also highlights the importance of a careful design through collaborative working and sharing of ideas across different disciplines.*

***Keywords:** Digital Competencies; Digital Education; Inter-university Education; Officers Training; Security and Defence Education; Students Digital Skills; Teacher Training.*

INTRODUCTION

In the digital era, teachers and students need to acquire a set of digital competencies that will enable them to navigate the ever-changing technological landscape and effectively integrate digital tools and

resources in their teaching and learning practices. In fact, digital technology has become an integral part of teaching and learning, and as such, teachers and students need to possess digital competencies. That is why this work is inserted in the context of the Erasmus+ Key Action 2 Strategic Partnership "Digital Competences for Improving Security and Defence Education – DIGICODE", addressing education in the Security and Defence context combined with the use of digital education, tools, artifacts, and software. One of the objectives of the project is to favour teachers' development of the needed digital competences. Several military academies and universities in Europe participated in the activities of the project:

- Military University of Technology, Warsaw, Poland;
- National Military University, Shumen, Bulgaria;
- Military Technical Academy, Bucharest, Romania;
- University of Turin together with the IT Army Education and Training Command and School of Applied Military Studies, Turin, Italy.

Digital competencies are developed in relation with specific disciplines in Security and Defence education, mainly cybersecurity, logistics, mathematics, technical systems. The expertise on these disciplines has been brought by partner institutions, even though a full spectrum of topics is required for the training of military officers: STEM, foreign languages, law studies, etc. In this context, multidisciplinary scenarios have been developed by a joint work of teachers with different backgrounds, both military and civilian teachers.

The aim of this paper is to investigate the design of formative activities for students, a work carried out by an international team of teachers participating to a staff training week.

The first chapter delineates the framework of theoretical perspectives that are relevant to the development of digital competencies in teachers and students. The second chapter describe the activities that were carried out in the context of the DIGICODE project. The third chapter describe research question and methodology. The fourth chapter shows results of the collaboration among teachers and of the activities among students. The fifth chapter discusses the analysed results and the educational digital context according to four dimensions: pedagogical, human, technological and institutional.

I. THEORETICAL FRAMEWORK

This chapter explores the different digital competencies that students and mainly teachers need to possess to integrate technology effectively in educational activities. There are several models for digital competencies of teachers and students. These models provide a holistic approach to understanding the digital competencies to integrate technology effectively in teaching and learning. Digital literacies are well known in the scientific community, they refer to the skills, knowledge, and dispositions that enable individuals to effectively use digital technologies for communication, collaboration, and learning [3]. Digital literacies encompass a range of competencies, including information literacy, media literacy, and digital citizenship. These competencies are essential for teachers and students who are working in a digital learning environment.

One of the frameworks encompassing technologies in education is given by the Technological Pedagogical And Content Knowledge (TPACK) model, that highlights teachers need to possess three types of knowledge to integrate technology effectively in their teaching: technological knowledge, pedagogical knowledge, and content knowledge [4]. Technological knowledge refers to the knowledge of different technologies that can be used in education. Pedagogical knowledge refers to different teaching strategies. Content knowledge refers to the knowledge of the subject matter that is being taught. The TPACK framework states that effective technology integration in teaching requires teachers to have a deep understanding of the interaction and integration between technology, pedagogy, and content knowledge.

Another important framework on the integration of technology in education is given by the SAMR (Substitution, Augmentation, Modification, Redefinition) model [8]. This model is hierarchical, from low to high integration of technology. Substitution refers to using technology to replace a face-to-face teaching method. Augmentation refers to using technology to enhance a face-to-

face teaching method. Modification refers to using technology to redesign a teaching method, the activities are re-designed to consider the potentiality of technologies. Redefinition refers to using technology to create a new teaching method that was not possible before.

There are also institutional frameworks that must be considered when dealing with digital competencies: firstly, developed by the European Commission, there is the DigComp, a model that is useful for all citizens to provide a common understanding of what a digital competence is. It classifies digital competencies into five areas: information and data literacy, communication and collaboration, digital content creation, safety, and problem-solving [2]. Information and data literacy refer to the ability to find, evaluate, manage, and use information collected from web searches effectively. Communication and collaboration refer to the ability to interact, communicate, share, and collaborate effectively with other people using digital tools. Digital content creation refers to the ability to develop and re-elaborate digital content using different tools with a close eye on copyright issues. Safety refers to the ability to use digital tools safely and responsibly, especially when dealing with personal and sensitive data: protection must act on two level, the one of devices (hardware) and the one of cyber threats (software). Problem-solving refers to the ability to use digital tools in different ways to make life easier: being able to solve technical problems, identifying needs and gaps. The framework is refined when dealing with education in the Digital Competence Framework for Educators, the DigCompEdu framework [9]. It provides a comprehensive set of competencies that teachers need to possess in order to effectively integrate digital technologies in their teaching practice. The framework identifies 22 competencies, organized into six categories: (1) Professional Engagement, (2) Digital Resources, (3) Teaching and Learning, (4) Assessment, (5) Empowering Learners, and (6) Facilitating Learners' Digital Competence. More on the institutional point of view, the European Commission also developed the Digital Education Actin Plan [1], to provide guidelines for European educational systems for a common vision of high-quality, inclusive, and accessible digital education in Europe (European Education Area, 2020). The DEAP proposes two main priorities, Priority 1 works on fostering the development of a high-performing digital education ecosystem. Priority 2 works on enhancing digital skills and competences for the digital transformation. The priorities are sub-divided into actions that target specific objectives that need to be achieved.

Digital competencies also play an important role in the new ways of promoting mobility (physical and virtual) across Europe. The Blended Intensive Programs (BIPs), short mobilities with learning, teaching, and training programs combined with a compulsory virtual phase (cooperative online learning exchange).

As a summary of what emerged from the theoretical framework, teachers need to possess different competencies that gravitate around education with digital technologies, as well as the ability to integrate all the various areas in their teaching.

II. THE DIGICODE PROJECT

The European Erasmus+ Project Key Action 2 Strategic Partnership "Digital Competences for Improving Security and Defence Education – DIGICODE" addresses education in the Security and Defence context using digital education, tools, artifacts, and software to promote quality of education in military academies and universities. Several activities have been conducted. First, a survey was delivered to collect good practices and experiences from teachers and lecturers from international universities comparing processes, strategies, methods, and practices adopted by the respondents. From this activity, three scientific outputs were published [5,6,7]. Second, a handbook of best practices and solutions adopted by universities during COVID-19 has been issued, collecting the results from the survey. Third, a teacher toolkit was developed, containing online training materials to support teachers and trainers in using a digital learning environment for education, several digital tools, and in adopting innovative interactive methodologies like problem solving, problem-based teaching, learning by doing, formative and data-driven automatic assessment and collaborative learning. It must be mentioned that teachers shared this common toolkit before other activities on staff training, so they started improving their competencies both on digital tools and on innovative methodologies before meeting the students. Fourth, a curriculum for a school on "Systems for Command and Control in

Security and Defence Field" was designed, to help teachers have an integrated view with the other disciplines.

In the framework of the DIGICODE project, 4 Learning, Teaching and Training Activities (LTTA) took place. The first LTTA was a staff training week in Warsaw at the Military University of Technology: in this event teachers exchanged their didactic practices and shared opinions on the teacher toolkit. The second LTTA was a school in Bucharest at the Military Technical Academy, for 10 selected students, 2 per partners plus two additional students from the home institution. These two LTTA are considered for this research. Other LTTA are the second edition of these two LTTA, with improvements suggested by this research according to strength and weaknesses that were detected: staff training in Shumen at the National Military University and the school for students in Turin at the IT Army Education and Training Command and School of Applied Military Studies.

Other outputs of the DIGICODE project concerned other aspects very important in education, like the cybersecurity requirements for digital learning environments. All these activities are meant to be transferred into a better skill for teachers and students to face the challenges of digital teaching and learning in the context of Security and Defence and will support future activities of higher education institutions.

III. RESEARCH QUESTIONS AND METHODOLOGY

We have detailed the challenge of digitally competent stakeholders in education. The aim of this paper is to investigate the design of activities in the specific area of security and defence. The main research question of the paper is the following: how to design and implement training activities that require digital skills from teachers and make inter-university students develop digital skills in the field of Security and Defence? In the context of the DIGICODE project, which aims to help teachers develop digital skills that cascade onto students, an analysis of the needs has been carried out to understand what the advantages and disadvantages of online education are [6] in relation to digital competencies of teachers [5,7]. As mentioned before, one of the activities of the project was the implantation of LTTA which include discussions, focus group, collaborative group activities. In this paper the first edition of the staff training and of the school for students are considered to answer the research question. According to the frameworks, the activity of students and teachers will be analysed across 4 different dimensions: (P) Pedagogical, (H) Human, (T) Technological and (I) Institutional. We asked the participating students to submit a questionnaire. The questionnaire was composed of closed-ended and open-ended questions. The analysis has been carried out with a mixed method approach, joining both quantitative and qualitative results. Median values are considered for quantitative scales. Qualitative indicators are collected by open answers to the students' questionnaire and focus groups, which took place at the end of the week, to detect the effectiveness of the staff training and of the school.

IV. RESULTS

The analysis involved 10 students (4 students from Romania, 2 from Bulgaria, 2 from Poland and 2 from Italy) who participated to the staff training week. First, we asked students about "How would you rate your digital competencies in the following areas?" (Q1), comparing their perception before and after the school and "Did you improve your digital competencies during the latest years in relation to the changes the COVID-19 pandemic required in the following areas?" (Q2), just as it was before participating to the school. The rates are expressed over a 5-point scale from "very little" to "very much". Results are reported in Tables 1 and 2.

Item	Median (before)	IQR (before)	Median (after)	IQR (after)
Approach new software	4	1	4	1
Artificial Intelligence	3	0.75	3	1
Communication and collaboration (e.g. Social Media)	4	0.75	4	1
Digital content creation and editing (texts, images, audios, videos)	4	1.75	4	0
Military applications of digital tools	3	0	4	0
Retrieve, store and manage digital data	3	0.75	4	1
Safety and Cybersecurity	3	0	4	1

Table no. 1. Teachers' digital competencies as in (Q1) before and after the staff training

Item	Median (before)	IQR (before)
Approach new software	3	1
Artificial Intelligence	3	1
Communication and collaboration (e.g. Social Media)	4	1
Digital content creation and editing (texts, images, audios, videos)	3	1
Military applications of digital tools	3	1.5
Retrieve, store and manage digital data	3	0.75
Safety and Cybersecurity	3	1

Table no. 2. Improvement of digital competencies as in (Q2) in relation to the COVID-19

Results show the confidence of students in their digital competencies varying from average to high. The school helped in improving several rates. This trend is also highlighted by the fact that almost all students have used a digital learning environment (1 student rarely, 5 students usually and 4 students a lot / always) and they consider digital competencies quite important in fields such as: their own career, defence and security (and related technical systems), logistic support for military operations, cybersecurity, mathematical problem solving. This is confirmed by observing a median 4 for all these items, 4.5 for cybersecurity.

Second, the initial questionnaire proposed items about learning activities. The aim of the question was to understand "How much are you familiar with the following learning methodologies?" (Q3) and, since the methodologies are used in a specific context, we asked students also: "How much do you think these learning methodologies are of help in learning the topics of this international module?" (Q4). Students could evaluate the various items over a 5-point scale, where 1 was "very little" and 5 was "very much". Results are listed in Table 3.

Item	Median (familiarity)	IQR (familiarity)	Median (helpfulness)	IQR (helpfulness)
Problem solving	4	1	4	1
Problem posing	4	1	4	0
Learning by doing	4	1	5	1
Collaborative learning	3.5	1	4	0
Formative assessment	3	0.75	3	1
Problem based learning	3	1	4	0.75
Flipped classroom	2.5	1.75	4	0.75

Table no. 3. Students' familiarity with learning methodologies as in (Q3) and (Q4)

From Table 3, we can see that students are averagely or quite familiar with most learning methodologies, especially problem solving/posing and learning by doing which are typical practices in military training. All the methodologies are perceived as helpful (the formative assessment has a 3.7 average) for learning in an international module (and not only in this case presumably). These methodologies can be adopted with different activities and students were asked "Which activities do you think are more effective for learning?" (Q5) and "Which learning activities do you like more"

(Q6). Students could evaluate the various items over a 5-point scale, where 1 was “very little” and 5 was “very much”. Results are listed in Table 4.

Item	Median (effectiveness)	IQR (effectiveness)	Median (liking)	IQR (liking)
Lectures, seminars	3.5	1.75	3	1
Team working	4	0	4.5	1
Discussions and focus groups	4	0	4	0.75
Student presentations	3.5	1	3	1.75
Interactive activities in a digital environment	4	0	4	1

Table no. 4. Perceived effectiveness and confidence with activities as in (Q5) and (Q6)

From Table 4, we can infer that students are aware that transmissive lectures are the less effective activities among those listed, but in general students tend to feel confident in delivering any kind of activity.

In the questionnaires there were no specific questions about institutions and organizational policies, but these aspects emerged in the open answers, which are treated in the Discussion chapter.

V. DISCUSSION

In this chapter we are going to discuss the results and the discussions among teachers, creating relations among the various dimensions: (P) Pedagogical, (H) Human, (T) Technological and (I) Institutional.

Let’s start analyzing from the technological point of view (T). From discussion among teachers, it emerged that their digital competencies are quite developed since the recent pandemic required them to use many digital tools for education and it emphasized the need for improvement. Some teachers highlighted that they started a change in the way of teaching even before the pandemic, the use of technologies in their daily teaching was quite spread. Future improvements of students and teachers are also connected to the policies of institutions (I), to the sharing of good practices (P) with other teachers and other students, maybe in international modules, through digital media in dedicated staff training and schools (H) and to meet the expectancies of students (H). Among the various digital competencies, the ones that are mostly useful to teachers are related to educational digital contents (in particular Open Educational Resources), to effective communications and cooperation, and the ability to approach new software. This importance of digital competencies in education was asked even after the school, to compare with the previous perception, but no differences were detected, just a strong emphasis on those competencies that were cited at the beginning of the staff training.

Moving to the pedagogies (P), from the results we can see that students are aware and accustomed to any kind of methodology and activity, and they know that practical formative activities are to be preferred. From open answers, it emerges the importance of collaborative learning (H) with students from different countries and institutions (I). Moreover, teacher highlighted that not every digital tool (T) can be used in Security and Defence, thus an appropriate choice must be made and that the training with digital tools is aimed at using them in their future career, not only for educational purposes.

About the human dimension with its interactions (H), it emerged from the questionnaire that collaborative learning between teachers and students of different institutions (I), working on different scientific fields in the field of Security and Defence plays an important role. In particular, a positive aspect is given by the fact that teachers collaborated in blended mode, remotely and face-to-face. Unfortunately, students lacked an online phase, which would have fostered face-to-face collaboration, The school organization was focused on the event with several commitments and things to be designed and prepared, given the novelty of the experimentation. Considering this, the second school will be designed to boost attendance with online moments, both synchronous and asynchronous, in order to let students to know each other and to prepare for some of the activities. The encouragement of

collaboration among students should occur in different modalities (blended mode, remotely and face-to-face), inside specifically designed activities (P) and enhanced by digital and social tools (T). Furthermore, students were able to acquire in turn competencies and teamwork capabilities, but not on crosscutting themes. In the second school, it would be good for teachers to better define the interdisciplinary scenarios, connecting them to both the formative goals and didactic methodologies and technologies.

Last dimension deals with institutional (I) participation: the design of the school was an effective moment of collaboration between different institutions and of internationalization, but since teachers encountered each other for the first time during staff training, it has not been possible to fully harmonize the various disciplines in the activities of the school, even if they are strictly related. This interdisciplinarity will be an important aspect in the future to network among institutions and stakeholders, and to design effective BIPs.

The exploration of these four dimensions can pertain also the detection and classification of strengths and weaknesses, as benchmark for establishing what is adequate, and what on the contrary should be improved in subsequent initiatives. For example, a weakness concerning the pedagogical dimension (P) regarded the fact that, being this school the first one, teachers had to meet and share educational practices, spending less time on the design phase and not developing a completely organic logical thread. Another weakness, this time concerning the human dimension and its interactions (H), is related to have single students in the groups to prevail on the other ones during certain group activities, with an individual overtaking the other members of the group: in the end not all the students developed competencies uniformly. Strengths and weaknesses that were highlighted here and by the previous discussion are reported in Table 5, which shows a selection of these elements for each of the four dimensions.

Dimension	Strengths	Weaknesses
Technological (T)	• Awareness and proficiency in using digital tools for education • A variety of tools can be used to show students different possibilities	• Difficulty to choose the most appropriate tools (not all tool are suitable for educational purposes) • Need of more digital competencies
Pedagogical (P)	• Students can learn by means of various methodologies and activities • Students recognize some learning activities as more effective	• It is difficult to design a first edition of a school since most teachers meet for the first time • Lack of interdisciplinarity
Human (H)	• Collaborative learning, transversal with respect to several scientific fields • Promoting internationalization among teachers and students	• Single students can prevail in a group, causing discrepancies and reducing personal learning • Lack of online meeting phase
Institutional (I)	• Collaboration between institutions, in an international setting • International networking and sharing of good practices	• Policies or constraints may not promote the most effective practices • Involve more stakeholders (more students, even not only officers)

Table no. 5. Strengths and weaknesses relative to the four dimensions.

VI. CONCLUSIONS

The paper presented an experience of teacher training and students' school in Security and Defence field across European Military Academies and University. Teachers' and students' digital competencies were found to be high: the pandemic emphasized the need for improvement. There is always room for improvements, which are connected to institutional policies, sharing of good practices with other teachers in international networks, and meeting student expectations, which are changing together with the digitalization of society. This answers to the research question on how to design and implement training activities that require digital skills from teachers and make inter-university students develop digital skills in the field of security and defence: a careful design through

collaborative working and sharing of ideas across different disciplines. Collaborative learning between teachers of different institutions and scientific fields in the Security and defence area is important, and institutional participation is useful in designing effective BIPs. The development of digital competencies is also essential: the most useful digital competencies for teachers are related to educational content, effective communication and cooperation, and the ability to approach new software. Teachers are aware and accustomed to different teaching methodologies and activities, and practical formative activities are preferred. Collaborative learning with students from different countries and institutions must be promoted, and appropriate digital tools must be chosen for Security and Defence. The findings of the paper connected all the different dimensions in education in the digital world, emphasizing the relationships pedagogical, human, technological, and institutional dimensions.

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(omitted)

Reference Text and Citations

[1] European Education Area, 2020. *Digital Education Action Plan (DEAP)*. https://education.ec.europa.eu/document/digital-education-action-plan

[2] Ferrari, Anusca, 2013. *DIGCOMP: A Framework for Developing and Understanding Digital Competence in Europe*. Joint Research Centre, European Commission.

[3] Hague, Cassie; Payton, Sarah, 2010. *Digital literacy across the curriculum*, Futurelab. Retrieved from: http://www.nfer.ac.uk/publications/FUTL06/FUTL06.pdf

[4] Koehler, Matthew J.; Mishra, Punya; What is technological pedagogical content knowledge? *Contemporary issues in technology and teacher education*, 2009, 9(1), pp. 60-70.

[5] Marchisio, Marina; Roman, Fabio; Sacchet, Matteo; Spinello, Enrico; Teachers' perception of higher education in a transition scenario, *Proceedings of the 2022 IEEE 46th Annual Computers, Software, and Applications Conference (COMPSAC)*, 2022, pp. 139-144.

[6] Marchisio, Marina; Roman, Fabio; Sacchet, Matteo; Spinello, Enrico; Nikolov, Linko; Gontarczyk, Mariusz; Zelkowski, Jaroslaw; Moldoveanu, Cristian-Emil; Advantages and disadvantages of digital remote education in the Security and Defence contexts, *Proceedings of the 18th eLearning and Software for Education Conference (eLSE)*, 2022.

[7] Marchisio, Marina; Roman, Fabio; Sacchet, Matteo; Spinello, Enrico; Nikolov, Linko; Grzelak, Malgorzata; Rykala, Madgalena; Moldoveanu, Cristian-Emil; Teachers' Digital Competences before and during the Covid-19 Pandemic for the Improvement of Security and Defence Higher Education, *Proceedings of the 16th International Conference on E-Learning (EL) - Part of the 16th Multi Conference on Computer Science and Information Systems (MCCSIS)*, 2022, pp. 68-75.

[8] Puentedura, Ruben R., 2006. *Transformation, Technology, and Education*. http://hippasus.com/resources/tte/

[9] Punie, Yves, editor(s); Redecker, Christine, 2017. *European Framework for the Digital Competence of Educators: DigCompEdu*, EUR 28775 EN, Publications Office of the European Union, Luxembourg.