EU SECURITY AND DEFENCE STUDENTS' PERCEPTION AND USE OF DIGITAL COMPETENCIES IN HIGHER EDUCATION

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ABSTRACT

The use of digital tools in teaching and learning has become increasingly common in recent years. Even prior to 2020, their usage was steadily growing, but the outbreak of the COVID-19 pandemic in the early part of the current decade significantly accelerated their adoption. This trend has persisted even as the virus is no longer a pressing emergency, indicating that certain changes will have a lasting impact. Utilizing digital tools in education offers advantages, but it also presents challenges. Transitioning from using computers and other devices for everyday purposes to incorporating them into educational contexts is not as straightforward. In this research, we examine how students perceive higher education during the transition prompted by the pandemic. We conducted a survey among military and civilian students enrolled in security and defence studies, focusing on their experiences and perceptions as they undergo significant changes in their educational routines. Analysis of the questionnaire revealed that students encountered difficulties in various aspects, including establishing connections with teachers and experiencing the same level of engagement when unable to interact with them in person. An increase in the students' perception of digital competencies was detected. This research is part of the activities undertaken in the European project DIGICODE, which aims to enhance the quality of education in security and defence by promoting the proper use of digital tools and fostering the development of digital competencies among both students and teachers.

KEYWORDS

Digital Education, Distance Learning, Online Education, Security and Defence, Student Training

1. INTRODUCTION

Security and defence education needs suitable tools that facilitate learning in various ways, such as blended learning (Marchisio et al., 2022c), hybrid learning (Marchisio et al., 2022d), and other modalities that enable strategic internationalization of educational settings without mandating purely online courses (Mihalova, 2006). To foster effective and long-term collaboration, it is beneficial for military officers and civilians involved in security and defence to cooperate early in their educational journey, such as during their student or training years (Marchisio & Spinello, 2021), also through digital media: in fact, e-learning widespread adoption across the globe took a significant leap forward during the COVID-19 pandemic (Hodges et al., 2020). It is important to provide specific training to teachers, students, and all stakeholders, as it helps them understand the unique application of digital tools in education (Marchisio, M. et al, 2022a). The DIGICODE project, funded by the European Union as an Erasmus+ Key Action 2 Strategic Partnership project, is facing these challenges at the European level. It involves several nations such as Bulgaria, Italy, Poland, and Romania. The project, which stands for DIGItal COmpetencies for improving security and Defence Education, aims to promote effective utilization of digital tools for teaching in the military context. This paper aims to examine the digital competencies of students both before and during the COVID-19 pandemic. To achieve this, we conducted a questionnaire survey among students, which assessed various aspects

including engagement, communication, development of digital competencies, and achievement of learning outcomes. Additionally, we compared students' time management when using computers and electronic devices. Finally, open-ended questions explore some complementary insights. The study focuses on European students enrolled in security and defence courses, interdisciplinary programs with a strong emphasis on international cooperation. A similar survey has already been conducted and analyzed among teachers (Marchisio et al., 2022a), enabling us to establish comparisons between the perspectives of students and teachers. The paper is organized as follows: Section 2 provides the theoretical framework in which this research takes place, while Section 3 discusses the research question and methodology. Section 4 presents the findings, and Section 5 provides a comprehensive discussion. Finally, Section 6 offers concluding remarks.

2. THEORETICAL FRAMEWORK

Numerous recent studies have examined the significance of acquiring digital competencies in the context of security and defence. Firstly, it is evident that digital tools form the foundation of e-learning, necessitating all stakeholders, particularly those involved in education, to possess digital competencies. Attitude, motivation, self-efficacy, and use of technology play a significant role in the cognitive engagement and academic performance of students (Patricia Aguilera-Hermida, 2020). However, a critical issue arises when individuals overestimate their skills, leading them to believe that their existing knowledge is sufficient and that they can rely on others with better tool proficiency if assistance is needed. This misconception is prevalent among both students (Buffardi & Taddeo, 2017) and teachers (Tomczyk, 2021), resulting in a diminished emphasis on the importance of acquiring adequate digital competencies. Pinchuk and Prokopenko (2021) analyzed the experiences of various countries, including the United States, Australia, China, Britain, Israel, Korea, and Singapore, in implementing modern educational approaches to STEM subjects. They identified the potential for transdisciplinary integration in providing advanced training for the Armed Forces of Ukraine, their home country, and the need for effective ownership of tools for planning and organizing project work. Barron and Rowles (2021) emphasized the significance of digital literacy, specifically in the Air Force and other military branches. The optimization of technology for educational purposes requires technical tools to serve as means rather than ends (Goldin & Katz, 2009), thereby involving various other skills (Van Laar et al., 2017). One well-known concern is that despite digital competencies aligning with future skills (Ehlers, 2020, and references therein), nearly half of Europeans lack even basic digital skills, with a gender gap and digital divide exacerbating the situation based on 2017 data (European Education Area, 2020). The European Union's publication of the Digital Education Action Plan (DEAP) in 2020 underscores the strategic importance of digital competencies in education, inspiring the initiation of the DIGICODE project. Overall, these skills are crucial for addressing the challenges of sustainable education (Mentsiev et al., 2022) and align with the United Nations' Sustainable Development Goals (United Nations, 2015).

3. RESEARCH QUESTION AND METHODOLOGY

Fixing the context of security and defence higher education in a transitional scenario caused by the COVID-19 pandemic, our study was driven by the need to address the following research questions: (RQ1) what are the perceptions of military and civilian students and (RQ2) what are the perceptions of digital competencies? To assess these factors, we submitted, measured and analyzed a survey that examined both quantitative and qualitative aspects about these perceptions of students. The research in this paper considers 6 pairs of questions, a subset of the whole questionnaire. The quantitative aspects allowed for a comparison of the situations before and during the COVID-19 pandemic. We utilized Likert scales for Pairs 1-4 and categorical levels for Pairs 5-6. For ratings, we established a five-level Likert scale, with 1 representing the lowest score and 5 indicating the highest. Regarding time spent, we categorized it based on the actual number of daily hours in one case, and in the other case, we utilized reasonable ranges of weekly hours (e.g., "from 4 to 10 hours"). We performed both descriptive and inferential analyses on the resulting numerical data in particular we performed the paired Wilcoxon signed-rank test and the paired t-test. This approach enabled us to effectively demonstrate any existing differences and establish their statistical significance. Similar questions provided to students and teachers allow us to compare the perceptions, highlighting similarities and

differences in how both groups experienced the scenario. The qualitative aspects gave us some perspectives about students' perceived problems and threats resulting from remote education, and how to deal with them, along with some practices they deemed as good to address the situation both during and after the COVID-19. The data was collected from 832 European students in Security and Defence studies, categorized by age and gender as follows:

Table 1. Distribution of the students by age and gender

Age range	Females	Males	Did not specify
18-22 years old	103	239	4
23-25 years old	106	309	5
Over 25 years old	11	51	4

Approximately 83% of the participants are military students, the remaining 17% are civilians. They are nearly evenly divided between bachelor's and master's students, with a slight majority of the former. The questionnaire was proposed to students who experienced security and defence education in the transition scenario, thus from last year of bachelor's students upwards (almost 95% of the sample). We considered even other responses because they represent a very little part of the sample and some students attended military secondary schools, thus experiencing security and defence education even prior to university. Considering that the COVID-19 pandemic compelled the use of digital tools that were not previously mandatory, it is reasonable to anticipate that ratings and time spent are important indicators that have undergone changes.

4. RESULTS

In the subsequent tables, the term "before" refers to the period "before the pandemic, in a face-to-face context," while "during" refers to the period "during the pandemic, in an emergency or online context."

Pair 1: how do you perceive your personal engagement?

Table 2. Rating of students' personal engagement

Engagement	Before	During	Difference
Very low (1)	9	13	+4
Low (2)	21	97	+76
Average (3)	169	240	+71
Good (4)	404	356	-48
Very good (5)	229	126	-103

Table 2 demonstrates a decrease in students' perception of their engagement during the pandemic. Out of the total number of scores, 344 decreased, 131 increased, and 357 remained the same. This decline is also evident in the average score, which decreased from 3.99 (standard deviation: 0.82) to 3.58 (standard deviation: 0.93). The analysis of the paired data reveals a mean difference of -0.41 (standard deviation: 1.10). The paired Wilcoxon signed-rank test and the paired t-test (both approximated normally), indicate the significance of this deterioration with respective z-scores of 9.77 and 10.69. Generally, a value higher than 3 is considered significant, which is clearly surpassed in this case. The practical implication is that students faced difficulty in maintaining the same level of engagement remotely as they did in the classroom.

Pair 2: how do you rate the/your communication with teachers?

Table 3. Rating of communication with teachers

Communication	Before	During	Difference
Very low (1)	6	16	+10
Low (2)	22	69	+47
Average (3)	168	268	+100
Good (4)	432	339	-93
Very good (5)	204	140	-64

Table 3 presents a decrease in the quality of communication between students and teachers. Out of the total scores, 301 decreased, 119 increased, and 412 remained unchanged. This decline is evident in the average score, which decreased from 3.97 (standard deviation: 0.79) to 3.62 (standard deviation: 0.92). The mean difference is -0.35 (standard deviation: 1.06). The z-scores for the Wilcoxon signed-rank test and the t-test indicate statistical significance, with values of 8.57 and 9.45 respectively. This suggests that students faced difficulties in feeling equally comfortable communicating with teachers remotely compared to face-to-face interactions, despite the general tendency of young people to communicate through virtual means.

Pair 3: how do you rate your own development of digital competencies?

Table 4. Rating of development of digital competencies

Digital competencies	Before	During	Difference
Very low (1)	7	5	-2
Low (2)	32	16	-16
Average (3)	219	148	-71
Good (4)	405	444	+39
Very good (5)	169	219	+50

In contrast to Tables 2 and 3, Table 4 reveals an increase in scores. Out of the total, 234 scores increased, 97 decreased, and 501 remained unchanged. The average score rose from 3.84 (standard deviation: 0.82) to 4.03 (standard deviation: 0.76), with a mean difference of 0.19 (standard deviation: 0.79). The z-scores for the Wilcoxon signed-rank test and the t-test are 6.43 and 7.00 respectively, indicating statistical significance. However, the significance is lower compared to Pairs 1 and 2. This suggests that students developed some digital competencies because of the situation, but not uniformly. In fact, more than 60% of students did not improve these competencies as stated.

Pair 4: how do you rate your achievement of the learning outcomes?

Table 5. Rating of achievement of the learning outcomes

Learning outcomes	Before	During	Difference
Very low (1)	6	10	+4
Low (2)	18	29	+11
Average (3)	206	243	+37
Good (4)	465	413	-52
Very good (5)	137	137	0

In this instance, Table 5 presents a more balanced situation. Out of the total scores, 145 increased, 193 decreased, and 494 remained unchanged. The average score shifted from 3.85 (standard deviation: 0.74) to 3.77 (standard deviation: 0.81), resulting in a variation of 0.09 (with a standard deviation of 0.89 for the mean difference). These changes appear to be less pronounced compared to previous cases, as indicated by the z-scores of 2.80 for the Wilcoxon signed-rank test and 2.78 for the t-test. These scores imply statistical significance, but with a higher p-value, close to 0.01. This implies that some students may have felt satisfied with their achievements as learners in the transitional scenario. The uncertainty surrounding the situation could have potentially led to even greater difficulties, leading to their perception of relative success.

Pair 5: how many hours per day do you spend on the PC for learning purposes?

Table 6. Daily time spent on a PC

Daily time in front of PC	Before	During	Difference
Less than 1 hour (1)	172	35	-137
About 2 hours (2)	281	95	-186
About 3 hours (3)	146	93	-53
About 4 hours (4)	84	100	+16
About 5 hours (5)	30	98	+68
6 hours or more (6)	39	331	+292

In this case, we excluded 80 students who responded "It's hard to say" regarding the pre-pandemic period, resulting in a slightly smaller sample size of 752. The increments observed in the analysis are significant: the amount of time increased 468 times, while it decreased only 64 times (remaining the same in 220 instances). The average number of hours increased from 2.52 (standard deviation: 1.34) to 4.49 (standard deviation: 1.64), indicating a substantial jump of 1.98 (with a standard deviation of 1.95 for the mean difference).

The z-scores provide strong confirmation, with the highest scores among all the pairs considered: 19.13 for the Wilcoxon signed-rank test and 27.82 for the t-test. This implies that most students required more time on a/their PC, with significant differences observed for many students. However, a minority of students did not require additional time and some even needed less time. The students who required less or the same amount of time likely already used the PC sufficiently before the transition, as indicated by the evidence from the following pair of questions. It is important to note that these students had a reasonable level of PC usage before the pandemic, as there is substantial uniformity in the reported number of hours.

Pair 6: how much time per week do you spend studying for classes?

Table 7. Weekly time spent studying for classes

Learning outcomes	Before	During	Difference
Less than 1 hour (1)	46	59	+13
From 1 to 4 hours (2)	279	247	-32
From 4 to 10 hours (3)	313	286	-27
From 10 to 20 hours (4)	131	154	+23
More than 20 hours (5)	63	86	+23

In the final pair of questions, the situation is once again more balanced. The category increased 226 times, decreased 172 times, and remained unchanged 434 times. The average score increased from 2.86 (standard deviation: 1.00) to 2.95 (standard deviation: 1.09), resulting in a mean difference of 0.09 (standard deviation: 1.05). Like Pair 4, these modifications hold less significance, as indicated by the z-scores of 2.50 for the Wilcoxon signed-rank test and 2.47 for the t-test. This implies a p-value higher than 0.01, indicating the inability to reject the null hypothesis of insignificance in the changes with a 99% confidence level (although it is possible to reject it with a 95% confidence level). Consequently, students feel less compelled to significantly increase the time they dedicate to studying, and it can be assumed that a portion of them already devoted enough time to studying before the COVID-19 pandemic. It could be argued that the subdivision of the scale may influence these considerations, but the proximity of the numbers in relation to the increments and decrements reasonably suggests the absence of a clear trend regardless.

Table 8. Pairs of questions versus differences before/during (percentages)

Pairs	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5
1		0.0	3.7	11.7	26.0	42.9	12.6	2.4	0.5	0.2	
2		0.7	2.4	9.9	23.2	49.5	10.8	2.9	0.6	0.0	
3		0.1	0.2	1.7	9.6	60.2	23.6	4.1	0.4	0.1	
4		0.1	0.6	5.5	16.9	59.4	14.1	2.5	0.7	0.1	
5	0.0	0.1	0.9	2.5	4.9	19.8	13.4	14.2	16.2	18.4	9.4
6		0.6	1.0	3.8	15.3	52.2	19.5	5.6	1.7	0.4	

Table 8 summarizes the situation of increase and decrease of students' answers in all pairs of questions. We see that the differences relative to Pairs 1 and 2 are asymmetrically distributed toward the negative values (left), while those concerning Pairs 3 and 5 have an asymmetric distribution favoring the positive values (right), which is particularly marked in the latter case. Pairs 4 and 6 exhibit a more equilibrated scattering. Let us present some qualitative aspects now. We asked students if during the pandemic they had experienced problems with activities such as laboratories and projects, and if so, which ones. Only about 20% of them answered "yes", but we found some interesting responses:

- "Many times the assessment was not as fair as possible, because it was more difficult to develop connections between the teacher and the student, making it difficult to evaluate in the best way the quality of the knowledge depending on the progress of the student during the semester."
- "I failed an exam because the professor did not hear my correct answer due to audio buffering. Projects were difficult to manage, since there was no face-to-face interaction between students."

- "Very little time to take the test, in face-to-face classes a test would have never been administered under the same conditions; sometimes I also experienced lack of understanding for problems."

From these answers, we can see that sometimes technology causes problems (such as in the case of buffering), but more frequently it is the methodological approach that is perfectible, requiring for example an adaptation of the assessment to the changed conditions. In another question, we asked students if they had good practices in learning during and after the pandemic, and if so, to share them. Again, not more than 20% of students answered "yes", but several noteworthy answers occurred:

- "Discipline had a more important role during the pandemic. Before students lived closer one to the other and could hear news from their school easily. During the pandemic, it was necessary to check your e-mail periodically and to evaluate our level of knowledge before an exam ourselves."
- "Organizing the acquired materials from classes on an ongoing basis, controlling and verifying emerging activities in teams so as not to get lost in the course of teaching, subject scope, material..."
- "Reading a lot of scientific papers and books and learning by myself from extra topics than the ones the teachers were presenting."

The general impression has been that a certain degree of autonomy, higher than the one required before the pandemic, can help in learning under the new conditions. Finally, a question regarding students' perception of the biggest threats that could result from remote education was asked. In this case the number of answers was considerably higher, here some examples:

- "From an educational point of view, I believe that my institution has adapted and countered the threats of exam fraud. I believe that the biggest threat is not the online or hybrid learning system, but the isolation of the individual from the collective (individual and not collective work). The military system is based on teamwork, and the exclusive use of online courses can damage the student's integration in the future workplace. I believe that the hybrid system my institution adopted is ideal."
- "At a military level, we need to stay in contact with people and with the military context. In my opinion there are no threats for university studies, so we should study remotely but we should also have some hours where we can do (in presence) only military things."
- "We may risk shifting the focus from deeply understanding the subject to being able to answer quizzes and online questions."

We see that remote learning itself cannot be blamed for generating threats, but rather problems arise when it implies a significant reduction of social interactions, especially in the security and defence context where working in a team is pivotal. It is also recognized how solutions like hybrid and blended learning, which contemplate the coexistence of a part in presence with one at a distance, can deal with this issue. From last perception, we can see that students may be more tempted to perform specific training fine-tuned on the tests' format rather than really study the subject.

5. DISCUSSION

These findings can be connected to the theoretical framework and research question. Starting from the quantitative ones, the decrease in averages for Pairs 1-2 (engagement and communication) and the increasing standard deviations indicate that students react differently, to some extent, to the challenges posed by the pandemic, likely influenced by their initial circumstances. Like what was found by Hodges et al. (2020), flexibility with learning activities, course policies, and institutional policies should be considered. Personalized learning paths could help address this diversity. Additionally, since students' digital competencies vary, targeted training to develop these skills (Pair 3) could be beneficial, since it was evidenced by Patricia Aguilera-Hermida (2020), students with no previous experience with online learning may think that online delivery is not desirable. It would have been expected to observe increments in Pair 5, but trained students tend to require less time for technical tasks, thereby reducing the additional time spent using PCs. Regarding Pair 4 (learning outcomes) and Pair 6 (weekly study time), the results indicate a more stable situation. However, improving students' engagement could enhance the quality of study time. Another crucial aspect is the need for accommodation: it takes time to adjust to changes, even when they may bring benefits. This is in line with other findings which showed that students struggled to adapt to online learning (Patricia Aguilera-Hermida, 2020). In our context, this adjustment depends on the extent to which students

use technology in education. It is evident that teachers should lead by example and utilize digital tools themselves.

We can also compare the recently obtained results with the corresponding survey conducted on teachers, as depicted in (Marchisio et al., 2022a). Pairs 1-2 are directly related to the questions posed to teachers, where they were asked to rate student engagement (corresponding to Pair 1) and communication with students (corresponding to Pair 2). In both cases, we observe a statistically supported decline in the ratings. This suggests that both students and teachers shared the perception that students faced greater difficulty in engaging, and that communication became more challenging in both directions—teachers found it harder to communicate with students, and vice versa. There is also a similar agreement regarding Pair 5, as we asked teachers about the number of hours per day they spent on the computer for teaching or preparing teaching materials. Both students and teachers experienced a significant increase in the daily time spent on educational purposes using computers, confirming the necessity for all stakeholders to engage with digital tools to a much greater extent than before. On the other hand, Pair 3 is less directly related to the questions asked of teachers regarding competencies. Teachers were asked to rate the development of students' competencies, while students were asked to rate their own development of digital competencies. This resulted in different outcomes: teachers perceived a significant decline in the development of students' general competencies, while students themselves perceived an increase in their digital competencies. Pair 4 also has only partial relevance to the question posed to teachers regarding learning outcomes, where they rated the implementation of learning outcomes, while students rated their own achievement. While teachers perceived a strong difficulty in implementing learning outcomes like pre-pandemic times, students had a less negative perception, with difficulties still present but not so marked. Lastly, in Pair 6, we return to a higher level of similarity. However, while teachers strongly reported needing more time to fulfill their commitments, the statistical evidence suggesting the same for students was relevantly weaker. This can be explained by the fact that adapting learning to new scenarios may be easier than adapting teaching methods.

The discussion on the qualitative findings can start from this last observation: about experiencing problems while a practical part is involved, the proportion of teachers answering “yes” was about one third, higher than the 20% of students, thus supporting the greater ease in the adaptation of learning with respect to teaching. However, the two sides did not perceive the issues exactly in the same way. Several students’ answers focused on the assessment, highlighting the difficulties in guaranteeing the same fairness a more traditional evaluation may assure; teachers spoke instead mostly about didactic methodologies and practices (Marchisio et al., 2022b). If on the one hand this is understandably related to their different goals, on the other hand this does not mean that students are interested in the assessment alone, since they recognized the risks in specifically preparing for tests rather than for gaining knowledge on the subjects. Concerning good practices, the similarities between students’ and teachers’ answers are more marked, since both groups of stakeholders agree on the fact that autonomous organization plays a more important role in these forms of didactics. Finally, yet importantly, students and teachers concur also on having a teaching approach comprehensive of blended or hybrid elements to highly consider the human factor. Practically, educators and policymakers should address the challenges by means of proper strategies, including the consideration of digital tools to foster collaboration across disciplines and implement creative approaches.

6. CONCLUSION

This research provided us with insights into how students' perception of higher education changed during the transition caused by the COVID-19 pandemic, providing a general response to (RQ1). We found students’ difficulties in various aspects, including establishing connections with teachers, and increase in the perception of digital competencies (RQ2). These perceptions and changes have practical implications. Digitally skilled teachers and organizations, enabling students to develop more specific competencies beyond their existing ones, can overcome the experienced difficulties. Furthermore, incorporating interdisciplinary activities and innovative methodologies through digital tools can broaden students' understanding of the subject matter. The impact of design and activities on teachers and students is under examination, specifically in the context of the DIGICODE Learning, Teaching and Training Activities like the school "Systems for Command and Control in Security and Defence Field". A large part of the adopted approach is not limited to security and defence education, but the international nature of the project offers a noteworthy context for

studying and implementing suitable interventions in education. As future work, each partner of the DIGICODE project is interested in collaborating more to study specific competencies related to security and defence education, like mathematical competencies, critical thinking and problem-solving skills. Moreover, further research will include surveys and interviews to measure other variables such as cultural differences, academic results, and degree of satisfaction.

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