
Rebuilding Stronger: Students' Digital Resilience in the Post-Pandemic Era

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Abstract

During the pandemic, education faced challenges coupled with a quick shift to remote learning and mandatory use of online teaching tools, requiring students to manage new technologies and alter their lifestyles. Digital resilience refers to an individual's ability to adapt and cope with digital disruptions, which became crucial in this period. This study examines the post-pandemic condition of digital resilience of the students who attend the Faculty of Technical Sciences in Čačak. A survey was conducted among the undergraduate and graduate students including those who experienced the pandemic during their higher education and secondary school studying. The data on digital resilience elements, such as cyber-security features and communication behaviour, were gathered by the survey. The analysis of the responses provided the deeper insights into the evolution of the students' digital resilience during the global health crisis. It showed up that the students tend to solve the problems on their own and that those who experienced online learning in high school expressed a higher level of resilience. The implications of the study can serve as a guide for further research and practice.

Keywords 1

Digital resilience, online learning, pandemic

1. Introduction

The term digital resilience has come into focus recently due to a series of crises which disrupted the everyday life of millions of people. The earthquakes, military conflicts and the pandemic initiated a digital shift for many workers and students and their companies and institutions. Working and teaching/learning online become prevalent. Moreover, such a trend did not stop once the pandemic was over. The remote work concept proved to be efficient for many companies which kept this model or moved to a hybrid one. The similar happened to universities. The flexibility and learners' opportunities emerging from the necessity are likely to shift the expectations of students and educators, eliminating further the border between classroom-based instruction and virtual learning [1].

There are numerous ways for things to turn wrong and jeopardize business or academic operations now that the use of digital technologies has become so intensive. There are technical disruptions such as cyber-attacks, power outages, hardware malfunctions; physical disruptions (eye strain, video-conference fatigue) and social issues such as inappropriate behaviour (spamming, cyber-bullying, disclosing private data) or spreading fake news on social media. Digital resilience is the ability to adapt and cope with such digital disruptions. It is a personal trait that one needs to develop. An individual can be considered digitally resilient if they possess the capacity to handle the disruption and remain operative in the digital world. Cyber-security and digital resilience go hand in hand. However, the need is recognized to shift from traditional cyber security principles (evaluating risks and applying security measures) to critical digital literacy, digital citizenship practices and socio-emotional learning [2].

Proceedings for the 14th International Conference on e-Learning 2023, September 28-29, 2023, Belgrade, Serbia

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CEUR Workshop Proceedings (CEUR-WS.org)

Arguably the most influential event leading to the wide digitalization of the learning/teaching process is the COVID-19 pandemic. World Health Organization (WHO) declared the pandemic on March 11th 2020. Three years later WHO stated that the global emergency was over [3]. Universities and schools all over the world switched to online learning [4]. The Faculty of Technical Sciences in Čačak moved almost entirely to online learning, keeping only freshmen in small face-to-face groups. During the pandemic, several platforms were activated. The important point was that many students and professors had already used Moodle and MS Teams for various asynchronous activities. Therefore, the shift was not too stressful. The teachers who had not previously been familiar with these platforms started using them and both teachers and students started using video-lectures. After the pandemic was stated as "not emergent", most teachers and students kept using the platforms for asynchronous learning and senior undergraduates and graduates were kept in hybrid mode.

This paper investigates how the COVID-19 pandemic and the shift to online learning affected students' digital resilience. We supposed that there might be a connection between the shift to online learning (when/how long students were using it) and their digital resilience. Therefore, we conducted research to gather more insights into digital resilience among our students. Firstly, the related research is analyzed and the methodology is further presented. Finally, the obtained results are interpreted and discussed in the conclusion and suggestions for further research are presented.

2. Related work

Weller et al. proposed a framework for digital resilience in higher education, using the resilience metaphor from ecology. It proved to be a reliable qualitative tool, useful for detecting areas of concern and establishing intervention priorities [5].

Measuring digital resilience is a challenge, as this is a complex personal trait. In [6] authors analyzed current research in this field. It is concluded that there is an urge to further agree with the digital resilience conceptualization. Also, it is advised to further engage in longitudinal studies on this topic.

Researchers explored how students reacted to COVID-19 in Asia and Australia [7], regarding their digital resilience. They used a large sample of students in five countries. The results showed a significant level of digital resilience and increased digital competencies. However, there are various recommendations set up in the conclusion, such as the need for providing more interactivity and teacher training.

Sun et al. designed a study to clarify the concept of digital resilience among students in a school education context, describing antecedents and consequences and suggesting a conceptual model for health educators [8]. This model is circular and it is constructed to help develop intervention measures for students, acting in an early phase of need for support.

Ang et al. developed a digital resilience training program based on theory, evidence, and contextual information [9]. The training was well accepted by the students and both resilience and meta-cognitive self-regulation scores significantly improved after the training program.

3. Research Methodology

This research aims to determine potential differences among the students in the improvement of digital skills (based on their self-assessment) depending on the duration of online classes at faculty or secondary school. Also, one of the objectives is to explore in how students used technology for online teaching and learning during the pandemic.

Quantitative analysis was conducted to collect data. For this purpose, a questionnaire was developed. The first part of the questionnaire includes the questions about the study year, study programs, and the duration of the online classes. The second part of the questionnaire contains the questions about used platforms, antivirus programs, passwords, the causes of the problems with platforms, how students solved the situations, such as losing the data for studying, etc. The third part of the questionnaire is related to behavior in case of unpleasant situations in communication with others, help-seeking, and improvement of the digital skills. The study was conducted at the end of the summer semester (July 2023).

3.1. Research questions

Based on the main research aim, the following research questions can be identified:

- Are there any differences among the students who attended online classes over a shorter or longer period in the estimation of the improvement of digital skills?
- Which platforms did the students mainly use during the online classes?
- How did they use technology and how did they solve technical and other problems during online teaching and learning?

3.2. Sample

A sample consisted of 64 Faculty of Technical Sciences in Čačak students (University of Kragujevac). Most of them were in the first year of study (28%), 25% of them attended the second year, while the percentage of the students attending the third year was 12%. There were 15% of students attending the fourth year and only 3% of the students were in the fifth year of studies. The total number of Information Technology students was 77.6% while the rest of them were the students of other study programs in the technical field.

To determine whether the students attended online classes, they were asked to declare how long (in the number of semesters or school years) they were in an online teaching mode. Due to the differences in the duration of the studies, some students had the online classes either only in the secondary school or only at Faculty, or both. (Table 1 and Table 2).

Table 1

Duration of online teaching at Faculty

Semesters	Frequency	Percent (%)
More than 4 semesters	20	31.3
2-4 semesters	10	15.6
1 semester	20	31.3
I did not attend online classes	14	21.9
Total	64	100.0

Table 2

Duration of online teaching during secondary education

School years	Frequency	Percent (%)
More than one school year	12	18.8
One school year	17	26.6
Less than one school year	12	18.8
I did not attend online classes	23	35.9
Total	64	100.0

4. Results and discussion

The results of the research are presented according to three research questions. To determine whether there are differences in the estimation of improvement in digital skills between students who attended online classes over a shorter or longer period, ANOVA analyses were conducted. The results of descriptive statistics are presented in Table 3 and Table 4.

Table 3

Improvement in digital skills after online classes at the Faculty

Duration of online classes at Faculty	N	Mean	Std. Deviation
More than 4 semesters	20	3.25	1.293
2-4 semesters	10	3.60	1.350
One semester	20	3.40	1.046
I did not attend online classes at the Faculty	14	3.79	0.893
Total	64	3.47	1.14

Table 4

Improvement in digital skills after online classes in secondary school

Duration of online classes during secondary education	N	Mean	Std. Deviation
More than one school year	12	4.00	0.603
One school year	17	3.76	1.200
Less than one school year	12	3.67	0.888
I did not attend online classes in secondary school	23	2.87	1.217
Total	64	3.47	1.140

There are no statistical differences among the groups of students who did not attend online classes at the Faculty and the other groups of students (more than 4 semesters, 2-4 semesters, one semester), $F(3,60) = 0.663$, $p = 0.578$. However, there are significant differences in the estimation of improvement of digital skills among the students who attended online classes for more than one school year and the students who did not attend classes in online teaching mode during secondary education ($F(3,60) = 3.981$, $p = 0.012$). A longer period of online teaching during secondary school education resulted in higher estimations of improvement in digital skills ($M = 4$). Such findings have been expected regarding the fact that the students at the Faculty have more experience with technology, especially due to their fields of study.

However, because of the small number of students in different groups, these results cannot be generalized. They can be used as an initial insight into students' evaluation of improvement in digital skills after a period of online learning and teaching.

The students were asked to select which platforms they used during online teaching mode. The results are shown in the following table (Table 5).

Table 5

Used platforms during online teaching mode

Platform	Frequency	Percent (%)
LMS Moodle	29	45.3
Microsoft Teams (asynchronous)	33	51.6
Microsoft Teams (synchronous, video conferencing)	32	50
Zoom	34	53.1
Google Meet	21	32.8
Viber and other social networks	25	39.1
I did not use platforms	6	9.4

As shown in Table 5, more than half of the students used Microsoft Teams for asynchronous and synchronous communication. It means that the teachers used the platform for sharing files, and communicating via chat, as well as for real-time classes. LMS Moodle was also frequently used. Based on the frequency, it can be concluded that online teaching was organized in different ways and supported by various platforms.

On the five-point scale, students assessed how often they had technical obstacles during online classes (Table 6).

Table 6

The causes of platform interruptions

The cause of the problem	Mean	Std. Deviation
The computer broke down	1.98	1.20175
The internet connection is lost	2.83	1.21570
Power outage	2.09	1.13695
Unknown reason	1.63	0.95119

N = 64

According to the result, the main problem was weak internet connection. However, we can conclude that there are three problems whose estimates are below 3. This indicates that students did not have technical obstacles during online teaching and learning which was expected regarding to students' field of study.

The students were also asked (on a five-point scale) to estimate in which way they would solve potential problems (Table 7).

Table 7

How students solve problems

The way of solving a problem	Mean	Std. Deviation
Independently by searching for solutions on the internet	3.89	1.26136
I seek help from colleagues	2.63	1.30323
I seek help from teachers/staff	2.11	1.19678

N = 64

The students prefer to solve problems on their own by searching for solutions on the internet rather than seeking help from the others (M=3.89). It would be interesting to explore possible reasons why the students prefer to search for solutions independently. It can be either because of their developed digital skills or a poorly developed skill for communicating and seeking help.

As many as 34.4% of students declared that they lost data (documents) for study or school in some way. The causes were different (Table 8).

Table 8

Frequency of losing data for studying (documents)

Causes of the losing data	Frequency	Percent (%)
The hard drive has failed.	4	6.3
The file was deleted by mistake.	7	10.9
I am not sure.	9	14.1

N = 22

The results indicate that around one third of students lost their documents for study, and most of them (about 14%) are not sure about the reason for losing the data. About 11% declared that the file was deleted by mistake.

In case they lost the documents for studying (project, document, etc.), the students were asked to choose how they solved the situation (Table 9).

According to the results, the students mainly prefer to try to finish their tasks again. Therefore, we can conclude that the students do not give up the task in case they lose the documents.

Table 9

Students' behaviour in case of losing the document

Behaviour in case of losing the document	Frequency	Percent (%)
I did the task again.	14	22.6
I gave up on the task.	2	3.2
I explained to the teacher what happened, and he/she helped me.	3	4.8
My colleagues helped me.	1	1.6
N = 20		

Most students back up their data in some way (75%). They did not have problems with computer viruses or similar malicious programs during online teaching (only 9.5%). Only 4.7% of students state that the virus caused problems during online classes or finishing tasks.

To determine how the students protect their devices from the viruses, they were asked whether they have installed an antivirus software. The students mainly use the embedded antivirus software by Windows OS (56.3%). About 40% of students use other programs such as Kaspersky, Avast, etc. Only 3.1% of students are not sure about the installed software.

Additionally, it was also interesting to explore how the students generally use passwords (Table 10).

Table 10

Description of how students use passwords

Using passwords	Frequency	Percent (%)
For each system (sites, computers) I use different strong passwords.	9	14.1
For most systems, I use different, strong passwords.	10	15.6
For important systems, I use strong passwords and for less important I use simple passwords.	27	42.2
I use the same, strong password for most systems.	15	23.4
I use the same, simple password for most systems.	3	4.7
N = 64		

It seems that the students are aware of the importance of properly used passwords. As many as 42.2% of them use strong passwords for important systems while they use simple passwords for less important ones. Only 4.7% of students use simple passwords for most systems.

On the other hand, one of the research questions is related to seeking help from others and behaviour in general in unpleasant situations on the internet (spamming, insulting, sharing personal data, etc.). The results are presented in the following table (Table 11).

Table 11

Frequency of seeking help from others

Seeking help	Frequency	Percent (%)
I would not tell anyone and ask for help or advice.	20	31.3
I would tell my friend/colleagues/parents, but I would not ask them for help or advice.	12	18.8
I would tell my friend/ colleagues and ask them for help or advice.	24	37.5
I would seek advice or help from the teacher.	8	12.5
N = 64		

It is interesting that 37.5% state that they would ask for help and advice for help in case of an unpleasant situation on the internet. However, 31.3% of students would not ask for help or talk about problems.

Related to other patterns of behaviour in case of problems on the internet, students were asked which strategies they would apply to solve the situation (on a five-point scale) (Table 12).

Table 12
Strategies that students use in unpleasant situations

Behavior pattern	Mean	Std. Deviation
I would ignore	3.42	1.34288
I would enter the discussion	1.88	1.01575
I would report the problem to the site owner or provider	2.39	1.49727
I would block the contact	3.55	1.46850

N = 64

The highest estimated statements are related to blocking the contact and ignoring the situation which indicates that the students are not encouraged to apply more appropriate strategies in case of potential online threats.

5. Conclusions and future work

This research confirmed several authors' assumptions regarding the use of technology in the previous period, particularly in the pandemic period. A great majority of students used online learning either in secondary school or at the faculty and became familiar with a wide scale of digital tools and platforms. The results have shown that the students' digital resilience reached a significant level. The students who spend more time learning online in secondary school tend to perceive higher digital skills and therefore, can be more digitally resilient.

This research also showed that the students mostly decide to rely on their own when it comes to various disruptions of their digital operations. As one pillar of digital resilience is actually seeking help, this finding is drawing our attention. It is important to build institutional help and provide procedures and guidelines for students facing various digital challenges. Also, peer help and building a community of trust, comprising both students and faculty staff, should be promoted.

Digital resilience is a complex trait and cannot be easily measured. It heavily relies on the subjects' properties. Therefore, it is important to improve the data collection tools and eventually adapt the questions trying to acquire a better image of participants' behaviour and digital practice. For example, 75% of students said they regularly performed a backup which represents quite an indicative and significant number. It is questionable if all participants are actually familiar with details of what is considered a real backup and if all the systems being used are actually taking care of keeping the backup automatically.

For future work, it is advisable to improve the questionnaire and further tackle the issue of help, or in other words investigate what kind of assistance would be preferable for students. Also, carefully constructing the aggregate variable representing digital resilience could probably expose additional insights into digital resilience structure.

6. Acknowledgements

Authors would like to express their gratitude to the students of the Faculty of Technical Sciences Čačak, who participated in this study.

This study was supported by the Ministry of Science, Technological Development and Innovations of the Republic of Serbia, as part of GrantNo.451-03-47/2023-01/200132 with University of Kragujevac - Faculty of Technical Sciences Čačak and by Erasmus+ Project Enhancing digital and

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