The Use of Smartphones and Tablets for Teaching Biology at a Distance: A Comparison between Rural and Urban Schools

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Abstract – Smartphones and tablets (SPT) have become an integral part of daily life, and their added value for biology education was seriously tested during the COVID -19 pandemic in distance education. We collected data from 355 elementary-aged children attending 6th to 9th grade; 30% of the participants were from rural schools and 70% from urban schools. Results show that most children, 75.7%, used SPT very frequently to search for information on the World Wide Web and 65.9% used SPT frequently to participate in distance learning (videoconferencing). Very rarely, if ever, was SPT used to conduct experiments, virtual field trips, or hands-on work in virtual laboratories. PCA analysis revealed 2 components. The first component explained the non-use of SPT for hands-on work (33.6%, Cronbach's alpha = 0.85) and the second component explained the use of SPT for communication and collaboration (28.8%, Cronbach's alpha = 0.77). We were also interested in whether the environment of the school (rural or urban) influenced the use of SPT. There is no statistically significant difference in access to wearable smart technology between urban and rural students.

Keywords – biology; distance learning; lower secondary; rural school; school students; smartphones and tablets; urban school.

I. Introduction

The outbreak and spread of the 2019 coronavirus pandemic (COVID -19) have had a profound impact on education systems around the world. Schools have been partially or completely closed in more than 190 countries, affecting 1.6 billion school-aged children [1]. Many education systems have begun using distance learning.

The power of mobile phones and tablets was felt more than ever during the COVID -19 pandemic, when the entire world came to a standstill and billions of people relied on their mobile devices to explore the world, stay connected with their families, friends, teachers, students, services, and for current events. Time spent on mobile devices has increased in 2020 [2]. Many educational institutions have offered distance education to their students. This has been facilitated by mobile technologies such as smartphones, tablets, laptops, e-readers, and other practical devices. It is the development of technologies that has reduced the barriers to distance education. The use of mobile technologies has enabled teachers and students to interact and create a classroom anytime, anywhere [3]. Mobile technologies have improved the connectivity, interactivity, and accessibility of educational materials on the Internet [3]. Smartphones and tablets with built-in cameras have become an integral part of the daily lives of students and teachers in distance education. According to a study [2], educational app downloads doubled during the pandemic COVID -19. Another advantage of smartphones is that they provide access to a wide variety of educational apps and resources. The importance and impact of smartphones on the methods, forms, and outcomes of education can be recognized in at least three aspects: Mobility of technology, mobility of learning, and mobility of students [4]. Smartphones can play multiple roles in biology education. Access to educational resources: smartphones allow students to access a wide range of biology resources, such as e-books and online lectures. Smartphones have high-quality cameras and screens that can be used to capture and display images and videos of biological concepts such as coagulation [5] or colorimetry [6] or visual aids for viewing microscopic organisms [7]. Smartphones can be used to collect and analyze data, such as environmental data or biological samples, for laboratory experiments or field studies. Overall, smartphones can be a valuable tool in the biology classroom, enhancing students' learning experiences and expanding their access to information and resources.

Smartphones have become an integral part of our lives, and their presence in the classroom is no exception. According to recent Slovenian studies [8,9], the majority of students in lower secondary, upper secondary, and tertiary education own smartphones, and the use of tablets has also been reported [5,6,10,11,12], so the availability of the technology cannot be considered a limiting factor for its adoption in daily classroom practice. This article examines how smartphones are used in urban and rural schools in COVID -19 distance education.

The aim of the study was to:

- find out the extent to which students use SPT for distance learning during school closures.
- to find out if there is a statistically significant difference in the use of SPT between urban and rural students.

II. MATERIALS AND METHODS

A. Sample and sampling

The population of interest was elementary school students from 6th to 9th grade of Slovenian 9-year-old compulsory school. The survey instrument, in the form of an online questionnaire based on the 1ka platform (www.1ka.si), was made available to students through various channels, online social media, contacts with schools and individual teachers. The sample began in May 2022 and ended in July 2022. We collected data from 355 school-aged children (44.6% boys and 55.4% girls) attending 6th (5.7%), 7th (6.5%), 8th (54.9%), and 9th (33.0%) grades of elementary school. 30% of participants were from rural Slovenian schools from different regions and 70% of participants were from urban Slovenian schools from different regions. They reported that 96% of them owned a smartphone.

B. Instrument

A structured questionnaire was used as the primary instrument for data collection. The questionnaire is part of a larger questionnaire on the added value of smartphones in biology education [13]. In this paper, we present part of the questionnaire in which we asked students about the use of SPT during the COVID -19 pandemic and the resulting distance learning. For each item, participants indicated their agreement on a 6-point Likert scale ranging from never (1) to very often (6).

In the second question, we asked students whether they owned smart mobile devices and whether they shared them with their siblings or family members.

In the third part of the questionnaire, we were interested in demographic data: Gender, class, and the neighborhood where the school they attend is located (rural or urban).

C. Statistical analyses

Statistical analyses were performed using the open-source statistical programme Jamovi, 2.3.21. Each research variable was analysed for mean, median (Me), Mode (Mo), and standard deviation (SD).

Cronbach's alpha was calculated to assess the reliability of the constructs. Principal component analysis (PCA) with direct oblimin rotation was performed to assess the unidimensionality of the constructs. The reliability of the components resulting from the PCA analysis was assessed using the Cronbach's alpha coefficient. Values greater than 0.7 indicate reliability of the components.

The nonparametric Mann-Whitney U test was used to analyse differences between rural and urban schools. The Mann-Whitney U test, also known as the Wilcoxon rank sum test, tests for differences between two groups on a single ordinal variable with no specific distribution [14,15]. Results with a significance coefficient of less than 0.05 (p< 0.05) were flagged as statistically significant differences. When the effect size was less than 0.02 (r<0.02), statistically significant differences were also considered nonsignificant.

III. RESULTS

A. Use of SPT for distance learning biology classes during school closures

TABLE I. Measures of central tendencies on the question of the use of a SPT for distance learning biology classes during school closures (N = 355, Cronbach's alpha = 0.85). Results are presented as percentages and sorted by decreasing Mode (Mo).

Use of SPT for distance learning during school closures	***Mean***	***Me***	***Mo***	***SD***
Participation in distance learning (video conferencing).	4.80	5	6	1.50
To find information on the Internet.	5.11	6	6	1.23
For the assessment and verification of knowledge.	4.61	5	6	1.70
Communicating with teachers via email.	4.46	5	5	1.42
To view and analyze video experiments.	4.01	4	4	1.55
To take a virtual video tour.	2.77	2	1	1.76
For working in the virtual lab.	2.55	2	1	1.69
For photo search (collect photos, identify, and add information).	3.63	4	1	1.83
To perform experiments using the SPT built-in measurement devices.	2.97	3	1	1.76

Note: Likert scale ranging from never (1) to very often (6), Me- median, Mo – Mode, SD – standard deviation.

In the statistical analysis, the mode shows us the value that was chosen most often. Table I shows that students used SPT very often (Mode > 5) for participation in distance learning (video conferencing), to find information on the Internet, for the assessment and verification of knowledge, for communicating with teachers via email. The most common response of " never" (Mode = 1) was to use SPT for a virtual tour, to work in a virtual lab, to search for photos, or to conduct experiments.

The PCA analysis, the results of which are shown in Table II, revealed two components that explained 62.4% of the variance.

The first component (PCA1) explained 33.6% of the variance and consisted of statements about the use of smartphones for practical teaching purposes (participation in distance learning, video conferencing. To find information on the Internet. For assessing and reviewing knowledge. To communicate with teachers via email. To view and analyze video experiments.). The PCA1 statements describing when smartphones were not used during distance learning (Mode = 1) were distributed here. The reliability of the first component is indicated by the high value of Cronbach's alpha of 0.85.

The second component (PCA2) had 28.8% of variance and consisted of the statements that smartphones were used for information search, learning, and communication with teachers. The value of Cronbach's alpha was 0.77, indicating high reliability of the component.

An analysis of differences between rural and urban areas was conducted. It was found that there are no statistically significant differences (p > 0.05 and r< 0.02) in the use of SPT for distance education. There is also no statistically significant difference between genders (results not reported).

TABLE II. Measure of Principal Component loading on the question about using SPT for distance learning during school closures and comparison between groups (N = 355, Cronbach's alpha = 0.85).

Use of SPT for distance learning during school closures	**PCA1**	**PCA2**	***U***	***p***	***r***
To take a virtual video tour.	0.89		12967	0.789	0.018
For working in the virtual lab.	0.88		12732	0.5 83	0.035
To perform experiments using the SPT built-in measurement devices.	0.81		12025	0.176	0.089
For photo search (collect photos, identify, and add information).	0.68		12871	0.708	0.0258
To view and analyze video experiments.	0.45	0.49	12522	0.437	0.051
Participation in distance learning (video conferencing).		0.84	12292	0.275	0.069
To find information on the Internet.		0.81	11624	0.052	0.120
Communicating with teachers via email.		0.79	12798	0.642	0.030
For the assessment and verification of knowledge.		0.44	5282	0.506	0.052
Explained variance (%)	33.6	28.8			
Eigenvalue	4.18	1.44			
Cronbach's alpha	0.85	0.77			

B. Do students own their smart mobile devices?

The question about owning a smartphone or tablet was answered by 354 students. The data obtained are summarized in Table III. From the results in the table III, 96% own a smartphone and 79% own a computer. Tablet computers are less common among 6th-9th grade students. (42.1%). The results also show that 35.9% of the participating students share a computer with their family. Only 7.6% of the participants share a smartphone with their family.

TABLE III. Frequency (%) analysis of the ownership of smart mobile devices and ICT (N = 354) and difference between rural and urban groups.

Item	**YES [%]**	**NO [%]**	***U***	***p***	***r***
I own a smartphone.	96.0	4.0	12824	0.283	0.024
I own a computer.	79.1	20.9	12939	0.742	0.016
I own a tablet.	42.1	57.9	12722	0.576	0.032
I must share my computer with my family.	35.9	64.1	12264	0.230	0.067
I must share my tablet with my family.	28.8	71.2	13603	0.907	0.006
I must share my smartphone with my family.	7.6	92.4	12805	0.404	0.026

An analysis of the differences between rural and urban areas was conducted. It was found that there were no statistically significant differences at the $p < 0.05$ and $r< 0.02$ levels in the ownership of smart mobile devices. There is also no statistically significant difference between genders.

IV. CONLUSION

Using smartphones and tablets for distance learning in biology can be an effective way to enhance students' learning experiences, especially in areas where traditional classrooms are not available. A comparison between rural and urban schools can provide insight into the potential benefits and challenges of using these technologies in different contexts.

Based on the results presented in the previous chapter and the research questions posed, we can draw a conclusion about the use of smart mobile phones and tablets in distance education (COVID -19).

Our first research objective was to find out how SPT is used in distance education. The results show that SPT was mainly used during distance education for participating in distance education (video conferencing), searching for information, checking and evaluating knowledge with online quizzes, communicating, and watching video experiments. However, smart mobile devices were never or very rarely used for hands-on work, such as taking a virtual video tour, working in a virtual lab, conducting experiments, and using already built-in sensors. We believe that the use of SPT for schoolwork has increased, but only for communication and solving current problems. SPT offers much more. In our work with students [5,10,11], we have found that smartphones can be used in a variety of ways, but they cannot replace professionally developed equipment (e.g., a microscope). However, they can be a useful, practical, and engaging didactic tool that we always have in our pockets or at hand. If we want the use of smartphones to be introduced even more into the school system, it is certainly first necessary to inform teachers and school management about the advantages of smart mobile devices, to prepare workshops on the smart use of smartphones or pedagogical publications with examples of use.

The second research objective was to investigate whether the use of smart mobile phones differs between students from urban and rural areas. The results show that 96% of students own a smartphone and 79% own a computer. Tablet computers are less common among 6th-9th grade students. (42.1%). They very rarely share their smartphone with their siblings or family members. These data are not surprising, since according to the reports of the Statistical Office of the Republic of Slovenia [16] for the year 2020, 97% of the inhabitants of Slovenia use mobile phones, 81% of them use smart mobile phones. From the research of Macuh [17] we can conclude that primary school students are also big users of smart mobile devices and tablets. Therefore, we assume that it should not be a problem if the BYOD (bring your own device) work method were introduced in classes, i.e., using and bringing one's smartphone or tablet to school for the purpose of schoolwork.

In summary, smartphones have become an integral part of the educational experience in both urban and rural schools. There is no statistically significant difference in access to wearable smart technologies between urban and rural students. Overall, the use of smartphones and tablets for distance education in biology can be a valuable tool to enhance the student learning experience, especially in areas where traditional classrooms are limited. However, it is important to carefully consider the potential benefits and challenges associated with these technologies in different contexts and provide adequate support and resources to ensure their effective use.

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