ICT in Education Development

Budic, Hrvoje; Horvat, Duro; Ruzic, Ivan

DOI: 10.2507/33rd.daaam.proceedings.003

ICT IN EDUCATION DEVELOPMENT

Budić Hrvoje, Đuro Horvat & Ružić Ivan

This Publication has to be referred as: Budic, H[rvoje]; Horvat, D[uro] & Ruzic, I[van] (2022). ICT in Education Development, Proceedings of the 33rd DAAAM International Symposium, pp.0017-0023, B. Katalinic (Ed.), Published by DAAAM International, ISBN 978-3-902734-36-5, ISSN 1726-9679, Vienna, Austria
DOI: 10.2507/33rd.daaam.proceedings.003

Abstract

The introductory part of the paper emphasizes the importance of using ICT in the educational process and emphasizes its fundamental developmental determinants. The second part of the paper emphasizes the concept of digital literacy, which is superior to the concepts of information and IT literacy. Also here, the differences between distance learning and online learning are highlighted, as well as the characteristics of both models. Regarding the increasing number of users of mobile devices, data on the use of mobile and PDA devices as well as their elementary advantages in learning are quantitatively presented. The practical part of the work is based on the assessment of the distinctiveness of the use of ICT, and with regard to the type of scientific educational institution, it was tested with relevant statistical tests, and the basic hypothesis was confirmed. The conclusion presents an overview of the entire work, recommendations and assumptions for the future.

Keywords: ICT; Digital literacy; Distance learning; E - learning; Mobile learning (m - learning)

1. Introduction

Today society is heavily influenced by the development and implementation of modern information and communication technologies (ICT). Last fifty years it was changing from industrial to informational, which creates a completely new society, society - based knowledge. In a such society, the economy and the quality of individual life depend on knowledge and on the finding, processing and application of information. The result of that is a continuous growth of human knowledge which creates the need for acquiring increasing volume and quality of knowledge of every individual and institution in a very short time [1]. Learning through the use of technology cannot be identified with classical, frontal, face - to - face learning in the classroom. The ultimate goal is the same, but the form of acquiring knowledge in the learning process is completely different. A different approach to learning implies the necessity of thinking about the best possible use of technology in the learning process to achieve the best possible results. Beforehand, it is necessary to know the possibility of the used media for knowledge transfer, know its limitations, and know the answer to the question of why this particular media is the best for improving learning outcomes. Taking into account the definition of educational technology, we can say that it is a complex process that includes people, procedures, ideas, tools and organization for analyzing problems, selecting tools and evaluating different viewpoints of human learning. Following the above, educational design and technology include the analysis of learning and teaching, design, development, use, evaluation and organization of teaching and other processes and materials for improving learning and action in different environments, especially in educational institutions and workplaces.

The study of education as an object of research, the development of its scope and methods beyond the concrete limits and goals of science with the latest scientific and technological achievements and the increased demands of education is in the program of the perception of today's education. Educational technology actually represents an act of systematized transformation of scientific knowledge into its application. Many authors who have dealt with the impact of technology on learning so far emphasize that it is an important element for effective learning. First of all, the use of technology, in addition to other indisputable factors that it possesses and implies, encourages the development of critical thinking of the fundamental participants of the educational process. Computers successfully provide effective learning related to nature and learning techniques. Effective technology enabled learning involves principles that may require new learning environments [2]. The concept of information and communication technology, which is applied in education, grew out of the previous concept of information technology and new technologies and represents a huge area of rapid changes and rapid growth. In this sense, ICT also contributes highlighting new concepts such as information and communication literacy and digital literacy. When talking about ICT in education, the acronym ITLET (Information Technology for Learning, Education and Training) is used, which represents a key element in all forms and models of distance learning [3].

Today, learning through the application of information and communication technology is a generally recognized and accepted way of knowledge transfer, both at the national and international level. This is evidenced by numerous documents (strategies) such as Europe 2020 and the Education, Science and Technology Strategy of the Republic of Croatia [4]. The Europe 2020 strategy, in its analysis of key issues states that higher education institutions are agents of change, i.e., catalysts of systemic changes in improving and raising the quality level of new educational models [5]. Under the European Digital Agenda, the need to take advantage of the transformational advantage of information and communication technology is stated, all to improve teaching processes. Also, it is suggested to encourage greater diversity in the ways of studying, continuing education for people who have stopped education, and taking advantage of information and communication technology for more effective learning and new research methods [6]. Due to the increasing level of digital literacy and the implementation of ICT in institutions of higher education and science authors considered it appropriate to investigate the assessment of the volume of its use. As the level of digital literacy is generally increasing, especially among the younger population living in the digital age, and taking into account the level of their education, as well as the characteristics of the teaching staff, authors wanted to assess how similar it is, or not, i.e. different. For this purpose, a hypothesis was set up where relevant statistical tests are used to determine the above.

2. New educational model based on ICT

Technology opens a new perspective for education in the transfer of knowledge. The correct use of technology can give exceptional results, can enrich teaching process, and make education accessible even in the most inaccessible parts of the world, recognized in the term of distance learning. Computer and information literacy is necessary in order to use ICT in the correct way. Although they have similar names, information and IT literacy are fundamentally different. Informatics, or computer literacy, represents the ability to use computers and associated computer programs, while the term information literacy refers to the ability to find and use information, manage and analyze it in order to turn it into knowledge. The use of information and communication technology also implies the acquisition of digital literacy, which is related precisely to the use of textual material in the form of hypertext, or multimedia on which educational materials in the process of e - learning and in mobile applications (m - learning) are largely based. Digital literacy skills include the ability to make judgments about Internet sources, search, content management, and online communication. However, the process of searching for information and evaluating the necessary information belong to the field of information literacy, while the use of multimedia materials and communication belong to computer literacy. Searching for information and making judgments are competencies of information literacy, while managing multimedia content and communicating via the network belong to computer literacy skills.

2.1. Distance learning

Distance learning as a term is primarily related to the situation when the participants in the teaching process are not physically located in the same locations, so their mutual interaction is carried out via computers, i.e., ICT. However, in addition to spatial dislocation there is also temporal dislocation, and depending on according to the mode of interaction, distance learning is categorized into synchronous and asynchronous [7]. Although synchronous and asynchronous learning are fundamentally different, and synchronous communication provides direct real - time communication, asynchronous also has certain advantages:

1. Accessing educational content from anywhere at any time,
2. Allowing enough time to consider and solve the problem. In this way, it is possible to have much better quality discussions than in classical classes. A typical representative of asynchronous communication are distance learning systems (Learning Management Systems - LMS like Loomen, or Moodle),
3. Possibility of anonymity of the user,
4. There is no time limit (eg time zones),
5. Does not require investments in expensive hardware and fast communication networks [8].

2.2. Internet learning (e - learning)

Instead of the previous practice where teachers traveled to other faculties, ideas are exchanged using the Internet, and the teacher is located at the home university, and the educational content is transmitted to the students via the Internet. The Internet is first of all:

- easily accessible - it is not technically limited to a narrow circle of IT specialists, it is not exclusive in the sense of restricting access to information, it is financially available to a wide range of users;
- interactive - does not filter communication through political or economic mediators, but quite the opposite enables direct communication between individuals, individuals and groups, and the groups themselves;
- diverse - in relation to easy accessibility, individuals and groups of the most diverse viewpoints can express their opinions, ideas and attitudes. The Internet is connected to contemporary culture, but it is not its substitute and it enables the creation of new cultural forms by combining contemporary culture and communication technology;
- experimental - it is open to new ideas, uses and processes, and is determined by its cultural, social and political benefit, not just a commercial basis [9].
- The system of adoption of educational content via the Internet must enable the following:
- communication between participants of the educational process via computer;
- presentation and adoption of educational content in a certain order;
- the organization of learning in connection with the generation of various educational data about students and educational content;
- knowledge tests with various tests and self - check quizzes;
- storing educational content on the web server (server), and connecting them and creating tests and discussions about the above [10].

E - learning implies multiple forms, and some of them use technology with a description as shown in Figure 1.

Shape		**Description**	**Technology**
Classic teaching (face - to - face)		Teaching in classroom	Not used (except preparing the lesson before teaching process
E - learning	Teaching without the help of ICT	Technology to improve classical teaching in classroom	Presentations, multimedia, CD - ROM, Web sites, interactive posters, online quizes, e - mail, forum, blog, wiki, e - portfolio, etc., web 2. 0 tools, webinars…
	Mixed education	Classical teaching with the help of ICT	Educational contents are delivered through the Website, or using the Learning Management System, video conference...
	Online education	Learning and teaching exclusively with the help of ICT; no face - to - face classes	

Table 1. Technology and e - learning [11]

Internet applications used by educational institutions in the Republic of Croatia have different purposes and use different technological platforms. As an example of the use of Internet applications for educational purposes in the Republic of Croatia, the following main categories can be cited:

- Administration and administrator applications,
- Control and monitoring applications,
- Applications for viewing content,
- Applications for research purposes (data collection),
- Applications for submitting content,
- Websites, web content management systems
- Databases - digital repositories,
- Applications for distance learning
- Cloud applications
- Internal information services,
- Other special purpose applications [12].

2.3. Significance of mobile applications for learning processes

Mobile learning can be simply described as learning using portable devices anytime and anywhere. The basic platform for the development of mobile learning is distance learning in conjunction with the use of mobile technology, i.e. portable devices. The use of mobile technology basically means the use of mobile, or "smartphones", personal digital assistants (PDA), and laptops. Today, there are various internet services through which the user can download the desired mobile application, and install and use it for various purposes, including educational ones. Some of the leading services are Google Play adapted for Android operating systems, App Store adapted for iOS operating system, and Microsoft Store adapted for Windows Mobile operating system. Also, the main feature of today's websites is the so - called Responsiveness that enables a display adapted to the screens of portable devices. According to data obtained from the Quora website, the number of educational content applications in the App Store is approximately 176,000 out of a total of 2.2 million, which represents a share of 8.5%. The same source states that the number of applications intended for user education on Google Play is approximately 500,000 out of a total of 2.8 million, which represents a share of 17.8%. According to the content, educational - type applications highlight differences in the concepts of learning approaches so some have already predefined material, and some are intended to repeat previously mastered material.

It should be noted that the application has the ability to adapt to the size of educational material, time dynamics, and adapt to one's own preferences [13]. According to data obtained from the website We Are The Social, the number of unique mobile phone users is 5.15 billion with a penetration of 67%, while the number of Internet users is 4.47 billion with a penetration of 58%. [14]. A kind of technological revolution in its first appearance in 2007 mostly included changes in the way of using mobile phones, which was marked by the appearance of the first mobile phones with iOS and Android operating systems [15]. The use of mobile applications in teaching enables the collection and processing of data even during current teaching lessons, emphasizing the technological component as a useful supplementary tool in the hybrid model of teaching. Ozdamli believes that it is more useful to improve and enrich standard methods of learning and teaching with additional activities aimed at the use of mobile phones, the Internet and mobile applications outside the classroom. [16]. The development of mobile technologies marked an evolutionary progress in application of technology, both in everyday life and in the business environment.

Mobile platforms offer greater flexibility, and give the possibility of using services on the go, which opens up new possibilities. New mobile platforms and operating systems such as Android and iOS are recording a significant growth in mobile application downloads. The market shares of popular operating systems for mobile devices are shown in table 1**.** The market reach of the most popular applications according to categories at the world level are shown in table 2. It should be noted that 85% of the holding share belongs to the Android mobile platform, while the most popular category is communication applications with the market with a reach of 99.39%. Categories of applications for the Android platform in the field of education have a market reach of 30% at the global level. Market shares of mobile applications according to operating systems are shown in table 1.

Year	2017	2018	2019
Android	85.1%	85.1%	85.0%
iOS	14.7%	14.9%	15.0%
Others	0.2%	0.0%	0.0%
Total	100%	100%	100%

Table 2. Global indicators of the market share of mobile applications by operating system [17]

Year 2019th										
Category	Tools	Communication	Society	Fun	Photography	Books	Video	Shopping	Education	Sport
Reach %	99.81	99.39	95.02	83.85	75.77	70.74	96.63	35.79	29.28	30.44

Table 3. Market reach of some of the most popular Android app categories as of September 2019 [18]

3. Research sample and methodology

The primary research was conducted at 3 public polytechnics, 2 private higher education institutions and at 2 public universities, (3 faculties within public universities), and includes two target populations - teaching staff and students of the 2nd and 3rd year of undergraduate studies at the mentioned scientific - teaching institutions of higher education. A scale from 1 = "extremely low" to 5 = "extremely high" volume was used to assess the volume of use of information and communication technologies in the teaching process and extracurricular communication in scientific and teaching institutions of higher education. The program package IBM SPSS Statistics for Windows, version 23.0 was used to process the research results. The research was conducted using an online questionnaire with a purposive convenience sample. The results are presented at the level of the target population, i.e. the responses of 70 teachers and 474 students who participated in the research.

The empirical research is based on the following **hypothesis:**
The difference in the level of use of modern communication devices and Internet applications in the academic community for the needs of the teaching process and extracurricular communication is visible depending on the type of scientific and educational institution (public polytechnic studies, high private business schools, university studies), although it is about the same educational level. The total sample of teaching staff included 42.9% of teachers at public polytechnic studies, 34.3% at public universities and 22.9% at private universities. The total sample of students included 63.7% of public higher education students, 24.5% of public university students and 11.8% of private higher education students.

Note: Students could choose more than one answer to the questions related to the undergraduate studies they are studying and therefore the sum of the percentages within a single question may be greater than 100%.

				Total		Very high volume	High volume	Neither high nor low volume	Low volume	Extremely low volume
				Count	Column N %	Row N %	Row N %	Row N %	Row N %	Row N %
Target group	Teaching staff	**Total**	.	**70**	100,0%	14,3%	28,6%	34,3%	22,9%	0,0%
		Type of scientific - teaching institutions	Public higher education institution	30	42,9%	0,0%	26,7%	40,0%	33,3%	0,0%
			Private higher education institution	16	22,9%	25,0%	25,0%	25,0%	25,0%	0,0%
			Public university	24	34,3%	25,0%	33,3%	33,3%	8,3%	0,0%
	Students	**Total**		**472**	100,0%	11,0%	43,2%	36,4%	7,6%	1,7%
		Type of scientific - teaching institutions	Public higher education institution	302	64,0%	9,3%	39,1%	43,7%	7,3%	0,7%
			Private higher education institution	56	11,9%	32,1%	53,6%	10,7%	3,6%	0,0%
			Public university	114	24,2%	5,3%	49,1%	29,8%	10,5%	5,3%

Table 4. Assessment of the volume of use ICT in the teaching process and extracurricular communication of higher education institutions according to target groups and type of scientific and teaching institutions [19]

4. Research results

The normality of the distribution of the variable assessing the volume of ICT use was tested with the Kolmogornov - Smirnov test and the results showed that the distribution of the results of the degree of agreement with the observed statement in both target groups significantly deviated from the normal distribution ($p < .05$). Because of the above, non - parametric data processing methods were used in the analysis.

	M	IQR	Skew	Skew Se	Kurt	Kurt Se	Statistic	df	K - S p
Teaching staff (**Total**)	3,00	1,00	0,176	0,287	-0,980	0,566	0,207	70	p <.05
Students (**Total)**	4,00	1,00	-0,382	0,112	0, 246	0,224	0,247	472	p <.05

Table 5. Descriptive parameters of the variable for assessing the volume of ICT use in higher education institutions and testing the normality of the distribution according to the target groups [20]

Legend: M - median, IQR - interquartile dispersion, Skew - skewness of distribution, Kurt - flattening of distribution (kurtosis), SE - standard error, Statistic - result of the performed test, df - degrees of freedom, K - S p - level of significance Kolmogorov - Smirnov test

The difference in the average assessment of the volume of ICT use in the teaching process and extracurricular communication in relation to the target groups and types of scientific and educational institutions for each individual target group was tested with the Kruskal - Wallis test. No statistically significant differences were found in the average perceived volume of ICT use in relation to the target group.
Statistically significant differences were found in the average perceived volume of ICT use according to the type of institution and in the group of teachers ($X2 = 9,039$, $df = 2$, $p < .05$) and in the group of students ($X2 = 33,719$, $df = 2$, $p < .05$) .

The difference between the average perceived volume of use of individual pairs of groups of teachers and students according to the type of institution was tested using the Mann - Whitney U test. The results indicate that teachers at public universities estimate the volume of ICT use significantly higher than teachers at public universities ($U = 194.00$, $p < .05$). Furthermore, students at private universities estimate the volume of ICT use to be significantly higher than students at public universities ($U = 1752.00$, $p < .05$) and public polytechnics ($U = 4712.00$, $p < .05$).

The obtained results confirm the hypothesis according to which the difference in the level of use of modern communication devices and internet applications in the academic community for the needs of the teaching process and extracurricular communication is visible depending on the type of scientific and educational institution (public polytechnic studies, high private business schools, university studies), although it is about the same educational level. The difference in the average volume of use was determined both in the group of teachers and in the group of students according to the type of scientific and educational institution, and the assumed direction of the difference was confirmed for the group of teachers, but rejected for the group of students. A more effective use of modern communication devices and internet applications was assumed among teachers and students of university studies, which is true for the group of teachers. However, in the group of students, the use is significantly higher among those who attend private universities.

5. Conclusion

The introductory part of the paper presented the basic premises of ICT in education, and distinguished the concepts of information and IT literacy. In this sense, the concept of digital literacy is created. Furthermore, the educational model from distance learning, e - learning to the use of mobile and PDA devices is presented. Here is a thorough presentation of the aforementioned and the basic characteristics of certain models, as well as their advantages and disadvantages. The practical part of the paper contains the testing of the set hypothesis with appropriate statistical tests. In this sense, the hypothesis was confirmed because the authors assumed that the assessment of the ICT used in the given sample was different. The authors assumed that the level of communication and digital literacy is higher in university studies than in public polytechnic studies and private business schools. In support of this is the fact that students at university studies have a higher previous level of knowledge and information and communication literacy, although this is not entirely necessary, so they use ICT more efficiently, just like the teaching staff at the mentioned institutions, which have stricter criteria for selection in scientific teaching professions and higher quality permanent education, so it is assumed that they should have the specified levels of knowledge at a higher level in order to be able to implement and use the specified applications and devices. Speaking of this, the hypothesis was confirmed because a different level of ICT use was proven, although not entirely according to the author's presumptions in the direction of use, but a statistically significant difference was proven.

Thinking about the future, it is impossible not to think that ICT in education will not have its role, in fact, it could play a key role, but it can not completely replace the teacher in the classroom. The connection of various tools, dynamism and progressiveness will be indisputable. Also, the use of virtual worlds and simulations in learning is assumed. Likewise, ICT in education will also help marginalized groups, for example by developing experimental interfaces for brain - computer communication without the intervention of limbs, which represents a fantastic advantage for people with impaired motor skills.

6. References

[1] Budic, H.; Marinac, A. & Filipovic, F. (2015). Technology and media in education, Proceedings of the ENTRENOVA - ENTerprise Research InNOVAtion Conference, Vol 1., No. 1., 10. - 11.09.2015., Kotor, Montenegro, ISSN 2706 - 4735, Bacovic, M.; Milkovic, M. & Pejic Bach, M.; Pekovic, S. (Ed.), pp. 130 - 137, Udruga za promicanje inovacija i istraživanja u ekonomiji "IRENET", Zagreb, Croatia.

[2] Akbiyik, C. & Simsek, N. (2009). Accelerated learning in classroom and computer environments, Eurasian Journal of Educational Research, Vol. 37., (October, 2009.), pp. 32 - 52, ISSN 1302-597X.

[3] Breslauer, N. (2011). Obrazovanje uz pomoć informacijsko - komunikacijskih tehnologije. Education with the help of information communication technology. Zbornik radova Međimurskog veleučilišta u Čakovcu, Vol. 2, No. 2., (October, 2011), pp. 27 - 31, ISSN 1847 - 702X, eISSN 1849 - 1138.

[4] https://vlada.gov.hr/europa-2020/19454 (2020). Europa 2020, Accessed on: 2022 - 20 - 09.

[5] Host, A.; Antonic Jardas, J.; & Skender Pavlic, H.; Racki, Z.; Sokolic, D. (2018). Uvođenje novih tehnologija u nastavni proces, Introducing new technologies into the teaching process, Ekonomski fakultet Sveucilista u Rijeci, ISBN 978 - 953 - 7813 - 39 - 0., Rijeka, Croatia [6]

[6] https://euroalert.net/publication/272/digital-agenda-for-europe-rebooting-europe-s-economy (2015). European Commission, Directorate - General for Communication, Digital Agenda for Europe. Rebooting Europe's economy, Accessed on: 2022 - 20 - 09 .

[7] King, Frederick B.; Young, Michael F.; & Drivere - Richmond, K.; Schrader, P. G. (2001). Defining distance learning and distance education, AACE journal, Vol. 9., No. 1., pp. 1 - 14, ISSN 1065 - 6901.

[8] Kung - Ming, T. & Khoon - Seng, S. (2005). Asynchronous vs. synchronous interaction, In: Encyclopedia of Distance Learning, pp 104 – 113, IGI Global, ISBN 1 - 59140 - 557 - 2.

[9] Budic, H. & Mario, H. (2014). Primjena suvremene obrazovne tehnologije u nastavi, Application of modern educational technology in teaching, Proceedings of the 4th International Conference "Vallis Aurea", Focus on Regional & Innovation Development, Pozega, Croatia, 18. - 20.09.2014. Katalinic, B. (Ed.), pp. 65 - 73, Polytechnic in Pozega, Croatia & DAAAM International Vienna, Austria, ISBNN 978 - 3 - 902734 - 02 - 0.

[10] Ruzic, D. & Budic, H. (2012). Utjecaj informacijsko komunikacijske tehnologije na poboljšanja nastavnog procesa, The impact of ICT on the improvement of the educational process, Proceedings of the 3rd International Conference "Vallis Aurea", Focus on Regional Development, Pozega, Croatia, 05.10.2012. Katalinic, B. (Ed.), pp. 895 - 903, Polytechnic in Pozega, Croatia & DAAAM International Vienna, Austria, ISBN 978 - 3 - 901509 - 78 - 0.

[11] https://www.carnet.hr/wp-content/uploads/2019/09/Digitalni_nastavni_materijali_-_prezentacija.pdf (2019). Digitalni nastavni materijali, Digital teaching materials, Accesed on: 2022 - 20 - 09.

[12] https://www.aaiedu.hr/statistika-i-stanje-sustava/web-aplikacije (2019). Statistika i stanje sustava, Statistics and system status, Accesed on: 2022 - 20 - 09.

[13] https://www.quora.com/How-many-educational-apps-are-on-the-App-Store (2019). How many educational apps are on the App Store?, Accessed on: 2022 - 20 - 09.

[14] https://wearesocial.com/blog/2019/10/the-global-state-of-digital-in-october-2019 (2019), Accessed on: 2022 - 20 - 09.

[15] https://www.cnet.com/reviews/t-mobile-g1-review/ (2017). T - Mobile G1 review: CNET reviews the first-ever Android phone, Accessed on: 2022 - 20 - 09.

[16] Ozdamli, F. & Cavus, N. (2011). Basic elements and characteristics of mobile learning, Procedia – Social and Behavioral Sciences, Vol. 28., (December, 2011)., pp 937 - 942, ISSN 1877 - 0428.

[17] https://www.cnet.com/reviews/t-mobile-g1-review/ (2019). Smartphone Market Share, Accessed on: 2022 - 20 - 09.

[18] https://www.statista.com/statistics/200855/favourite-smartphone-app-categories-by-share-of-smartphone-users/ (2019). Market reach of the most popular Android app categories worldwide as of September 2019, Accessed on: 2022 - 20 - 09.

[19] Budic, H. (2021). Marketing aspects of using modern internet application in academic community, Dissertation thesis, p. 163., https://repozitorij.efos.hr/islandora/object/efos:4211, Accessed on: 2022 - 20 - 09.

[20] Budic, H. (2021). Marketing aspects of using modern internet application in academic community, Dissertation thesis, p. 160., https://repozitorij.efos.hr/islandora/object/efos:4211, Accessed on: 2022 - 20 - 09.