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Students' habits and competencies for creating virtual learning environments

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Abstract

This study examines the habits and competences of IT students in the use of information technology resources. The survey includes 650 students from seven different higher education institutions in various countries in the region. The paper investigates which information technology tools, online applications, and offline programs are being used. The paper also aims to highlight the amount of time that students spend online and how much they participate in communicating online. The goal is to assess what the opportunities provided by the Internet have been used for in terms of learning and development. The obtained results can help to develop and improve virtual learning environments, as well as create an improved form and content of online courses in the future.

KEYWORDS

cognitive walkthrough, computer literacy, virtual learning environments, web applications

1 | INTRODUCTION

Students of technical faculties in the region have similar study programs related to IT (Information Technology). From Serbia, the Technical Faculty in Zrenjanin educates engineers and IT professors, the Faculty of Electrical Engineering and Informatics, Technical University of Kosice educates students in the field of information technology, intelligent systems, Cybersecurity, and Computer networks, while Subotica Tech—College of Applied Sciences trains IT engineers. In Hungary, Eötvös Loránd University—the Faculty of Informatics operates in the field of Informatics for Computer Programming. As a Macedonian institution, the University Goce Delcev in Stip works with students in the field of information technology, business informatics and informatics for teaching, while in Croatia, the Faculty of Organization and Informatics, University of Zagreb offers education in the field of information and business systems and information technology in business application.

Humans recognize that they are not all the same based on their own observations and interactions with each other. People look, speak, and act differently, and even their preferences and choices in life are completely

different. Thus, it can safely be assumed that people also tend to learn differently (Schmid, Yeung, & Read [40]). Each individual has a special way of grasping a particular concept or situation, which actually means that people prefer to learn in different styles [23].

The level and structure of the ICT competences (Information and Communications Technologies competence) of university students have a decisive influence on ICT application in students' everyday activities [10]. Thus, it influences their learning approaches for using ICT, too.

Considering the considerable similarity in the study programs, the aim was to examine whether there were differences among the students' habits using ICT. The authors also sought to determine whether there were differences in age and gender regarding the use of ICT.

Improving educational outcomes will require efforts on many fronts, but the central premise of this paper is that one part of the solution involves helping students to better regulate their learning through the use of effective learning techniques [9].

This study was conducted to analyze students' competences so as to create an effective virtual learning environment (VLE) that can be adapted to all students, regardless of gender, nationality, and years of study.

Apart from an appropriately created content, the success of distance learning affects students' ability to adapt their learning habits to the requirements imposed by distance learning [28,32]. Some of the specific abilities of the individual may be highly developed, but if the person is not motivated enough, then these skills are brought into question or are minimized. Distance education ensures the time and space flexibility that traditional education cannot offer, but it also has its own limitations, including insufficient guidance for students and the lack of effective monitoring of their learning [13].

Learning is crucial for every individual to be educated. Learners need to possess solid study habits so as to be able to learn, given that learning is the only key to eradicate illiteracy, no matter what level it is. Through education, learners can make a significant advancement, yet it is vital for educators to ensure teaching effectiveness to promote a high-quality teaching-learning environment. All tertiary or higher education institutions and technical colleges aim to improve their students' learning capability and then guide them in their matched study habits to promote learning [18,20,24,26,34,35].

2 | LITERATURE REVIEW

The term VLE has been subject to multiple interpretations. For the purpose of the present research, an operative concept was chosen, appropriating the definitions by Butcher et al. [5], which define the VLE as a collection of integrated tools enabling the management of online learning, providing a delivery mechanism, student tracking, assessment, and access to resources.

Most educational institutions have already established their active e-learning Centers with the primary mission of integrating all web-based courses.

The strong implementation of VLEs in higher education institutions justifies the concern with such environments aiming to assess their influence on students' performance. Consolidating the use of these environments implies their contextualization within the formal teaching and learning processes as well as questioning their potentialities according to their known and consolidated features, namely the ones associated with traditional onsite classroom learning [1,2,3,21].

VLEs have been associated with formal learning and with relationships between teachers, students, and schools. There is an increasing interest in VLEs supported by the Internet, namely among education institutions, students, and teachers. The concept of VLE could be considered as a dynamic concept due to the constant evolution of digital technologies, its features and potentialities, and due to the important role that such environments play within the learning processes. Educational systems based on the web are being used by an increasing number of universities, schools, and companies, not only to incorporate various web technologies into their courses but also to complement their traditional face-to-face courses. These systems collect a great quantity of data, which is a valuable source in terms of analyzing the course contents and how the students use it [34,38,39].

This paper focuses on how competent students are in creating VLE because while many studies deal with the competencies that a university teacher must have to teach in VLEs, the students' competencies are a much less researched area.

Williams [37] defines four major dimensions to categorize the functions of university teachers in environments introducing ICT: (a) communication and interaction; (b) instruction and learning; (c) management and administration; and (d) use of technology (transversal to all).

Creating a VLE is a complex process that should involve the teacher, as an expert in the subject matter and competent in the functions outlined; the tutor, who guides the student throughout their university course, and management staff, to deal with administrative and technological aspects, among others [16].

The term competency has been subjected to multiple interpretations. For our research, we chose an operative

concept, appropriating the definitions by Eraut [12] and the Directorate for Education, Employment, Labour and Social Affairs Education Committee of the Organisation for Economic Co-operation and Development/DeSeCo (2005), which define competency as a system of complex actions including the knowledge, abilities, and attitudes required for the successful completion of tasks. This configuration as a whole can be summoned to act effectively on certain demands from social practice, that is to say, external social demands, capabilities, individual disposition, and context are all part of the complex nature of competency. However, bearing in mind this approach to the notion of competency, we consulted other bibliographical materials that more clearly outline teachers' performances required in VLEs (i.e., [4,6,7,19,22,25,31,36,37]).

In a rapidly changing social and technological environment and increasingly competitive and highly interconnected world, under the umbrella of lifelong learning paradigm, each person will need a wide range of life skills and to develop them continually throughout life. Strategies and aims in public education emphasize lifelong learning, especially focusing on self-directed learning and learning skills and competences [14]. Starting with the definition of competence: "the ability to do something well," parallel to the list of life skills, work-related competencies play an important role as well. Basically, work-related competencies (n62) start the structuralization process. They are defined as "A cluster of related abilities, commitments, knowledge, and skills that enable a person (or an organization) to act effectively in a job or situation. Competence indicates a sufficiency of knowledge and skills that enable someone to act in a wide variety of situations." These structural elements (knowledge and skills and later attitudes) are overlapped in strengthening inter- and transdisciplinary approaches in education. In fact, there are several connections with life skills and work-oriented competency areas. Regarding this growing complexity, the DeSeCo project stated: "A competency is more than just knowledge and skills. It involves the ability to meet complex demands, by drawing on and mobilizing psychosocial resources (including skills and attitudes) in a particular context." In this project, the experts emphasized the role of communication, especially, practical IT skills. The European Council Recommendation on key competences for lifelong learning defined key competencies as "Key competences are those which all individuals need for personal fulfillment and development, employability, social inclusion, sustainable lifestyle, successful life in peaceful societies, health-conscious life management, and active citizenship." The recommendation indicated the growing importance of competency areas such as literacy competence, multilingual competence, mathematical competence and competence in science, technology, and engineering, digital competence, personal, social and learning to learn competence, citizenship competence, entrepreneurship competence, cultural awareness and expression competence. Turning to digital competence, the recommendation defined this competency. Council recommendation [8]: "Digital competence involves the confident, critical and responsible use of, and engagement with, digital technologies for learning, at work, and for participation in society. It includes information and data literacy, communication and collaboration, media literacy, digital content creation (including programming), safety (including digital well-being and competencies related to cybersecurity), intellectual property related questions, problem-solving, and critical thinking" [27,30].

3 | RESEARCH METHODS

3.1 | Research objective

This study aims to examine the habits of students of different ages, gender, and nationality in their use of information and communications technologies and the learning management system (referred to in short as LMS).

Although the assumption is that at the mentioned faculties, the analyzed study program contents are similar, the authors sought to determine whether the students had the same competences for LMS development. This is vital since students play a crucial role in the development of distance learning systems, which will be used by pupils of primary and secondary schools, as well as students. What must be kept in mind is that these pupils and students are members of Generation Z, born and raised in the digital age.

The concept of education is changing; therefore, the teaching materials must also be adjusted, just like the competencies of engineers and teachers, whose task it is to create and implement the LMS. It is impossible to create generalized models, yet the question arises whether it is possible to define standard competences.

Global changes affecting universities today call for guidance and agreement on defining the teachers' functions in virtual environments and their corresponding competencies. These conclusions should be kept in mind, particularly when considering the teachers' need for training so as to cope effectively with educative changes [16].

The recommendations for teacher competencies necessary for working in an online environment as given here are, in fact, a selection of a wider set of

competencies compiled in the "The eLearning Competency Framework for Teachers and Trainers" by the European Institute for eLearning (EIfeL). The most important competencies are highlighted, and are necessary for the development and implementation of study programs in distance learning at higher education institutions. The competencies that students, as future creators of LMS, need to have focus on three key areas: preparing online teaching activities, implementation of online teaching activities, and online student evaluation. As high-quality and effective online education primarily refers to a suitable level of interactivity, the key areas of teacher competencies mainly revolve around teacher–student interaction.

The following operational tasks have accordingly been set in the research:

- to present basic parameters for student ability to create VLEs, according to the faculty at which they study;
- to identify similarities and differences in abilities among students from technical sciences institutions to create VLEs, categorized by the institution of study;
- to define student characteristics for each institution; and
- to determine homogeneity among students from each institution.

In the final analysis of the data obtained, all other matters which are subsequently found to be of significance will also be discussed in detail so as to present a more complete picture of the examined problem.

3.2 | The research area

The research area consists of six thematic units:

- students' ICT usage habits (the ability of students to use computers);
- students' experience in using offline programs (their skills in using Text, Picture, Sound, Video, Animation, and Database editing software);
- students' habits when using the Internet (the time students spend online, devices they use to access the Internet, Internet availability, the social networks they use);
- analyzing the patterns in students' use of smartphones related to the operating system;
- students' habits in terms of using distance learning systems (Cloud technology, e-learning material, Online courses, e-learning technologies, experiences in creating e-learning materials);
- the ability to create VLEs (frequent use of Web applications, creating WA experience, Web usability, testing web applications, usability testing with users).

3.3 | Hypotheses

Hypotheses were formulated in all six thematic units.

(A) Hypotheses about students' ICT usage habits:
H/A: *There is no difference in the ICT usage habits of university students in different countries, there is no difference in the ICT usage habits of male and female students, there is no difference in the ICT usage habits of students studying for different years of study at an institution of higher education.*

(B) Hypotheses about students' time spent online:
H/B: *There is no difference in the length and quality of time spent online between students from different countries, between age and gender.*

(C) Hypotheses regarding students' online communication:
H/C: *There is no difference in the intensity of online communication between students in different countries, between age and gender.*

(D) Hypotheses about students' skills in using offline programs:
H/D: *There is no difference in the ability of students studying in different countries, between age and gender of students in their use of the application programs.*

(E) Hypotheses about students' skills in using online applications:
H/E: *There is no difference between students studying in different countries, between age and gender, in their skills using online applications.*

(F) Hypotheses about students' e-learning practices:
H/F: *There is no difference in the use of e-learning with students studying in different countries, between age and gender.*

(G) Hypotheses about "Web usability":
H/G: *There is no difference in how students, male or female, studying in different countries learn about web usability.*

3.4 | Data collection

A questionnaire with 33 questions was used in the study, created by the authors. The survey was conducted online. The results were analyzed using Pearson's correlation study. The first three questions examined the background

data of the students: gender, age, institution/country. The following 30 items were designed to test the LMS efficiency. The questionnaire analyzed the competencies and habits of students in e-learning training.

The key issue, as well as the overall orientation of this study, relates to the analysis of five thematic units concerning the ability of students from technical sciences institutions of informatics to use the following: personal computer, Internet, smartphones, distance learning systems, and web applications.

3.5 | The sample

The participants in this study were students from the following institutions:

- Technical Faculty "Mihajlo Pupin", Zrenjanin, Serbia (97 respondents);
- Subotica Tech—College of Applied Sciences/Department of Informatics, Serbia (31 respondents);
- Óbuda University, Budapest, Hungary (6 respondents);
- Eötvös Loránd University—Faculty of Informatics, Hungary (74 respondents);
- South-West University "Neofit Rilski", Blagoevgrad, Bulgaria (2 respondents);
- Faculty of Electrical Engineering and Informatics, Technical University of Košice, Slovakia (209 respondents);
- Goce Delcev University in Stip, Macedonia (64 respondents);
- University of Shkodra "Luigj Gurakuqi", Albania (1 respondent); and
- Faculty of Organization and Informatics, University of Zagreb, Croatia (175 respondents, all students in the first year of undergraduate studies).

Given that only few students responded to the questionnaire from the institutions Óbuda University, South-West University "Neofit Rilski," and the University of Shkodra "Luigj Gurakuqi," their responses were not be taken into consideration in the process of analysis.

Thus, an overall sample of 650 subjects was analyzed, divided into six subsamples according to their institution of study.

3.6 | Background information of the sample

The sample background data based on the tested variables are:

TABLE 1 Gender

	Frequency	Percent
Male	464	71.4
Female	186	28.6
Total	650	100.0

- Gender: 71% of the sample were male, 29% were female students (Table 1).
- Year of study: The ratio of first and fourth-year students participating in the study was equally 27%. A further 14% were second-year students, 23% were third-year students, while the smallest portion of 9% were fifth-year university students (Table 2).

4 | RESULTS AND DISCUSSION

4.1 | Students' ICT usage habits

Regarding the use of laptops versus desktop computers, the majority of the interviewed students agree only slightly that they would prefer using a laptop to desktop computers, while 19% of the respondents strongly denied that they would prefer using a laptop (Table 3). There were 19% of students who expressed moderate and 23% a little agreement. The ratio of responses is illustrated in Figure 1.

In terms of mobile phones, only 17% of the interviewed students do not have a smartphone, 83% regularly use this device. However, the respondents expressed a clear preference for Android with 75%. The ratio of Windows or IOS users is a smaller percentage of less than 10% for each (Table 4).

Exactly 50% of the students in the sample were typically connected to the Internet through their computers. An additional 18% stated that they were most often connected to the Internet via smartphone or tablet, while 31% of the students used multiple devices to access the

TABLE 2 Year of study

	Frequency	Percent
First	175	26.9
Second	93	14.3
Third	149	22.9
Fourth	172	26.5
Fifth	61	9.4
Total	650	100.0

TABLE 3 I prefer to use a desktop computer instead of a laptop

	Frequency	Percent
Strongly disagree	123	18.9
Moderately disagree	123	18.9
Slightly disagree	148	22.8
Slightly agree	103	15.8
Moderately agree	70	10.8
Strongly agree	83	12.8
Total	650	100.0

Internet. Only 3 out of the 650 respondents claimed they did not use any of the mentioned devices (Table 5).

4.2 | Time spent online by IT students

Most of the students, 83%, confirmed that they had permanent Internet access. Examining the time spent online showed that most students, 54% spent at least 3–8 hr a day online (Table 6), and the percentage of those who spent no more than 1–2 hr online was 13%. Only 1% of the students spent less than 1 hr online each day, and another less than 1% stated that they were not connected to the Internet daily. Conversely, 31% of the students would spend more than 8 hr a day online (Figure 2).

TABLE 4 Which operating system is on your smartphone?

	Frequency	Percent
Android	486	74.9
Windows	62	9.6
IOS	64	9.9
Other	37	5.7
Total	649	100.0

TABLE 5 Which device do you use most often to connect to the Internet?

	Frequency	Percent
Computer	324	49.8
Mobile phone, tablet	119	18.3
Both	204	31.4
Not use any	3	0.5
Total	650	100.0

4.3 | Examining online communication habits of IT students

As for their online communication habits, the students were using Skype and Messenger in equal proportions when communicating online. Several respondents also used Viber, whereas the applications Snapchat and Ask.fm applications proved to be less popular (Figure 3).

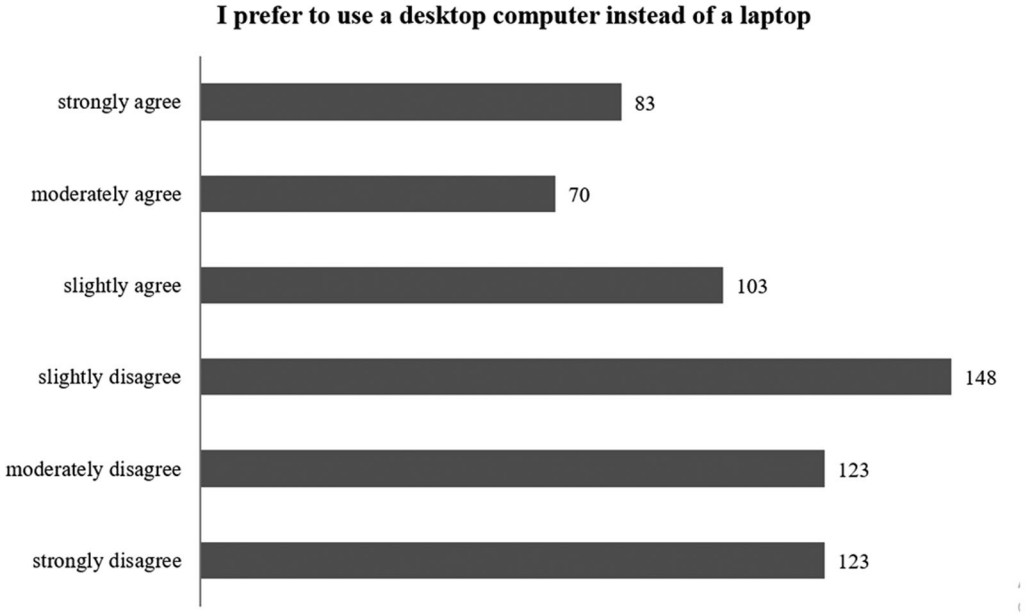

FIGURE 1 I prefer to use a desktop computer instead of a laptop

TABLE 6 How much time do you spend online?

	Frequency	Percent
More 8 hr a day	204	31.4
3–8 hr a day	352	54.2
1–2 hr a day	81	12.5
Less than 1 hr a day	9	1.4
Not every day	4	0.6
Total	650	100.0

4.4 | Examining the habits of information technology students using offline programs

The majority of the students declared themselves to be mid-level users for the majority of the offline programs examined (text editors, picture editors, audio editors, database editors), as seen in Figure 4. In contrast, for most animation editing programs, the majority of the users stated that they were beginners, a total of 63% of them (Table 7).

The highest percentage of expert users occurs using text editor programs. For this question, 38.5% of students answered they were able to use the program at a high level. Most, however, a total of 54%, were just medium-level users.

The results of the Pearson's correlation study showed a low level of correlation between students who had good knowledge in text editing and students who were good in database editing and the time spent online. Based on the results, students who considered themselves to be medium or high-level text editors and database managers would typically spend less time online (Table 8).

4.5 | Examining the practice of IT students in using online applications

Less than half of the interviewed IT students (49%) had experience in web application design. The majority of students who were capable of creating web applications had less than 2 years of experience (Table 9).

4.6 | IT students' skills in using e-learning

A total of 82% of the students have experience in using e-learning materials. However, it is interesting to note that only 30% of the respondents ever participated in some type of online course. The students were asked to elaborate on their opinions and experiences regarding online courses. Some of the answers are partially given below:

- I find online courses to be very useful.
- My experience with using these platforms was great. They are great sources of step-by-step learning and study materials.
- Creating online courses in Moodle.
- I have nothing but positive experiences—understandable presentation of teaching content, enough time to solve tasks, correct testing, and so forth.

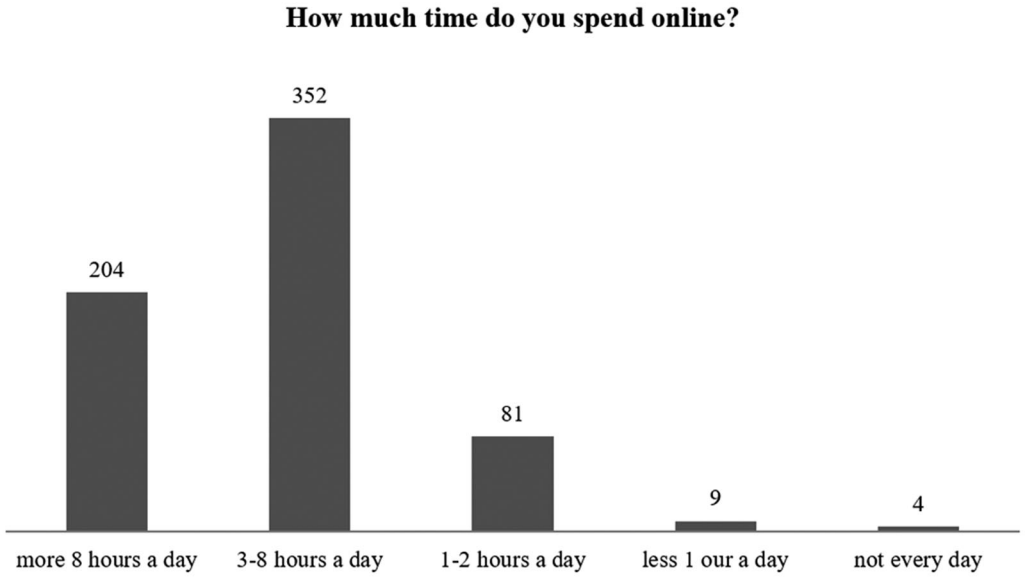

FIGURE 2 How much time do you spend online?

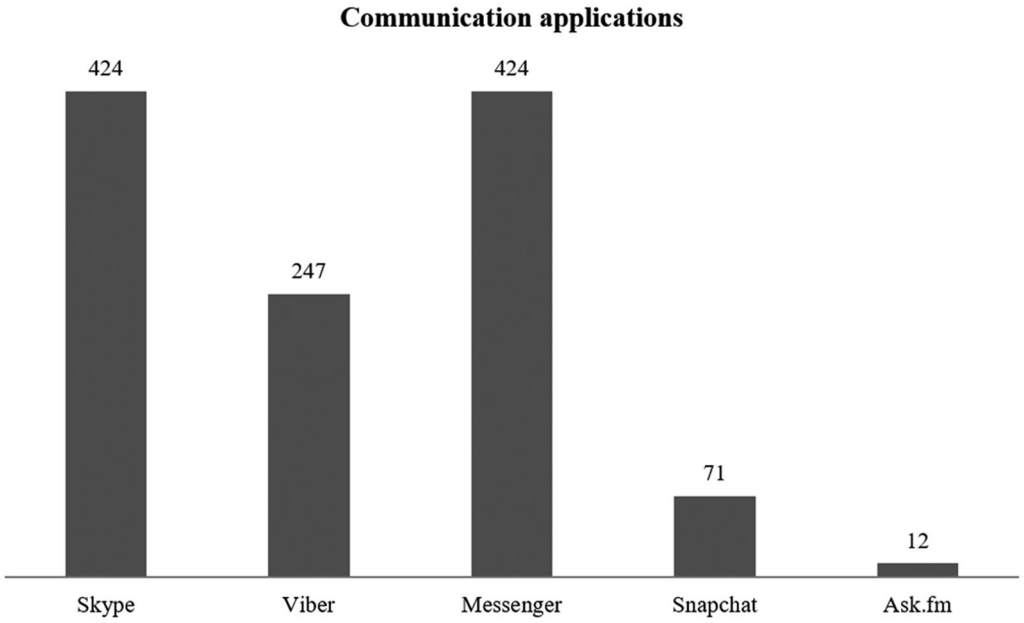

FIGURE 3 Communication applications

- I studied a lot of programming on different websites helping students in understanding programming languages in an interactive way.
- Very good option for learning.
- I would encourage every university to use them to supplement their own courses (maybe instead of traditional lectures).
- Many courses are better than at the university. Self-paced learning is cool. You can view the videos as many times as you want so that you understand the material the best way.
- The best place to learn current and useful technologies.
- An online course helps a lot but cannot make you an expert.
- A well-prepared online course can be as good as a university lecture because everyone can learn at their own pace.
- They are excellent for trying new materials. Most of them are fun to take and offer large amounts of knowledge.

Almost half of the respondents (44% of the students) stated that they most often used e-books while studying, whereas 22% used the e-learning platform provided by their educational institution (Table 10).

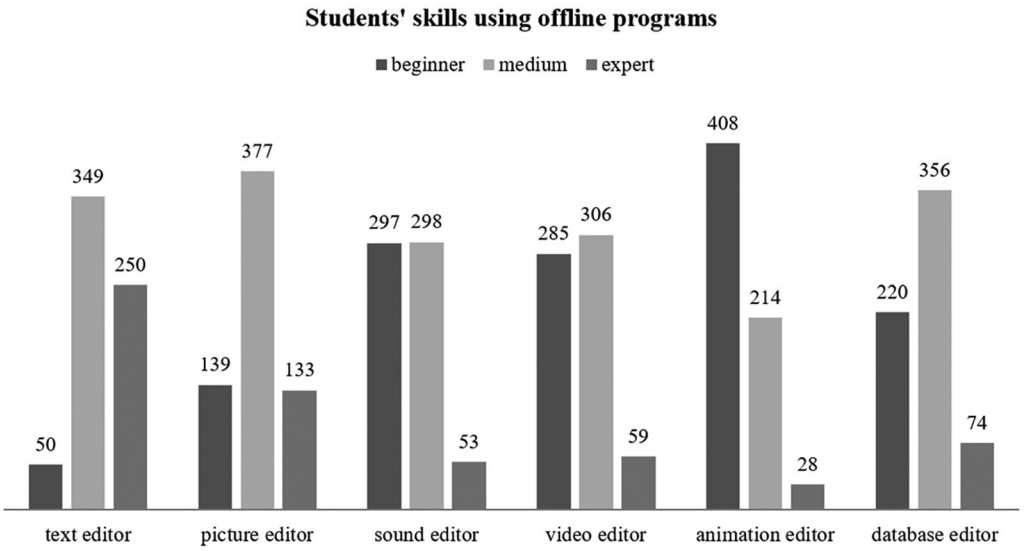

FIGURE 4 Students' skills using offline programs

TABLE 7 Students' skills using offline programs

Offline editor	Ability	Frequency	Percent
Text editor	Beginner	50	7.7
	Medium	349	53.8
	Expert	250	38.5
	Total	649	100.0
Picture editor	Beginner	139	21.4
	Medium	377	58.1
	Expert	133	20.5
	Total	649	100.0
Sound editor	Beginner	297	45.8
	Medium	298	46.0
	Expert	53	8.2
	Total	648	100.0
Video editor	Beginner	285	43.8
	Medium	306	47.1
	Expert	59	9.1
	Total	650	100.0
Animation editor	Beginner	408	62.8
	Medium	214	32.9
	Expert	28	4.3
	Total	650	100.0
Database editor	Beginner	220	33.8
	Medium	356	54.8
	Expert	74	11.4
	Total	650	100.0

Although the majority of students were using e-learning materials, only 10% of them claimed to have any experience in making e-learning materials. The Moodle platform is used by 68% of the respondents to create e-learning materials, while 32% of them named different platforms.

4.7 | Informatics students' experience regarding Web usability

The majority of students, 53%, were not familiar with the concept of web usability. Accordingly, 47% of students did not use any method to test the usability of web applications.

TABLE 8 The relationship between offline programs and time spent online

	Pearson's correlation	Sig. (two-tailed)
Medium-level users		
Text editor	−0.143	0.001
Database editor	−0.148	0.001
High-level users		
Text editor	−0.132	0.01
Database editor	−0.114	0.04

TABLE 9 Students' skills in creating web applications

	Frequency	Percent
No experience	326	50.2
Less than 2 years	251	38.7
2–4 years	45	6.9
More than 5 years	27	4.2
Total	649	100.0

TABLE 10 The most often used e-learning technologies

	Frequency	Percent
E-book	286	44.1
Education software	71	11.0
Videoconferences	24	3.7
Webinar	19	2.9
E-learning platform	146	22.5
Other	102	15.7
Total	648	100.0

The proportions of students using some usability testing methods were as follows: most of them, 28%, used the heuristic evaluation method, 18% used the cognitive walkthrough method, while the remaining 7% used other methods (Table 11).

According to the survey, over half of the interviewed students (55%) knew a variety of techniques for testing Web usability, as summarized in Table 12. The most often used technique (22%) was the talking aloud technique, 11% of the respondents used the eye-tracking method, 5% opted for summative usability testing, while 4% used remote evaluation. Another 13% stated that they used mostly other techniques.

Students with experience in web applications had more knowledge of the concept of web usability. The

TABLE 11 Methods to test the usability of web applications

	Frequency	Percent
Heuristic evaluation	181	27.9
Cognitive walkthrough	114	7.6
Other	48	7.4
Not use any	305	47.1
Total	648	100.0

TABLE 12 Usability testing

	Frequency	Percent
Talking aloud	146	22.5
Eye tracking	69	10.6
Summative usability testing	33	5.1
Remote evaluation	24	3.7
Other	86	13.3
Not use any	291	44.8
Total	649	100.0

Pearson Party Correlation Study shows a correlation between the two variables ($r = .24$, $p = .001$).

There is no correlation between web usability knowledge and the experience of using e-learning technologies.

5 | DISCUSSION

In the framework of the discussion, the six research units were divided so as to compile data according to country, gender, and year of study.

(A.1) Students' ICT usage: A comparison of results by country

The ICT usage patterns of students studying in different countries were compared with a one-way analysis of variance (ANOVA) test.

- I prefer to use a desktop computer ($F = 4.3$, $p = .002$): [Slovakia] < [Croatia; Macedonia] < [Hungary; Serbia].
- Do you use a smartphone? ($F = 17.9$, $p = .001$): [Croatia; Serbia; Macedonia; Hungary] < [Slovakia].
- Which operating system is on your smartphone? ($F = 2.13$, $p = .07$): no difference based on country comparison.

Based on the results, it can be stated that there is a difference between countries in terms of computer and smartphone usage.

(A.2) Students' ICT usage: Gender comparison of results

The comparison of the ICT usage habits of male and female students with a two-sample t test revealed that male students preferred using a desktop computer. Women, in contrast, preferred using laptops (Table 13).

Regarding the use of smartphones, there was virtually no difference between the genders, male and female students had the same proportion of smartphones (Table 14) and the selected operating systems were also identical (Table 15).

TABLE 13 Comparison of men's and women's computer usage habits

	N	Mean	*SD*	*F*	Sig.	*t*	*df*	Sig. (two-tailed)
Male	64	3.38	1.65	6.05	0.014	4.9	380.33	0.01
Female	86	2.73	1.47					

TABLE 14 Comparing the use of smartphones for men and women

	N	Mean	*SD*	*F*	Sig.	*t*	*df*	Sig. (two-tailed)
Male	63	1.15	0.35	0.1	0.001	1.56	308.11	0.1
Female	86	1.20	0.4					

TABLE 15 Comparing the operating system usage for men and women

	N	Mean	*SD*	*F*	Sig.	*t*	*df*	Sig. (two-tailed)
Male	64	1.47	0.87	0.14	0.9	0.37	47	0.7
Female	85	1.44	0.92					

Differences in the use of the computer device type in the habits of men and women override the H/A hypothesis that there was no difference in the ICT usage habits of men and women.

(A.3) Students' ICT uses: Comparing results to years of study

The comparison of results by year of study was performed with one-way ANOVA:

- I prefer to use a desktop computer instead of a laptop ($F = 2.3$, $p = .05$): [fifth year] < [fourth, third, first year] < [second year].
- Do you use a smartphone? ($F = 7.9$, $p = .001$): [first year] < [second and third year] < [fourth and fifth year].
- Which operating system is on your smartphone? ($F = 3.14$, $p = .01$): [first year] < [fourth, second, third year] < [fifth year].

There was little difference in the habits of students depending on their year of study in terms of computer

and operating system usage. However, there were significant distinctions in the use of the smartphone. Students in higher years tended to use their smartphones less.

By analyzing the obtained results, the authors recommend that Android-based apps should be used to create LMS.

(B.1) Time spent online: Comparing students by country

The comparison of results by country was performed by one-way ANOVA:

- Do you have Internet access at any time? ($F = 17.9$, $p = .001$): [Croatia, Serbia, Macedonia, Hungary] <[Slovakia].
- How much time do you spend online? ($F = 5.9$, $p = .001$): [Macedonia, Hungary, Slovakia] < [Serbia] <[Croatia].
- Do you use the Internet for personal development? ($F = 3.7$, $p = .06$): no difference based on country comparison.

When considering Internet access and the length of time spent online, some differences can be detected between IT students studying in different countries. Based on the results, the H4/B hypothesis should be rejected.

(B.2) Time spent online: Comparing students by gender

The authors used a two-sample *t* test to compare male and female students' Internet access. According to the results, no distinction was found between the genders in this respect (Table 16).

Comparing the time spent online showed that women tend to spend significantly more time using the Internet (Table 17). These results refute the assertion in hypothesis H/B, as there was a significant difference between the time spent online based on gender.

However, there was no difference between the genders based on the quality of the time spent online. Neither men nor women spent a greater amount of time online learning and developing (Table 18).

(B.3) Time spent online: Comparing students by years of study

The summary of the results of student comparison by study year based on one-way ANOVA is seen below:

- Do you have Internet access at any time? ($F = 7.9$, $p = .001$): [first year] < [second, third, and fourth year] < [fifth year].
- How much time do you spend online? ($F = 6.4$, $p = .001$): [third year] < [second and fourth year] < [fifth and first year].
- Do you use the Internet for personal development? ($F = 4.8$, $p = .001$): [third and fourth year] < [second year] < [first and fifth year].

The results for each of the three aspects were different for the time spent online for each year.

(C.1) Online communication habits: Comparison of students by country

The comparison of results by country was performed by one-way ANOVA:

- Do you write blogs? ($F = 10.88$, $p = .001$): [Hungary] < [Serbia, Hungary, Croatia, Slovakia].
- Are you active in forums? ($F = 3.58$, $p = .007$): [Macedonia, Slovakia] < [Hungary, Serbia, Croatia].
- Are you active in the community pages? ($F = 1.59$, $p = .1$): no difference based on the country comparison.
- How often do you use video communication? ($F = 4.94$, $p = .01$): [Macedonia, Serbia] < [Slovakia, Croatia] <[Hungary].

The use of blogs, forum activity, and video communication also showed differences between the students' habits in the participating country. There was no difference in regard to activity on social networking sites alone.

TABLE 16 Comparing male and female students' internet access

	N	Mean	*SD*	*F*	Sig.	*t*	*df*	Sig. (two-tailed)
Male	68	1.15	0.35	10.1	0.001	0.56	308.11	0.1
Female	86	1.20	0.4					

TABLE 17 Comparing the time spent online based on gender

	N	Mean	*SD*	*F*	Sig.	*t*	*df*	Sig. (two-tailed)
Male	64	1.76	0.67	1.48	0.2	0.4	48	0.001
Female	86	2.10	0.80					

TABLE 18 Comparing the online activities of men and women

	N	Mean	*SD*	*F*	Sig.	*t*	*df*	Sig. (two-tailed)
Male	62	1.09	0.28	4.4	0.001	0.77	289.66	0.07
Female	86	1.14	0.34					

(C.2) Online communication habits: Comparison of students by gender

The authors compared the online communication habits of participating men and women with a two-sample t test. Based on the findings, the only difference detected between the genders was in terms of activity in the forums. Based on this result, hypothesis H/C was not verified. The use of blogs, the presence on social networking sites and the video communication did not reveal any difference based on gender (Table 19).

(C.3) Online communication habits: Comparison of students by years of study

The results of student comparison by study year based on one-way ANOVA:

1. Do you write blogs? ($F = 1.77$, $p = .1$): no difference based on country comparison.
2. Are you active in forums? ($F = 4.26$, $p = .002$): [fifth and third year] < [fourth, second, and first year].
3. Are you active in the community pages? ($F = 0.98$, $p = .4$): no difference based on country comparison ($F = 0.8$, $p = .4$): no difference based on country comparison.
4. How often do you use video communication? ($F = 0.98$, $p = .4$): no difference based on country comparison.

Based on the comparison of study years, only the participation in online forums showed a difference between the communication habits of students of different study years. This means that the hypothesis H/C should be rejected.

(D.1) Ability to use offline programs: Comparison of students by country

This is the comparison of the results by country performed by one-way ANOVA:

- Text editor ($F = 11.99$, $p = .001$): [Croatia] < [Serbia, Slovakia, Hungary, Macedonia].
- Picture editor ($F = 8.43$, $p = .001$): [Hungary, Croatia] < [Serbia] < [Slovakia, Macedonia].
- Sound editor ($F = 6.38$, $p = .001$): [Hungary, Slovakia] < [Serbia, Croatia] < [Macedonia].
- Video editor ($F = 5.8$, $p = .001$): [Hungary] < [Slovakia, Croatia] < [Serbia, Macedonia].
- Animation editor ($F = 7.75$, $p = .001$): [Hungary] < [Slovakia, Serbia] < [Croatia, Macedonia].
- Database Editor ($F = 5.61$, $p = .001$): [Serbia, Croatia] < [Slovakia, Hungary] < [Macedonia].

These results indicated a certain level of discrepancy in the capabilities of students from the given countries for all of the offline programs examined. On this basis, the H/D hypothesis should be rejected.

(D.2) Ability to use offline programs: Comparison of students by gender

The authors compared the abilities of the participating male and female students in using offline programs with a two-sample t test. The results showed a difference between the genders in three cases: text editor, animation editor, and database editor. Regarding the use of text editor and database editor, the male students had significantly greater abilities than their female colleagues. In the case of the animation editor, however, it was the female students who exhibited considerably greater abilities in using the program (Table 20). This result contradicts the H/D hypothesis.

TABLE 19 Comparison of online communication habits of men and women

	N	Mean	*SD*	*F*	Sig.	*t*	*df*	Sig. (two-tailed)
Do you write blogs?								
Male	64	1.93	0.26	3.2	0.001	1.68	286.05	0.09
Female	86	1.88	0.32					
Are you active in forums?								
Male	64	1.72	0.45	4.1	0.001	0.7	449.25	0.001
Female	85	1.87	0.33					
Are you active in the community pages?								
Male	64	1.01	0.08	4.89	0.27	1.73	463	0.08
Female	86	1.00	0.01					
How often do you use video communication?								
Male	64	2.22	0.61	0.25	0.8	1.38	648	0.1
Female	86	2.29	0.58					

TABLE 20 Comparing the abilities of male and female students in using offline programs

	N	Mean	*SD*	*F*	Sig.	*t*	*df*	Sig. (two-tailed)
Text editor								
Male	63	2.35	0.59	1.66	0.19	3.07	647	0.002
Female	86	2.19	0.62					
Picture editor								
Male	64	1.99	0.64	0.66	0.4	0.03	647	0.96
Female	85	1.99	0.66					
Sound editor								
Male	62	1.61	0.63	0.49	0.22	0.83	646	0.4
Female	86	1.66	0.61					
Video editor								
Male	64	1.67	0.64	0.001	0.98	0.85	648	0.3
Female	86	1.62	0.63					
Animation editor								
Male	64	1.38	0.54	0.83	0.001	2.11	305.22	0.03
Female	86	1.49	0.62					
Database editor								
Male	64	1.83	0.64	0.19	0.66	0.49	377.36	0.001
Female	86	1.65	0.58					

(D.3) Ability to use offline programs: Comparison of students by years of study

Below are the results of the student comparison by study year based on one-way ANOVA:

1. Text editor ($F = 14.8$, $p = .001$): [first year] < [second, fourth, third year] < [fifth year].
2. Picture editor ($F = 7.5$, $p = .001$): [first, second, third, fourth year] < [fifth year].
3. Sound editor ($F = 4.39$, $p = .002$): [second year] < [fourth, first, third year] < [fifth year].
4. Video editor ($F = 2.59$, $p = .03$): [second, first, fourth, third year] < [fifth year].
5. Animation editor ($F = 8.47$, $p = .001$): [second year] < [toast, fourth, first year] < [fifth year].
6. Database editor ($F = 7.42$, $p = .001$): [second and first year] < [third, fourth, fifth year].

The results showed there was a significant difference in the students' ability to use the offline programs in the various study years. In all cases, students in the higher years were also those with greater skills and who were more proficient in the individual offline programs.

These findings were expected, given that students of senior years tended to have more experience in using ICT.

(E.1) Experience in online applications: Comparison of students by country

The comparison of results by country was performed by one-way ANOVA:

- Use of cloud-based technologies ($F = 14.83$, $p = .001$): [Hungary, Macedonia, Slovakia] < [Serbia, Croatia].
- Skills in web application design ($F = 25.01$, $p = .001$): [Macedonia, Slovakia] < [Hungary, Serbia] < [Croatia].

This country-based analysis demonstrated that there were differences in the students' skills in the field of online applications. The obtained findings suggested that the H/E hypothesis should be rejected.

(E.2) Experience in online applications: Comparison of students by gender

The aim was to assess whether the male and female students demonstrated any difference in their ability to use online applications. In fact, women ranked higher both in the use of cloud-based technologies and in the development of web applications (Table 21). These results do not support the H/E hypothesis.

(E.3) Experience in online applications: Comparison of students by year of study

The following results were found for the student comparison by study year, based on one-way ANOVA:

- Use of cloud-based technologies ($F = 9.04$, $p = .001$): [third, fifth, fourth and second year] < [first year].

TABLE 21 Comparing the abilities of men and women in using online applications

	N	Mean	*SD*	*F*	Sig.	*t*	*df*	Sig. (two-tailed)
Cloud-based technologies								
Male	64	1.47	0.50	54.77	0.001	−4.68	648	0.001
Female	86	1.67	0.47					
Web apps								
Male	62	1.43	0.49	50.96	0.001	−6.71	364.6	0.001
Female	85	1.70	0.45					

– Experience in web application design ($F = 22.31$, $p = .001$): [fourth, fifth, and third year] < [second and first year].

The results demonstrated that there was a significant difference in the use of web applications between the various study years. The findings indicated that, quite unexpectedly, it was the first-year students who showed most skill in both the use of cloud-based technologies and the creation of web-based applications. Based on the results, the H/E hypothesis should be rejected.

(F.1) Experience in e-learning: comparison of students by country

The comparison of the results by country was performed by one-way ANOVA and is summarized below:

- Use of e-learning materials ($F = 8.73$, $p = .001$): [Macedonia, Croatia, Slovakia] < [Serbia, Hungary].
- Participation in an online course ($F = 58.62$, $p = .001$): [Slovakia] < [Hungary, Macedonia, Serbia] < [Croatia].
- E-learning technology ($F = 25.79$, $p = .001$): [Slovakia] < [Hungary, Serbia, Macedonia] < [Croatia].
- Preparation of e-learning materials ($F = 6.56$, $p = .001$): [Macedonia, Serbia] < [Slovakia, Hungary, Croatia].
- E-learning platform ($F = 4.22$, $p = .003$): [Croatia, Macedonia, Slovakia, Serbia] < [Hungary].

According to the results, there was a difference between the e-learning usage habits of students from different countries in all aspects examined. On this basis, the H/F hypothesis should be rejected.

One of the crucial factors for students' success in the e-learning process is self-motivation. The integration of information and communication technologies with the learning process depends on the participants' personal motivation. To enable students to maximize the ICT potential in their learning process, students need to be supported with their digitally enhanced learning [11].

(F.2) Experience in e-learning: Comparison of students by gender

With regard to the use of e-learning by male and female students, the only difference detected was in the students' participation in online courses (Table 22). The male students tended to take part in e-learning courses to a significantly higher degree than their female colleagues. This result contradicts the H/F hypothesis.

(F.3) Practice in using e-learning: Comparing students according to the year of studying

Below is the summary of the results of the student comparison by year of study based on one-way ANOVA:

- Use of e-learning materials ($F = 2.15$, $p = .7$): no difference based on the comparison of study years.
- Participation in an online course ($F = 28.35$, $p = .001$): [fifth and fourth year] < [third and second year] < [first year].
- E-learning technology ($F = 13.42$, $p = .001$): [fifth, fourth and third year] < [second and first year];
- preparing e-learning materials ($F = 13.15$, $p = .001$): [fifth year] < [fourth, second, third and first year].
- E-learning platform ($F = 2.2$, $p = .07$): no difference based on the comparison for study years.

The popularity of platforms for e-learning, the use of e-learning materials, as well as the need to design those materials can be seen as a difference between the habits of students of the various study years in the use of e-learning. Based on the results, the H/F hypothesis should be rejected.

(G.1) The usage of Web usability testing: student comparison by country

The effectiveness of the course will help the learners achieve the specific goals of the course. The ease of navigation through the course will help the learners achieve their goals. If the course is not effective or efficient, then it will affect the students' learning [33].

The comparison of results by country, too, was performed by one-way ANOVA, as described below:

1. Knowledge of the concept of web usability ($F = 1.75$, $p = .1$): no difference based on country comparison.

TABLE 22 Comparing the abilities of male and female students in e-learning habits

	N	Mean	*SD*	*F*	Sig.	*t*	*df*	Sig. (two-tailed)
Use of e-learning materials								
Male	58	1.17	0.38	0.23	0.62	−0.2	642	0.8
Female	86	1.18	0.38					
Attending an online course								
Male	62	1.65	0.47	9.2	0.001	−4.5	417.2	0.001
Female	86	1.82	0.38					
E-learning technology								
Male	62	2.97	2.06	0.23	0.63	0.1	646	0.9
Female	86	2.95	2.04					
Making e-learning material								
Male	64	1.91	0.29	3.12	0.07	0.89	648	0.3
Female	86	1.88	0.32					
E-learning platform								
Male	26	1.34	0.47	5.49	0.02	1.07	60.53	0.2
Female	6	1.25	0.43					

2. Testing web applications ($F = 6.36$, $p = .001$): [Macedonia] < [Serbia, Croatia, Hungary, Slovakia].
3. Web usability testing ($F = 3.72$, $p = .005$): [Macedonia] < [Slovakia, Croatia] < [Serbia, Hungary].

Although there was no difference in the use of web usability among the students in each country, the H/G hypothesis should still be rejected based on the differences between the methods of testing web applications and web usability testing.

(G.2) The usage of Web usability testing: students' comparison based on gender

There was no difference in the knowledge of male and female students about web usability (Table 23). This result supports the statement in H/G.

The study conducted by Pearson et al. [29] investigated the relative importance of five design criteria in the evaluation of the usability of an e-commerce site from the viewpoint of 178 web users. The objective of their research was to shed light on the criteria that influence successful web design and to determine if gender has an impact on the relative importance of these usability criteria. The criteria related to navigation, download speed, personalization and customization, ease of use, and accessibility. The results showed that these five criteria were significant predictors of website usability from the point of view of website users. Ease of use and navigation were the most important criteria in determining website usability, while personalization and customization were the least important. It was also found

TABLE 23 Web usability

	N	Mean	*SD*	*F*	Sig.	*t*	*df*	Sig. (two-tailed)
Web usability knowledge of the concept								
Male	61	1.55	0.49	1.42	0.2	1.32	645	0.1
Female	86	1.49	0.50					
Testing web applications								
Male	63	2.69	1.31	5.01	0.2	−1.3	349.9	0.1
Female	85	2.84	1.26					
Web usability testing								
Male	63	4.00	2.12	7.92	0.005	−1.8	356.4	0.07
Female	86	4.32	2.03					

that males and females viewed these web usability criteria differently. The two usability criteria, navigation, and ease of use, were found to have significant differences based on gender. Females placed greater emphasis on both of these web usability criteria than did males [17].

(G.3) The usage of Web usability testing: student comparison by year of study

The list below presents the results of the student comparison by study year based on one-way ANOVA:

1. Knowledge of the concept of web usability ($F = 1.28$, $p = .2$): no difference based on the comparison of years of study.
2. Testing web applications ($F = 2.48$, $p = .4$): no difference based on the comparison of study years.
3. Web usability testing ($F = 0.81$, $p = .5$): no difference based on the comparison of study years.

There was no difference between the students in each year of study in terms of web usability.

Also, Gonzalez [15] evaluated the usability of academic websites in the Spanish-Speaking Context of Use (SSCU) through the heuristic evaluation and cognitive walkthrough methods. A specialized software tool was developed based on heuristic evaluation techniques to support the usability evaluation of SSCU; this was used to evaluate the usability of 69 academic websites. The defined heuristics consisted of 25 questions related to four categories: design, content, navigation and search. The evaluation team which carried out the usability evaluation comprised two usability experts and two advanced students with solid knowledge of heuristic evaluation. The results showed the feasibility of applying both the specialized software tool and the particular cognitive walkthroughs while evaluating academic websites [17].

6 | CONCLUSIONS

Although the curricula of the analyzed study programs showed a great degree of similarity in the institutions covered by this study and the initial assumption was that students had similar competencies, it was concluded that there were significant differences in the use of ICT. This leads to the conclusion that it is necessary to adapt distance education systems to the students' gender, the year of study, and nationality.

Students exhibited similar habits when using the Internet and cloud technologies, which points to unity and a high-level of inter-connectedness among young people in the region.

Clear differences have been noted, but also similarities, when it comes to the computer literacy of students from technical faculties in the region. The results have also revealed that computer literacy influences the choice of method for testing web applications.

The conclusion is that it is not possible to create universal systems for distance learning, instead, the systems need to be adapted to the individual user's characteristics, even though they have similar knowledge and capabilities. Individualization of VLE is indispensable despite the fact that users may have similar competencies.

Although all students in the region use some methods to test the usefulness of distance learning systems, there are differences in the types of methods they tend to use.

It must, however, also be noted that this study also has drawbacks regarding the unequal nature of the sample and the possibly subjective answers given by respondents.

The aim of this study is to provide some guidelines toward a standardized curriculum development so as to enable faster and easier knowledge acquisition for generations of engineers. There are a few limitations of these standardized curricula. There are chances that these learning styles may not fit the preferred approach and style of many students. There are chances of an increase in procrastination amongst unmotivated students. Also, it requires students to be self-disciplined, self-motivated, and able to plan and work independently, which might not be possible for all students.

But, such curricula could alleviate the considerable lack of engineers experienced world-wide. Another vital aspect is education, namely, how to prepare the modern generations of engineers for the challenges of Industry 4.0 they will encounter in their work life, leading to new possibilities and a higher quality of life. One must not be afraid of these changes. Engineers of today must be equipped with a wide range of knowledge and education, which will enable them to adapt to technical challenges and novel methods. It is imperative for education to encourage creativity and innovation in young people and to promote a multidisciplinary approach in many areas. Today's engineers must be able to collect and acquire new knowledge when the need arises.

The obtained results can help to develop and improve VLEs, as well as create an improved form and content of online courses in the future.

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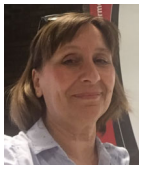

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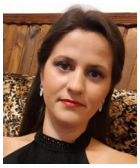

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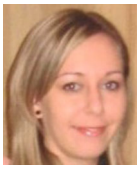

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