JOURNAL OF BALTIC SCIENCE EDUCATION
ISSN 1648-3898 /Print/
ISSN 2538-7138 /Online/

THE USEFULNESS OF ONLINE LEARNING DURING THE COVID19 PANDEMIC AS PERCEIVED BY ENGINEERING EDUCATION STUDENTS: A MULTIDIMENSIONAL MODEL

Gabriel Gorghiu,
Costin Pribeanu,
Valentina Iuliana Manea ,
Vincentas Lamanauskas,
Rita Makarskaitė-Petkevičienė

Abstract. *With the unprecedented crisis created by the Coronavirus pandemic, online teaching and learning became a global solution - embraced by the whole world - that tried to cover, at least in part, in part the problems encountered by the educational systems. An exclusively online format of teaching and learning proved to be a challenge for both the didactic and the learning process. Although the extant research during the pandemic is very abundant, there are few approaches addressing the different perceptions reported by university students enrolled in various programs. This research aims to explore the usefulness of online learning as perceived by civil engineering students, from a multidimensional perspective. A multidimensional model has been developed that manifests on four dimensions: social usefulness of online lectures, the usefulness of online learning platform, learning effectiveness, and, usefulness for school performance. The results show a relatively low perception of the online learning usefulness in an exclusively online educational context, which disables active learning through hands-on experience in laboratory and real-life building sites (considering the regular study process). The model has been cross-validated on a sample of students enrolled in various educational programs then the differences between samples have been analyzed and discussed.*
Keywords: *Covid-19 pandemic, engineering students, learning platform, online education, perceived usefulness*

Gabriel Gorghiu
Valahia University of Târgoviște, Romania
Costin Pribeanu
Academy of Romanian Scientists, Romania
Valentina Iuliana Manea
University of Building Engineering, Romania
Vincentas Lamanauskas,
Rita Makarskaitė-Petkevičienė
Vilnius University, Lithuania

Introduction

With the explosion of the Coronavirus pandemic, mobile teaching and learning became an important educational challenge. But, in essence, the use of modern technologies in school transposes the natural evolution of learning, and suggests solutions to such challenges, answering students' learning and needs. It is agreed that it is not an easy process, but the difficulties can be overcome taking into account the potential of this type of format.

The major value of exploiting technology in learning is referred to its potential. On the other hand, it represents an opportunity in creating experiences that can provide the proper patterns of teaching and learning suitable at a certain moment, place, topic, and even student or group of students. By extension, it can be discussed around a model valuable not only at school but also at home. Practically, this format becomes global, it transcends the formal country borders and brings together a group of students from various areas and different cultures. In this sense, a generalization related to the use of mobile teaching and learning in education could become one of the most important achievements at the beginning of the 21st century.

But considering the actual educational crisis, several questions have to be underlined, constituting good issues for research: *how is online learning perceived by university students*? *how do the perceptions differ between students enrolled in various programs*? and in particular, *what is the real perception of engineering students concerning the usefulness of online learning*?

Extant research shows various perceptions of distance education usefulness. Many studies are highlighting the advantages of distance learning in terms of learning flexibility, efficiency, and outcomes, self-efficacy, comfort (Almahasees et al., 2021; Cicha et al., 2021, Garcia-Alberti et al., 2021; Fahrurrozi et al., 2020; Manea et al., 2021; Rizun & Strzelecki, 2020; Rets et al., 2021). Also, most studies emphasize an agreement on the fact that the educational

https://doi.org/10.33225/jbse/21.20.716

crisis during the pandemic revealed the potential of distance education and the opportunities created for the development of the educational infrastructure, mostly taking into consideration that the distant learning institutional capacities have been underequipped and limited, including here some challenges concerning the internet access services (Adnan & Anwar, 2020; Bisht et al., 2020).

On the other hand, as several studies mentioned, technology and engineering students have been seriously affected by the distance education that inhibited the practice and the use of specific technological tools (Arroio, 2020; Asgari et al., 2021; Makamure & Tsakeni, 2020). For lecturers, distance teaching/learning proved confusing, which slightly reduced the quality of teaching compared to the regular type of study (Rizun & Strzelecki, 2020). Although university students have good computer skills, which enable the use of educational technologies, there are technical issues related to Internet access (Cicha et al., 2021). Also, as many studies pointed out, students' engagement and motivation are lower than in face-to-face education (Asagari et al., 2021; Garcia-Alberti et al., 2021).

Various online learning platforms have been used during the pandemic time. Each of them comes with advantages and disadvantages, but it is obvious that such platforms are not the best solutions for studying an integrated curriculum of theory and practice, as requested by engineering education (Thakker et al., 2021). Those instruments have to record an important increase in terms of adaptability, technical-friendly issues for users, together with dedicated methods for improving students' motivation to study, being able in this sense to achieve a high level of effectiveness (Roberts et al., 2018).

The present research aimed to explore the usefulness of online learning from a multidimensional perspective. A multidimensional model has been developed that manifests on four dimensions: *social usefulness of online lectures*, *the usefulness of online learning platforms*, *learning effectiveness*, and *usefulness for school performance*. The model has been tested on a sample of university students in civil engineering and cross-validated on another sample.

Background and Conceptualization

Background

Rizun and Strzelecki (2020) explored pandemic-induced distance learning. Polish students (the University of Katowice, study programs in economics) believed that distance learning tools and software are easy to master, so understanding the principles of the form of distance education did not cause them any problems. Anyway, the idea of distance learning is good, and it is planned to use it more often in university studies. In addition, distance education has increased student learning efficiency, improved outcomes, and productivity. However, in general, students evaluate the efficiency and effectiveness of studies on average. Assessing the convenience and usefulness of distance education, students indicated that they really want to return to regular education - to university, where they can communicate with their friends, discuss various issues, receive feedback from the lecturer, not from the computer screen, want to work in libraries, etc. In particular, they felt embarrassed to take exams remotely or present their final works to the commission. These procedures also cause tension, so when a student is left alone with a computer screen, the anxiety only intensifies. To the authors "best knowledge, this is the first study testing the shift to distance learning using the adapted GETAMEL model and PLS-SEM method". The results of the research are useful for the formation of university policy. When introducing technologies in studies, it is very important how students are introduced to them, involved in their use and how their expectations and feedback are met.

Cicha et al. (2021) analysed the distance study expectations of first-year students. GETAMEL, which is the adapted General Extended Technology Acceptance Model for E-Learning, was used in the study. The researchers analysed the expression of experience, subjective norms, enjoyment, computer anxiety, and efficiency in distance teaching/learning. To test the research model presented during the research, The Partial Least Squares method of Structural Equation Modelling was used. An online survey was created to conduct the research, which collected data from 670 Polish first-year undergraduate students. Research has shown that students have good computer skills, so they are not worried that distance education may cause them technical difficulties (related to the use of tools. At the same time, these student's opinions did not correlate positively with how students assess the ease of participating in distance learning.

Rets et al. (2021) presented an interview with undergraduate students that aimed to capture students' perceptions of the usefulness of Learning analytics dashboards (LADs) and the factors that explain these perceptions to students learning remotely. Identified factors: confidence in information, performance, academic self-confidence, etc. This allows visualization of the learner and his learning. In parallel, the Technology Acceptance Model (TAM)

https://doi.org/10.33225/jbse/21.20.716

ISSN 1648–3898 /Print/
ISSN 2538–7138 /Online/

is discussed, which is based on perceived utility constructs (to what extent a person thinks that using a particular system improves his capabilities) and perceived ease of use (perceived effort required to do so).

The Landrum (2020) study revealed positive and significant correlations between LMS self-efficacy, learning self-efficacy, self-regulation, and time management with perceived satisfaction and usefulness. It is noted that students who use LMS and have the ability to learn online, easily practice skills and understand strategies in online classrooms. For less confident students, online classes are less useful, and they are dissatisfied with both the platform and online learning in general. So, the student needs to be self-confident to realize that online classes can be helpful.

The results of a study by Fahrurrozi et al. (2020) demonstrated the usefulness of distance teaching/learning. In particular, the quality of the learning environment has been significantly affected. The usefulness of online learning was manifested through the impact on family cooperation and its quality. In addition, the usefulness of online learning has had a significant impact on the quality of teaching. Finally, the usefulness of online learning has had a significant impact on the quality of lecturers. According to the researchers, all learners who are positive about distance learning value it for comfort, accessibility, interactivity and adaptability, knowledge acquisition. In addition, those students who tend to do more activities at the same time have survived the pandemic period quite progressively.

The research of Garcia-Alberti et al. (2021) pointed out some disadvantages of distance learning based on a study in two countries. They analysed six civil engineering courses at three universities from Spain and Peru. They found that students are less engaged with the course because they lack face-to-face meetings and informal talks with lecturers, which make them feel as belonging to a community.

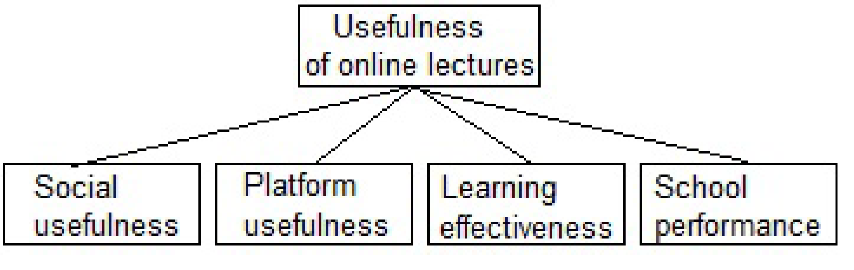
Asgari et al. (2021) also found a decrease in students' motivation and engagement during the pandemic. Their survey taken by 110 instructors and 627 students targeted six engineering education departments at California state university. Students complained of Zoom fatigue, lack of social connection with their colleagues, poor guidance from the instructors, time management issues, technical difficulties, work-life balance issues, and lack of motivation. In addition, the study highlighted the importance of hands-on training and experiments in engineering education.

In this respect, Kinney et al. (2012) demonstrated that technical topics are suitable to be effectively taught through online methods, suggesting at that moment that such methods are crucial for the future of online engineering education. On the other hand, the results of the study underlined that engineering lab experiences cannot be delivered online. However, teachers proposed simulations or even processing of already acquired data for engineering students to complete their course projects. For achieving such targets, the teachers must be familiar with effective ways for providing online hands-on training/experience, by acquiring knowledge on design, preparation, distribution/collection of the laboratory kits, or experiment recording (Asgari et al., 2021).

Research Model and Hypotheses

The perceived *usefulness of online learning* has been conceptualized as a second-order factor that manifests along four dimensions (first-order constructs): *social usefulness of the online lectures*, the *usefulness of the online platform*, *learning effectiveness*, and *usefulness for school performance* (Figure 1). The conceptualization as a second-order factor enables a distinction between the contribution of each dimension to the global factor and analysis on two levels (global factor and each dimension).

Figure 1
Research Model



https://doi.org/10.33225/jbse/21.20.716

The operationalization of the constructs is presented in Table 1. *Social usefulness* (*OL*) refers to the increased communication and interaction between students and between students and teachers. Since students and teachers are forced to stay home, online lectures became the main interaction environment, so it is expected that online lectures manifest a positive influence on communication and social interaction.

Table 1
Constructs and Measures

OL	Social usefulness
OL1	Online lectures enhance my communication skills
OL2	Online lectures improve the interaction with the teacher
OL3	Online lectures strengthen the students' community
OT	**The usefulness of the online platform**
OT1	The online platform is suitable for debate
OT2	The online platform is suitable for group work
OT3	With the online platform, I can better demonstrate my knowledge
OT4	With the online platform, I can better present my work
LE	**Learning effectiveness**
LE1	I could better understand the lecture by using the online platform
LE2	I find it easier to learn by using the online platform
LE3	I learn better by using the online platform
PU	**Usefulness for school performance**
PU1	The online platform could enhance my school performance
PU2	Using the online platform would improve my schoolwork
PU3	The use of the online platform would give me an advantage

The *usefulness of the online platform* (*OT*) refers to the increased possibilities for working in a group, hosting debates on various topics, and presenting the work to teachers and colleagues. *Learning effectiveness* (*LE*) refers to the possibilities for better understanding and supporting learning through the means and facilities proposed by the online platform. The *usefulness for school performance* (*PU*) refers to the advantages provided by the online platform that could enhance the quality of work and academic performance.

Research Methodology

Method

The evaluation instrument has been developed based on existing scales in the literature and preliminary research (Lamanauskas & Makarskaitė-Petkevičienė, 2021; Manea et al., 2021). Data has been collected from three universities - one from Lithuania and two from Romania.

Two samples are considered in this study. The first sample is collected from civil engineering students in Romania. The second is collected from students enrolled in various educational programs in Lithuania and Romania. The participants have been asked to answer several general questions as regards demographics, program study, and year of study, then to evaluate the items on a 5-points Likert interval scale.

The empirical validation of the multidimensional model follows a two-step approach: testing the inter-correlated first-order factors model and the second-order factor model, and four first-order factors, Figure 2), according to the recommendations from the literature (Edwards, 2001; Koufteros et al., 2009; Marsh & Hocevar, 1985).

https://doi.org/10.33225/jbse/21.20.716

ISSN 1648–3898 /Print/
ISSN 2538–7138 /Online/

Samples

The model has been tested on a sample of 214 civil engineering students (137 males, 73 females). Almost all are undergraduates (204, i.e., 95%). Most of the students are enrolled in the Civil Engineering program (119) and Railways, Roads, and Bridges Engineering program (37). The rest are being enrolled in other engineering programs. All students are using the platform Microsoft Teams.

The model has been cross validated on the second sample of students enrolled in two universities, one from Lithuania (primary education and science education) and the second one from Romania, all of them being involved in initial teacher training studies (science and engineering education). The Lithuanian subsample consists of 158 students and the Romanian subsample consists of 140 students, most of them being enrolled in the programs proposed by the Teacher Training Departments.

Statistical Data Analysis

Each model has been analysed for dimensionality, the internal consistency of the scale, and convergent validity. Discriminant validity is not so relevant for multidimensional models, since the dimensions are supposed to be highly correlated (Koufteros et al., 2009). Unidimensionality of each dimension and the convergent validity have been assessed according to the recommended thresholds from the literature (Fornell, & Larcker, 1981; Hair et al., 2010), as regards factor loadings (greater than 0.5), construct reliability (Cronbach's alpha), composite reliability, composite reliability (CR greater than 0.70), and average variance extracted (AVE, greater than 0.5).

The model fit with the data was assessed with the following goodness of fit indices (Hair et al., 2006; Schermelleh-Engel et al., 2003): chi-square (χ^2), degrees of freedom (*df*), χ^2/df, comparative fit index (CFI), the goodness of fit index (GFI), root mean square error of approximation (RMSEA), and standardized root mean square residual (SRMR). The model was analysed with Lisrel 9.3 for Windows (Mels, 2006), using a covariance matrix as input and maximum likelihood estimation method.

The model has been estimated on the civil engineering education sample then cross-validated on another sample. Then an analysis of invariance (Milfont & Fischer, 2010; Vanderberg & Lance, 2000) has been carried on to enable a meaningful comparison of the observed scores in the two samples.

Research Results

Model Validation on the Engineering Education Sample

The first step is to test the first-order factors model. The testing results show a good fit between the four-factors model and the data, according to the goodness-of-fit indices mentioned in the literature (Hair et al., 2006): χ^2=139.95, *df*=59, *p*=.0001, χ^2/df=2.372, RMSEA=0.080, CFI=0.967, GFI= 0.911, SRMR=.0403.

The scale reliability (Cronbach's alpha) is over .7. The factor loadings are over .5, which proves the unidimensionality of each factor. The convergent validity is very good since the composite reliability (CR) and the average variance extracted (AVE) are over .7, respectively over 0.5. The analysis results of unidimensionality, reliability, and convergent validity for the four-factors model are presented in Table 2.

Four items have been scored below the neutral value of 3.00, out of which three are from the first dimension, which suggests a low perception of the social value of online lectures. On the opposite side, only two items have been scored over 3.50: OT4 (I can better present my work) and PU3 (the online platform would give me an advantage).

Table 2
Descriptives, Factor Loadings, Reliability, and Convergent Validity (N=214)

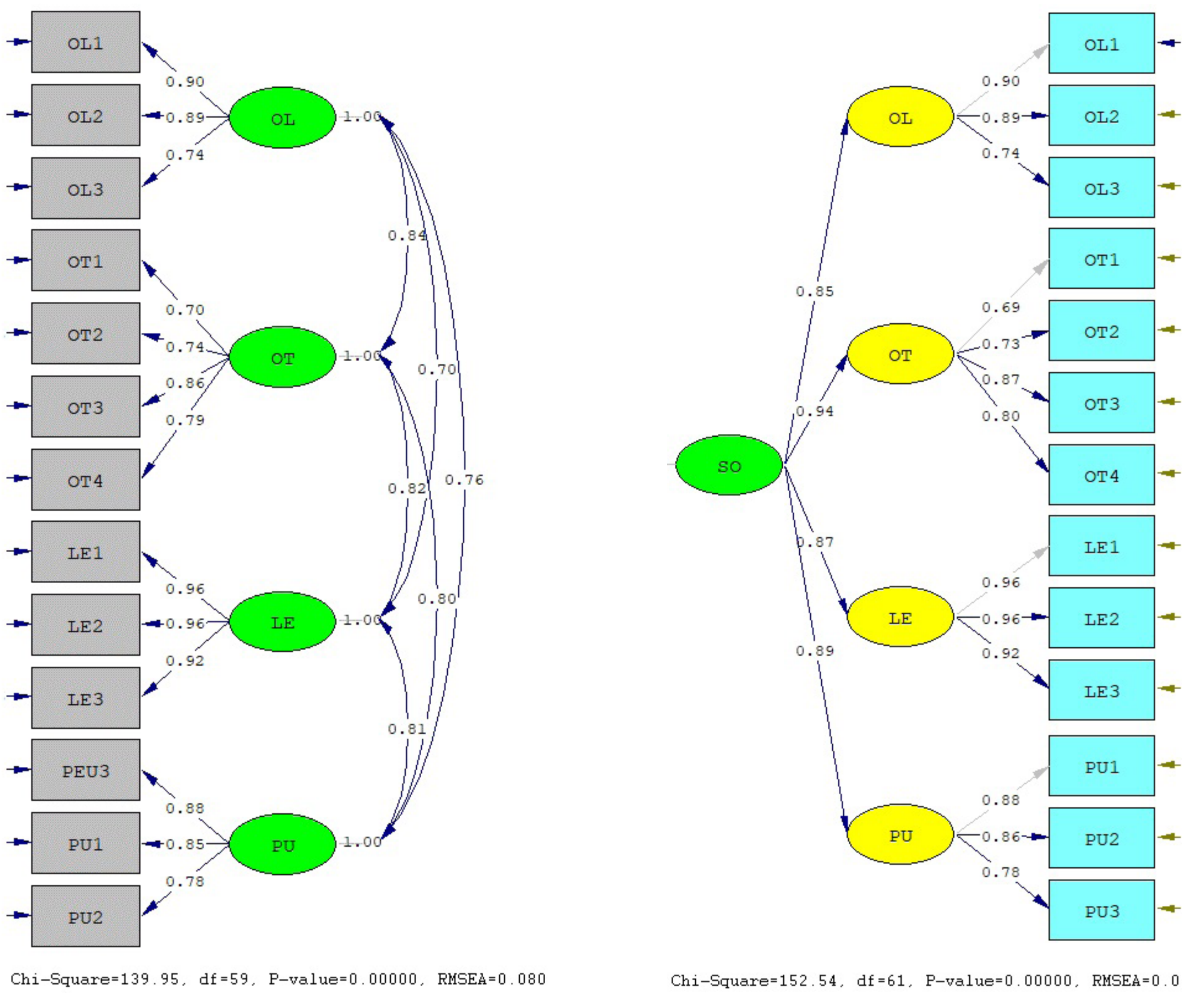
Factor	Item	M	SD	Loading	Alpha	CR	AVE
	OL1	2.86	1.40	0.90			
OL	OL2	2.77	1.45	0.89	.877	0.883	0.717
	OL3	2.55	1.49	0.74			

https://doi.org/10.33225/jbse/21.20.716

Factor	Item	M	SD	Loading	Alpha	CR	AVE
OT	OT1	3.31	1.32	0.70	.855	0.857	0.600
	OT2	3.14	1.54	0.74			
	OT3	2.98	1.46	0.86			
	OT4	3.52	1.43	0.79			
LE	LE1	3.11	1.41	0.96	.958	0.939	0.885
	LE2	3.16	1.43	0.96			
	LE3	3.11	1.42	0.92			
PU	PU1	3.26	1.39	0.88	.960	0.876	0.702
	PU2	3.29	1.35	0.85			
	PU3	3.58	1.31	0.78			

Then the second-order factor model (structural model) has been tested. The model estimation results are presented in Figure 2. The testing results also show a good fit between the structural model and the data, according to the goodness-of-fit indices mentioned in the literature (Hair et al., 2006): χ^2=152.54, *df*=61, *p*=.0001, χ^2/*df*=2.501, RMSEA=0.084, CFI=0.963, GFI=0.904, SRMR=0.0455.

Figure 2
Estimation Results (N=214) 4-factors Model (left), Second-order Factor Model (right)



ISSN 1648–3898 /Print/
ISSN 2538–7138 /Online/

The factor loadings for the first-order constructs (dimensions) are all above the threshold of 0.6, ranging from 0.69 to 0.96. The factor loadings for the second-order factor are also high, ranging from 0.85 to 0.89. The Cronbach's alpha is 0.960 thus proving scale reliability. The convergent validity for the second-order construct is very good (CR=0.937, AVE=0.789).

The second-order factor model explains 72.7% variance in OL, 87.8% variance in OT, 76% variance in LE, and 79% variance in PU. The existence of a second-order factor has been tested through the T coefficient (Marsh & Hocevar, 1985) computed as a ratio between the χ2 of the first-order model and χ^2 of the second-order model. For this sample, T=0.92 is greater than 0.80, suggesting the existence of a second-order factor, which explains 92% of the relations between the first-order factors.

Cross-validation on Another Sample

The testing results show an acceptable fit between the four-factors model and the data, according to the goodness-of-fit indices mentioned in the literature (Hair et al., 2006): χ^2=185.81, *df*=59, *p*=.0001, χ^2/df=3.149, RMSEA=0.085, CFI=0.943, GFI=0.91, SRMR=0.0545.

The scale reliability (Cronbach's alpha) is over .70 and the loadings are over 0.50, which proves the unidimensionality of each factor. The convergent validity is very good since the composite reliability (CR) and the average variance extracted (AVE) are over 0.7, respectively over 0.5. The analysis results of unidimensionality, reliability, and convergent validity for the four-factors model are presented in Table 2. The descriptive statistics and item loadings are presented in Table 4.

There is only one item (OL3) that has been scored below the neutral value of 3.00. On the other hand, six items have been scored over 3.50. Most appreciated were the features that support social learning: OT1 (online platform suitable for debate) and OT4 (I can better present my work).

Table 3

Descriptives, Item Loadings, and Convergent Validity (N=298)

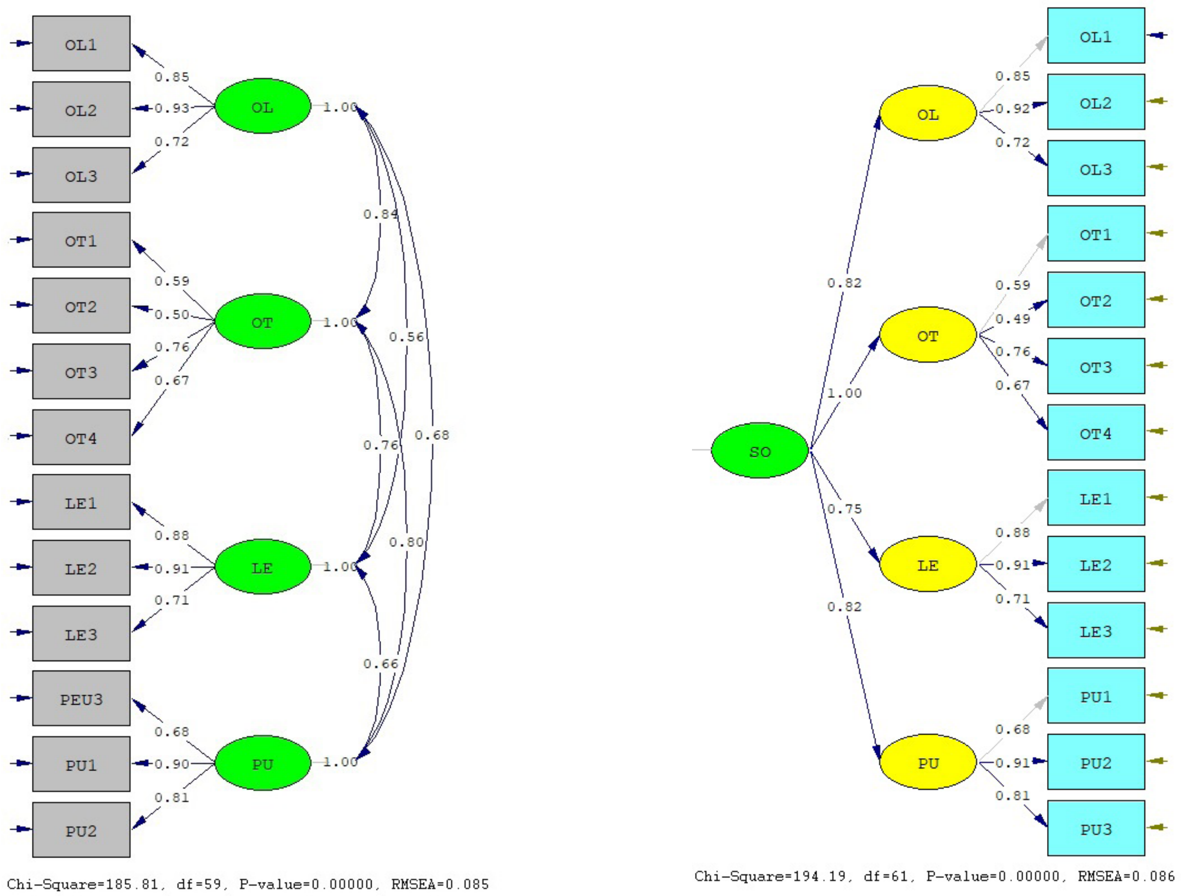
Factor	Item	M	SD	Loading	Alpha	CR	AVE
OL	OL1	3.06	1.30	0.85	.870	0.875	0.702
	OL2	3.12	1.26	0.93			
	OL3	2.89	1.33	0.72			
OT	OT1	3.95	1.01	0.59	.728	0.728	0.406
	OT2	3.65	1.13	0.50			
	OT3	3.30	1.17	0.76			
	OT4	3.80	1.11	0.67			
LE	LE1	3.16	1.04	0.88	.924	0.939	0.885
	LE2	3.23	1.10	0.91			
	LE3	3.33	1.12	0.71			
PU	PU1	3.54	1.03	0.68	.864	0.842	0.643
	PU2	3.53	1.22	0.90			
	PU3	3.69	1.14	0.81			

All item loadings are over 0.5, thus proving the unidimensionality of the first-order factors. The Cronbach's alpha is varying from 0.728 to 0.924, thus showing good reliability of the scales. The convergent validity is also good, with composite reliability (CR) over 0.7, varying from 0.728 to 0.939, and average variance extracted (AVE) over 0.5 with one exception (OT).

The model fit with the data is good: χ^2 =194.19, *df*=61, *p*=.0001, χ^2/df=3.183, CFI=0.940, GFI=0.909, SRMR=0.0576. The model estimation results for the second sample are presented in Figure 3.

https://doi.org/10.33225/jbse/21.20.716

Figure 3
Estimation Results (N=298) 4-factors Model (left), Second-order Factor Model (right)



The factor loadings for the first-order constructs (dimensions) are all above the threshold of 0.5, ranging from 0.5 to 0.93. The Cronbach's alpha is .936. The factor loadings for the second-order factor are also high. The convergent validity for the second-order construct is very good (CR=0.913, AVE=0.727).

The existence of a second-order factor for this sample has been tested through the T coefficient, which is 0.96, showing that the second-order factor accounts for 96% of the relations between the first-order factors.

Analysis of Differences

To compare differences between samples an invariance analysis is needed to check if respondents are interpreting the variables in the same way (Vandenberg & Lance, 2000). The first step is to test an unconstrained model on both samples taken. The results show a non-significant chi-square ($\Delta\chi^2 = 398.4$, $df=137$, $p=.004$) and acceptable GOF indices (CFI=0.976, GFI=0.906, RMSEA=0.086, SRMR=0.06353).

The next step is to test the metric invariance by constraining factor loadings to be equivalent in each group. Although the model comparison shows a significant chi-square difference ($\Delta\chi^2 = 39.17$, $\Delta df = 13$, $p = .0001$), the depreciation of CFI is not less than 0.01 so the model exhibits metric invariance, according to the criterion of Cheung and Rensvold (2002). This means that the model has been perceived in the same way in each group.

Testing the scalar invariance is done by constraining the intercepts to be equivalent. The model comparison shows a significant chi-square difference ($\Delta\chi^2 = 75.16$, $\Delta df = 9$, $p = .0001$), the depreciation of CFI is less than 0.01 so the model has scalar invariance. The results of the invariance analysis are presented in Table 4.

https://doi.org/10.33225/jbse/21.20.716

ISSN 1648–3898 /Print/
ISSN 2538–7138 /Online/

Table 4
Invariance Analysis Results (N=512)

Model	*df*		CFI	Δ CFI	Δ *df*	$\Delta\chi^2$	*p*
Unconstraint	137	398.400	0.976				
Metric invariance	150	437.570	0.971	-0.005	13	39.17	.0001
Scalar invariance	159	512.730	0.968	-0.003	9	75.16	.0001

The metric invariance enables the comparison of observed scores. As could be observed from tables 2 and 3, there are large differences between the mean values in the two samples. Students in civil engineering scored lower on all items. The one-way ANOVA (1, 510, 511) test for significance shows that differences are statistically significant for OL2 (F=8.627, p=.003), OL3 (F=7.114, p=.008), OT1 (F=38.989, p=.0001), OT2 (F=19.291, p=.0001), OT3 (F=7.027, p=.008), OT4 (F=5.858, p=.016), LE3 (3.880, p=.049), PU1 (6.962, p=.009), and PU2 (4.252, p=.040). The larger differences are between the mean values of OT1 (platform is suitable for debate) and PU2 (platform is suitable for group work)

The differences between samples as regards the mean value of each construct are presented in Table 5. A one-way ANOVA (1, 510, 511) showed that the differences are statistically significant for OL (F=7.312, p=.007), OT (F=20.364, p=.0001), and PU (F=4.620, p=.032).

Table 5
Comparison between Samples (N=512)

Sample	OL	OT	LE	PU
Engineering	2.73	3.32	3.13	3.38
Education	3.02	3.80	3.24	3.59

The largest differences are between the mean values of OT (usefulness of the online platform) which suggests that the students enrolled in educational programs are valuing the features that support social learning. In both samples, the highest scored dimensions were the usefulness of the online platform and the usefulness for school performance.

Discussion

This study contributes with an empirically validated multidimensional model measuring the usefulness of online learning. The usefulness of online lectures has been conceptualized as a global factor that manifests on four dimensions: *social usefulness*, the *usefulness of the online platform*, *learning effectiveness*, and *usefulness for school performance*.

The results bring evidence for the existence of a second-order factor which is a better conceptualization having a higher explanatory power. It is also a better alternative since it has fewer parameters to estimate and more degrees of freedom. The cross-validation on a second sample provides evidence that the multidimensional model is reliable.

Overall, the observed scores show a relatively low but positive perception as regards the usefulness of online learning which is not surprising given the restrictions of an exclusively online educational process. By studying remotely, students develop independence, responsibility, and become more disciplined. Better time planning skills are formed, participation in lectures without contact supervision of the lecturer. Clearly, most students have the appropriate knowledge of information technology that they have been able to apply in practice through distance learning. Distance lectures develop new skills and shape the character of young

https://doi.org/10.33225/jbse/21.20.716

people. Other studies also showed that comfort and accessibility are often cited as extremely significant benefits (Mukhtar et al., 2020). Despite the fact that online teaching/learning support and facilitate learning/teaching activities still remain a dire need to weigh the pros and cons of technology and harness its potentials (Dhawan, 2020).

In both samples, the lowest scored dimension was the social usefulness which refers to communication and students' community. This could be explained by the negative effects of the lockdown which prevented students from meeting face to face, for example, distraction and reduced focus, heavy workload, problems with technology, and the internet. This finding is similar to the results of other studies (Lamanauskas & Makarskaite-Petkevičiene, 2021; Hussein et al., 2020).

The comparison of mean values between the two samples revealed significant differences that highlight that overall, students in engineering have a lower perception of the usefulness of online learning. This is explained by the fact that they have many laboratory classes including experiments and building materials manipulation which need a physical presence. To promote active learning, a "hands-on" experience with materials and technological tools is needed. They also have practical assignments that require a physical presence in building sites where various engineering works are built.

In both samples, the most appreciated dimensions were the usefulness of the online platform and the usefulness for school performance although there is an interesting difference as regards the scoring of each dimension. While for the students enrolled in educational programs the most appreciated dimension was the usefulness of the online platform, the students enrolled in engineering programs mostly liked the usefulness for school performance.

There are several explanations for those differences. An explanation is the specific studying program. Students in civil engineering are future engineers, that are looking forward to working in design companies or construction enterprises. As such, they are working more individually and have a pragmatic view of the profession. This explains why they mainly appreciated the usefulness of school performance. As highlighted in a recent study (Manea et al., 2021), engineering students have many project assignments that require a presentation, which explains the relatively high score of the online platform's usefulness for presenting their work.

Students enrolled in the educational programs are future educators thus being interested in the educational process itself and the challenges brought by an online learning platform. This explains their high perceptions as regards the features supporting social learning. It should be noted that by distance learning, students have the opportunity to revisit the material presented during the lecture, to use additional information available on the Internet, to absorb it at a pace suitable for everyone, and thus to better understand the study content. According to researchers, in general, online education (using a variety of technologies) has a high effect on reducing negative emotions and increasing engagement and a moderate effect on increasing positive emotions of pre-service teachers (Başal & Eryılmaz, 2021). A study (conducted in Ghana) showed that pre-service teachers were digitally literate and mostly accessed online learning using smartphones. An increase in motivation to learn was also observed due to the flexibility of online learning (Ogbonnaya et al., 2020). It is important to emphasize the peculiarities of pedagogical/educational studies. These activities are based on communication, strong social skills development, reflective practice, close contact with school and cognition of students, development of their achievements, group dynamics and different educational environments, etc., which students seem to have missed. They were restricted from activities related to education, personal development; educational institutions could not test their own lessons scenarios or other educational activity projects in face-to-face mode.

Learning effectiveness must be seen in strong conjunction with human interaction, especially in the context of online learning, as an essential condition of qualitative education, in a world that is constantly changing and in which the individual must pass through a difficult adaptation process to the societal requirements. In general, online platforms are perceived to support learning outcomes equivalently as resulted from traditional format (Barry, 1995), but their particular affordances and constraints ("*difficult or negative interactions with interfaces*", "*clarity and consistency in course design, organization, goals, and instructor expectations*", "*ongoing assessment of student performance linked to immediate feedback & individualized instruction*") make the teachers adopt strategies and approaches that might enhance the learning effectiveness of online instruction (Gibson, 1996). In this respect, it is good to understand that *just being online does not automatically mean efficiency* and *effectiveness* - no matter how sophisticated the actual digital solutions are, they cannot save unconvincing teaching options, communication disabilities, lame, or poorly structured content. Unfortunately, *technology*

https://doi.org/10.33225/jbse/21.20.716

ISSN 1648–3898 /Print/
ISSN 2538–7138 /Online/

does not represent a teacher who replaces a real teacher, but it becomes very useful when it is integrated into a well-organized didactic approach, carefully planned, masterfully conducted, with controlled improvisations, with intentionally set objectives, and adequate communication.

On the other hand, a series of elements influenced the school performance during the pandemic period, being multiplied by the online educational contexts. Even the students' feedback is favourable to a certain gain in their school performance, there are clearly issues underlined in several cases that envisage stress, uncertainty about the future, changes in the way of socializing with colleagues, and even self-esteem problems. But at least a part of those issues seems to be natural and a major role of their limitation in practice is the teacher's task. Most of the teachers did not know how to behave, in the role of online teacher, sitting in front of the computer, as an authentic leader, proposing learning experiences in the format of seeing, thinking, working together with the students, helping students. In this respect, teachers have to be fully oriented on students' needs, focused on mission and objectives, helping students to understand the reality, and offering relevant learning. Considering the pandemic conditions, teachers must capitalize on their digital competencies and resources, with the view to adapt the educational process efficiently, to answer the students' requests and possibilities (Santi et al., 2020).

There are inherent limitations of this exploratory work. A limitation is related to the fact that students in civil engineering are from one university while students enrolled in educational programs are from two universities from two different countries. Another limitation is related to the sample size. Although the model has been cross validated, both samples are relatively small. Also, the degree of readiness for exclusive online teaching and learning differs by country and university. At the same time, such research studies are welcome to understand the role and importance of online learning, with the view to assess the usefulness of online learning, especially for engineering students, when the amount and quality of laboratory hands-on activities are important.

Conclusions and Implications

The study emphasized the students' perceived *usefulness of online learning* which has been conceptualized as a factor that co-interests four dimensions: *social usefulness of the online lectures*, the *usefulness of the online platform*, *learning effectiveness*, and *usefulness for school performance*. The results of the research provide useful insights into actual issues related to online education that enriched the concept of education in the last period and exploited the Internet as the main solution for "pandemic education". The results of the study illustrate a relatively low but positive perception as regards the usefulness of online learning, in general. Discussing the dimensions, the lowest scored was recorded by the social usefulness (referring to communication and students' community), the most appreciated dimensions being the usefulness of the online platform and the usefulness for school performance.

It can be stated that the pandemic situation and distance learning experience developed students' independence and planning skills, but the practice based on live communication decreased, students from education study programs lost real pedagogical situations they experienced at school and did not try many teaching/learning methods in didactic classes. While studying remotely, it was practically impossible to explore and test some teaching/learning tools and techniques.

Declaration of Interest

Authors declare no competing interest.

References

Adnan, M., & Anwar, K. (2020). Online learning amid the COVID-19 pandemic: Students' perspectives. *Journal of Pedagogical Sociology and Psychology*, *2*(1), 45–51, https://doi.org/10.33902/JPSP.2020261309

Almahasees, Z., Mohsen, K., & Amin, M. O. (2021). Faculty and students' perceptions of online learning during COVID-19. *Frontiers in Education*, *6*, Article 638470. https://doi.org/10.3389/feduc.2021.638470

Arroio, A. (2020). The value of education in the context of the Covid-19 pandemic. *Problems of Education in the 21st Century*, *78*(3), 309-313. https://doi.org/10.33225/pec/20.78.309

https://doi.org/10.33225/jbse/21.20.716

Asgari, S., Trajkovic, J., Rahmani, M., Zhang, W., Lo, R. C., & Sciortino, A. (2021). An observational study of engineering online education during the COVID-19 pandemic. *PLoS One*, *16*(4), Article e0250041. https://doi.org/10.1371/journal.pone.0250041

Barry, M., & Runyan, G. A. (1995). A review of distance-learning studies in the U.S. military. *The American Journal of Distance Education*, *9*(3), 37-47

Bisht, R. K., Jasola, S., & Bisht, I. P. (2020). Acceptability and challenges of online higher education in the era of COVID-19: A study of students' perspective. *Asian Education and Development Studies*, https://doi.org/10.1108/AEDS-05-2020-0119

Cheung, G. W., & Rensvold, R. B. (2002) Evaluating goodness-of-fit indexes for testing measurement invariance. *Structural Equation Modelling*, *9*(2), 233-255. https://doi.org/10.1207/S15328007SEM0902_5

Cicha, K., Rizun, M., Rutecka, P., & Strzelecki, A. (2021). COVID-19 and higher education: First-year students' expectations toward distance learning. *Sustainability*, *13*, Article 1889. https://doi.org/10.3390/su13041889

Dhawan, S. (2020). Online learning: A panacea in the time of COVID-19 crisis. *Journal of Educational Technology Systems*, *49*(1), 5-22. https://doi.org/10.1177/0047239520934018

Edwards, J. R. (2001). Multidimensional constructs in organizational behavior research: An integrative analytical framework. *Organizational Research Methods*, *4*(2), 144-192. https://doi.org/10.1177%2F109442810142004

Fahrurrozi, Murtono, Lestari, I., Sarifah, I., & Dewi R. S. (2020). The usefulness of online learning on quality of education during Covid-19 pandemic: Evidence from the department of elementary school teacher education at Universitas Negeri Jakarta, Indonesia. *International Journal for Quality Research*, *15*(1), 107-124. https://doi.org/10.24874/IJQR15.01-06

Fornell, C., & Larcker, D. F. (1981). Evaluating structural equation models with unobservable variables and measurement error. *Journal of Marketing Research, 18*(1), 39-50.

García-Alberti, M., Suárez, F., Chiyón, I., & Mosquera Feijoo, J. C. (2021). Challenges and experiences of online evaluation in courses of civil engineering during the lockdown learning due to the COVID-19 pandemic. *Education Sciences*, *11*, 59. https://doi.org/10.3390/educsci 11020059

Gibson, J. J. (1996). *The senses considered as perceptual systems*. Houghton Mifflin.

Hair, J. F., Black, W. C., Babin, B. J., Anderson, R. E., & Tatham, R. L. (2006). *Multivariate data analysis* (6th ed.). Prentice-Hall.

Hussein, E., Daoud, S., Alrabaiah, H., & Badawi, R. (2020). Exploring undergraduate students' attitudes towards emergency online learning during COVID-19: A case from the UAE. *Children and Youth Services Review*, *119*, Article 105699. https://doi.org/10.1016/j.childyouth.2020.105699

Kinney, L., Liu, M., & Thornton, M. A. (2012). Faculty and student perceptions of online learning in engineering education. In *Proceedings of the ASEE Annual Conference and Exposition, Conference*, (Washington, DC: American Society for Engineering Education).

Koufteros, X. A., Babbar, S., & Kaighobadi, M. (2009). A paradigm for examining second-order factor models employing structural equation modelling. *International Journal of Production Economics, 120*(2), 633-652. https://doi.org/10.1016/j.ijpe.2009.04.010

Landrum, B. (2020). Examining students' confidence to learn online, self-regulation skills, and perceptions of satisfaction and usefulness of online classes. *Online Learning*, *24*(3), 128-146. https://doi.org/10.24059/olj.v24i3.2066

Lamanauskas, V., & Makarskaitė-Petkevičienė, R. (2021). Distance lectures in university studies: Advantages, disadvantages, improvement. *Contemporary Educational Technology (CEDTECH)*, *13*(3), Article ep309. https://doi.org/10.30935/cedtech/10887

Makamure, C., & Tsakeni, M. (2020). Covid-19 as an agent of change in teaching and learning STEM subjects. *Journal of Baltic Science Education*, *19*(6A), 1078-1091. https://doi.org/10.33225/jbse/20.19.1078

Manea, I. V., Macavei, T., & Pribeanu, C. (2021). Perceived benefits of online lectures during the pandemic: A case study in engineering education. *Pro Edu International Journal of Educational Sciences*, *3*(1), 35-41. https://doi.org/10.26520/peijes.2021.4.5.65-41

Marsh, H. W., & Hocevar, D. (1985). Application of confirmatory factor analysis to the study of self-concept: First- and higher-order factor models and their invariance across groups. *Psychological Bulletin*, *97*(3), 562-582.

Milfont T. L., & Fischer R. (2010). Testing measurement invariance across groups. Applications in cross-cultural research. *International Journal of Psychological Research*, *3*(1), 112-131.

Mukhtar, K., Javed, K., Arooj, M., & Sethi, A. (2020). Advantages, limitations, and recommendations for online learning during the COVID-19 pandemic era. *Pakistan Journal of Medical Sciences*, *36*(COVID19-S4), 27-31. https://doi.org/10.12669/pjms.36.COVID19-S4.2785

Ogbonnaya, U. I., Awoniyi, F. C., & Matabane, M. E. (2020). Move to online learning during COVID-19 lockdown: Pre-service teachers' experiences in Ghana. *International Journal of Learning, Teaching and Educational Research*, *19*(10), 286-303. https://doi.org/10.26803/ijlter.19.10.16

Rets, I., Herodotou, C., Bayer, V., Hlosta, M., & Rienties, B (2021). Exploring critical factors of the perceived usefulness of a learning analytics dashboard for distance university students. *International Journal of Educational Technology in Higher Education*. https://doi.org/10.1186/s41239- 021-00284-9

Rizun, M., & Strzelecki, A. (2020). Students' acceptance of the COVID-19 impact on shifting higher education to distance learning in Poland. *International Journal of Environmental Research and Public Health*, *17*(18), Article 6468. https://doi.org/10.3390/ijerph17186468

Roberts, J., Kigotho, M., & Stagg, A. (2018). Expanding horizons in open and distance learning. *Distance Education*, *39*(1), 1-3. https://doi.org/10.1080/01587919.2018.1439367

ISSN 1648–3898 /Print/
ISSN 2538–7138 /Online/

Santi, E. A., Gorghiu, G., & Pribeanu, C. (2020). Teachers' perceived self-efficacy for mobile teaching and learning. *Revista Romanească pentru Educație Multidimensională, 12*(1Sup2), 157-166. https://doi.org/10.18662/rrem/12.1sup1/259

Schermelleh-Engel, K., Moosbrugger, H., & Müller, H. (2003). Evaluating the fit of structural equation models: Tests of significance and descriptive goodness-of-fit measures. *Methods of Psychological Research Online*, *8*(2), 23-74.

Thakker, S. V., Parab, J., & Kaisare, S. (2021). Systematic research of e-learning platforms for solving challenges faced by Indian engineering students. *Asian Association of Open Universities Journal*, *16*(1), 1-19. https://doi.org/10.1108/AAOUJ-09-2020-0078

Vandenberg, R. J., & Lance, C. E. (2000). A review and synthesis of the measurement invariance literature: Suggestions, practices, and recommendations for organizational research. *Organizational Research Methods*, *3*(1), 4-70. https://doi.org/10.1177%2F109442810031002

Received: *May 22, 2021* Accepted: *September 22, 2021*

Cite as: Gorghiu, G., Pribeanu, C., Manea, V. I., Lamanauskas, V., & Makarskaitė-Petkevičienė, R. (2021). The usefulness of online learning during the Covid19 pandemic as perceived by engineering education students: A multidimensional model. *Journal of Baltic Science Education*, *20*(5), 716-728. https://doi.org/10.33225/jbse/21.20.716

Gabriel Gorghiu	PhD, Professor, Teacher Training Department, Valahia University of Târgoviște, Str. Aleea Sinaia 13, 130004 Târgoviște, Romania. E-mail: ggorghiu@gmail.com ORCID: https://orcid.org/0000-0002-4026-345X
Costin Pribeanu *(Corresponding author)*	Dr., Senior Researcher, Academy of Romanian Scientists, Ilfov, No. 3, Bucharest, Romania. E-mail: costin.pribeanu@gmail.com ORCID: https://orcid.org/0000-0001-8182-5909
Valentina Iuliana Manea	Lecturer, Technical University of Civil Engineering of Bucharest, Bd. Lacul Tei 122-124, 020396 Bucharest, Romania. E-mail: valentina.manea@utcb.ro ORCID: https://orcid.org/0000-0002-5200-2257
Vincentas Lamanauskas	PhD, Professor, Chief Researcher, Vilnius University Šiauliai Academy, Institute of Education, P. Visinskio Street 25-119, LT-76351 Siauliai, Lithuania. E-mail: vincentas.lamanauskas@sa.vu.lt Website: http://www.lamanauskas.puslapiai.lt/; https://www.researchgate.net/profile/Vincentas_Lamanauskas ORCID ID: http://orcid.org/0000-0002-4130-7899
Rita Makarskaitė-Petkevičienė	PhD, Associate Professor, Institute of Educational Sciences, Vilnius University, 9 Universiteto Street, LT-01131 Vilnius, Lithuania. E-mail: rita.makarskaite-petkeviciene@fsf.vu.lt ORCID: https://orcid.org/0000-0003-1653-8094