An Instrument for Evaluation of the Use of the Web Conferencing System BigBlueButton in e-Learning

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Abstract. *The use of web conferencing systems in distant education and e-learning gained very much attention after the onset of the pandemic of the COVID-19 virus, when traditional academic teaching in the classroom was predominantly replaced with synchronous and asynchronous e-learning. After 16th March 2020 at all of the colleges at the University of Zagreb a fully online teaching modality was applied with less than one week of preparation. The predominant web conferencing tools that were used for that purpose were BigBlueButton, Adobe Connect and Zoom. The authors of this paper thus found it opportune to develop an instrument for the evaluation of web conferencing tools used in the context of academic teaching. Therefore, an evaluation instrument was created by combining scales designed to measure selected constructs of the DeLone and McLean IS success model with several constructs from the models of usability and user experience in software use. This paper presents the results of a pilot study of the evaluation of this newly developed instrument and of the BigBlueButton web conferencing system.*

Keywords. E-learning, survey, web conferencing, BigBlueButton, IS success model, usability, user experience, internal consistency, regression analysis

1 The Use of Web Conferencing Systems in e-Learning

Webinars are an important means of distance education and *BigBlueButton* web conferencing tool is commonly listed among the most popular applications for this purpose in related review papers (Černý, 2016). Webinars are widely applied in distance education and learning training programs (Gegenfurtner et al. 2020) as well as in blended online classes (Khechine et al., 2014).

BigBlueButton, Zoom, Adobe Connect and *Skype* can be used not only for the delivery of synchronous video lectures but also in various online learning designs such as, for instance, cooperative learning (Jacobs & Ivone, 2020). Such tools facilitate individualization of the learning process and cooperation in a multi-sited setting (Bernardi et al., 2018).

Web conferencing tools (software) allow different groups of users to conduct remote meetings via the internet. Their most important role is facilitating synchronous audio and video communication of participants in online teaching and learning. Features of web conferencing tools generally include audio calls and video conferencing, screen sharing, collaboration options (live chat, audience pooling, file sharing) and other functionalities like presentation slideshow or meeting recording. These activities increase online student engagement and contribute to student satisfaction with online classes (Kuo et al., 2010).

In our pilot study the *BigBlueButton* (BBB) web conferencing tool was used that was integrated with the Moodle learning management system at the level of one college in the northwestern part of Croatia. *BigBlueButton* (https://bigbluebutton.org/) is open source web conferencing and collaborative software for online learning that enables sharing of audio, video, screen, presentation slides, white board and chat in real time. *BigBlueButton* is an HTML5 client that, when used in Firefox and Chrome browsers, delivers a high-quality, low-latency WebRTC audio. One of the main advantages of *BigBlueButton* is that it can be integrated as a plugin in various types of learning management systems (LMS) such as *Moodle, SmartClass, IServ* or *Sakai*, as well as in content management systems, e.g. *Drupal* or *WordPress*. This web conferencing tool is a professional solution for remote online teaching.

The important features of *BigBlueButton* for educators who use it integrated in *Moodle* LMS are (Moodle, n.d.):

- It enables recording of lessons or meetings and sharing them later with students;
- Teachers can use the whiteboard to annotate most important parts of the presentation which are immediately displayed back to the students in real-time. Highlight, zoom, draw and write options are also available;
- At any time during the use of the system the teacher can download the list of users who attended an online lesson;
- The number of webcams being shared in one session is not limited (it is only limited by bandwidth).

Students using *BigBlueButton* can be more engaged in online lectures through pooling options, sharing of emoji and break rooms, which are perfect for collaborative work. There are two basic types of users in *BigBlueButton* – moderator and viewer. The *moderator* can have a complete control of the session by assigning and, if necessary, taking away user options: making any student presenter, (un)muting users or expelling a student from a session in case of misconduct. The *viewer* (which is a typical role for students) can raise a hand to ask questions, as well as use a public or private chat. Both types of *BigBlueButton* users can join a session using a microphone or/and a webcam.

2 The Importance of Web Conferencing in Fully Online Teaching During the COVID-19 Pandemic

Research regarding the COVID-19 pandemic conducted in 20 countries in 2020 revealed significant challenges for the global higher education community, with adaptive activities by higher education providers ranging from (a) providing no response to social isolation strategies on campus to (b) rapid teaching and curriculum adaptation for fully online education (Crawford et al., 2020). In 2020 *web conferencing tools* have become an inevitable part of teaching activities at all levels of education due to the global COVID-19 virus pandemic. They provided the most immediate and convenient solution for an unprecedented new situation of a lockdown of universities and cessation of traditional education in physical facilities like classrooms and laboratories. In their prompt reaction, most colleges, universities and their teachers turned to technological alternatives and distant learning to appropriately replace classroom teaching with virtual learning environments (for an example of tips for rapid migration to online learning during the COVID-19 pandemic see: Sandars et al., 2020).

The adaptive pedagogical measures after the onset of the COVID-19 pandemic are well denoted by the term "emergency remote teaching" (ERT). According to Hodges et al. (2020.), it represents a temporary change of means of instructional delivery in the classroom to an alternate delivery online mode due to a health crisis. These authors emphasize that in ERT the fully distance-based teaching solutions rapidly replace face-to-face or blended/hybrid courses with a possibility to return to the original format after the crisis has ended. It can be concluded that the primary goals of *emergency remote teaching* are medium-term or long-term when re-creating a "robust educational ecosystem" is concerned, as opposed to immediate or short-term goals in the sense of enabling "quick and reliable temporary access to instruction" until the end of an emergency or crisis.

One way to immediately respond to the challenge of transferring from traditional university lectures in the classroom to fully online lecturing is to use a web conferencing system. It is this approach that was taken by many colleges in the Republic of Croatia after the onset of the COVID-19 pandemic and shutdown of universities beginning on 16th March 2020. The university institutions and their teachers predominantly chose *BigBleButton*, *Zoom* and *Microsoft Teams*. They were among the most popular web conferencing tools at the beginning of 2020 together with *GoToMeeting*, *Bluejeans Meetings*, *RingCentralVideo* and *Google Meet* (TechRadar, 2020).

3 IS Success, Usability and User Experience Models

In this section the *DeLone and McLean model of IS success* as well as the concepts of software *Usability* and *User Experience* will be described to encompass both pragmatic and hedonic aspects of the *BigBlueButton* web conferencing tool from the students' point of view.

In 1992, DeLone and McLean (DeLeone & McLean, 1992) developed an information systems success model that is used as a framework for measuring complex dependent variables in different domains of IS research. The main assumption of this model is that the *quality of the system* directly affects the *use of the system*, i.e. the *intensity* of its use. The baseline model was improved in 2003 by its authors with the newer and innovated model containing the following dimensions in assessing IS performance: *System Quality*, *Information Quality*, *Service Quality*, *Intention to Use*, *User Satisfaction*, and *Net Benefits* (DeLone & McLean, 2003). The newer model was initially developed for the e-commerce context, but has been used in various empirical research in the educational context, e.g. in relation to e-portfolio in education (Balaban et al., 2013), learning management system success (Lin, 2007), blended learning (Ghazal et al., 2018), or e-learning in terms of students' perceptions (Freeze et al., 2019). Considering the constructs and their relationships, the model can be explained as follows: a system can be evaluated in terms of its quality, information and quality of service. These characteristics affect the use or *Intention to Use* the system, as well as *User Satisfaction*. Certain benefits arise from the use of the system. Consequently, "*Net Benefits* have a positive or negative impact on *User Satisfaction* and future use of IS" (Urbach, & Müller, 2014). Furthermore, the creators of the model believe that the selected/proposed dimensions of information systems success should be observed through their interrelationships rather than independently, and they also indicate the temporal and causal interdependence of dimensions (DeLone & McLean, 2003). *Information Quality* is a dimension related to measuring the quality of the output of an information system, which, in case of the pilot research presented in this paper, is the *BigBlueButton* system. In literature, this dimension has been highlighted as key for measuring *performance* and its association with *System Use*. The construct of *System Quality* refers to the means of data processing and the view of the system from the perspective of its technical specifications. Due to the changing role of IS and technology development, the *Service Quality* dimension was added in the new IS performance measurement model, although it is partly a subset of *System Quality*. The dimension *Intention to Use* refers

to the purpose and level on which an individual uses the functionalities of the system. In the model, this dimension is two-component: the intention to use is related to the attitude of the user and his future intentions, while (actual) use is related to the behavior of the user. *User Satisfaction* is a construct that refers to how much users like and approve of IS and its results (Petter & McLean, 2009).

The basic function of IS should not be observed only as *utilitarian*, since the *hedonistic* features of the system – how much an individual enjoys using the system – are also important. Because of that, *Usability* and *User Experience* concepts should also be considered when examining *BigBlueButton* and other web conferencing tools. The traditional *Usability* framework looks at an individual's work in interaction with the technology, while *User Experience* models go beyond the utilitarian aspects of interaction (see: Law et al., 2009). A frequently used method for evaluating *Usability* and also, to a certain degree, *User Experience*, are Nielsen's heuristics which assess: (1) the visibility of system status, (2) consistency between the system and the real world, (3) control and freedom of users, (4) consistency and standards, (5) error prevention, (6) recognition versus recall, (7) flexibility and efficiency of use, (8) aesthetics and minimalist design, (9) helping users recognize, diagnose, and resolve errors and (10) assistance and documentation (Nielsen, 1994). *User Experience* extends the concept of *Usability* beyond efficiency, effectiveness and satisfaction. According to ISO 9241-210 (2010), *User Experience* includes all user emotions, beliefs, preferences, perceptions, physical and psychological reactions, behaviors and achievements that occur before, during and after the use of a product, system or service.

4 Methodology

This pilot study had two main research goals: to develop a preliminary version of a survey (questionnaire) with scales designed to measure relevant constructs that could be suitable for the evaluation of web conferencing tools that can be used for *synchronous distant learning* in higher education, as well as to evaluate one of those tools in detail, namely the *BigBlueButton* system.

4.1 Instrument

After an extensive literature review, the authors of this paper developed a measurement instrument to investigate (1) the applicability of the web conferencing tool *BigBlueButton* in synchronous online teaching and (2) the experiences of students who attended online lectures delivered with *BigBlueButton*. This new measurement instrument was created on the basis of selected constructs from the theoretical backgrounds of: (a) DeLone and McLean IS success model, (b) *Usability* and (c) *User Experience*. This measurement instrument was in form of a survey with assessment scales. The first part of the survey consisted of socio-demographic questions, while the rest of the survey included rating scales with questions related to the experiences and evaluations of the *BigBlueButton* system and the courses students attended after the onset of the COVID-19 pandemic in which *BigBlueButton* was used. This part of the survey included students' rating of quality, functionality and usability of the *BigBlueButton* system which was used as the main web conferencing application in online teaching at one college in the northwestern part of Croatia from 16th March 2020 until the end of the summer semester of the 2019 /2020 academic year. In all of the rating scales the same five-point Likert-type response scale was used ranging from "1 – *I don't agree at all*" to "5 – *I totally agree*".

In the continuation of this section the selected constructs (variables) from the *DeLone and McLean IS success model*, as well as from *Usability* and *User Experience* research, will be specified with an example of one of the items from each scale adapted for the evaluation of *BigBlueButton*.

The categories of *Information Quality* that are most commonly measured when the DeLone and McLean IS success model is used are *Accuracy*, *Completeness*, *Consistency*, *Timeliness*, *Comprehensibility*, *Security*, *Personalization*, *Relevance*, *Accessibility* and *Uniqueness of Information* (DeLone & McLean, 2003; Urbach & Müller, 2012). However, for the evaluation of *BigBlueButton* only 6 items were included in the measurement scale (e.g. "*Easy and successful exchange of information between different users was achieved by using the BigBlueButton system"*).

Attributes such as *Tangibility*, *Reliability*, *Response Time* and *Security* from the *SERQUAL* model are characteristic of the *Service Quality* dimension (Pitt et al., 1995). This measurement scale was also adjusted regarding the *BigBlueButton* context to comprise 8 items (e.g. *"The educational processes in which I participated were very well supported by the BigBlueButton system"*). The most common attributes that are evaluated for *System Quality* are *Utility*, *Availability*, *Reliability*, *Customization*, *Flexibility*, *Functionality*, *Ease of Use*, and *Data Quality* (DeLone & McLean, 2003). In our research the related measurement scale included 8 items (e.g. *"BigBlueButton is a reliable system that works without difficulties and errors").*

The *System Usability Scale (SUS)* is a frequently cited instrument for measuring *Usability*. It has gained popularity among HCI (*Human-Computer Interaction*) experts due to its brevity (consisting of 10 items only), confirmed reliability and validity, as well as availability in different world languages (Lewis & Sauro, 2009). In models available in the literature (Nielsen, 1994; Shneiderman & Plaisant, 2010; Shackel, 1991) *Usability* predominantly consists of the following attributes: *Efficiency*, *Effectiveness*, *Suitability for Learning*, *Ease of Memory*, and *Reliability/Safety*. For this research a measurement scale consisting of 9 items was used (e.g. *"I mastered the use of the BigBlueButton system without any difficulties"*).

In technology acceptance models, *Intention to Use* reflects an individual's desire to use a specific technology in the future. *Intention to Use* is criterion variable in this pilot study because it has been proven as a reliable predictor of the actual technology use among students in various educational research contexts (Teo & Zhou, 2014). For the purpose of this study the related measurement scale consisted of 8 items combined from

scales used by other researchers (Park, 2009; Wu & Chen, 2017) (e.g. *"I hope to be able to use the BigBlueButton system in the future as much as possible"*).

The *Cognitive Involvement* scale combined the existing and newly developed items that reflect various constructs that appear in research papers on *User Experience*. In particular, the items in this scale reflect the quick passage of time when doing something interesting, the ability to perform for a longer time an activity which demands concentration, the sense of immersion when being fully mentally engaged in an activity, the little or no effect of distractions when someone is attentive and focused during certain activity, the hedonistic effects of using a technical system (satisfaction and fun), as well as the feeling of control over the functions and reactions of the system. An example of an item from this scale is *"It seems to me that time quickly passes by when I use the BigBlueButton system".* It must be noted that *Cognitive Involvement* is rather scarcely investigated in relation to *Usability* and *User Experience* (Kiili et al., 2014) even though it may be a potential predictor of *Intention to Use*.

The development of the *Design Appeal* scale was inspired by the *User Experience* scale in the research paper by Wani et al. (2017). The *Design Appeal* scale consists of items related to attractiveness and modern design of a user interface, interesting technical features that arouse curiosity, as well as the potential of a system to facilitate creativity and innovation when used. One item from this scale is *"The user interface of the BigBlueButton system appears modern and up-to-date".*

4.2 Subjects

The subjects in our pilot study were 193 students who attended a college in the northwestern part of Croatia. These students were enlisted in three courses at different levels of study: (1) first-year undergraduate course on organizational communication, (2) first-year graduate course on managerial communication and leadership, and (3) second-year undergraduate vocational study course on computer-mediated communication. This was a *convenience sample* with an equal number of students of male and female gender, of which 93.8% were aged 18-23 years, and 97.4% were full time students. Until the beginning of the lockdown at Croatian universities on 16th March 2020 all of the students had participated in traditional university courses at their college which were only partly delivered online. Also, before the lockdown, the students had never attended lectures in the form of *BigBlueButton* webinars since the delivery of synchronous online lectures was not a practice at their college. However, between the beginning of the lockdown and the end of the summer semester of the 2019/2020 academic year most of their courses included synchronous *BigBlueButton* lectures. In fact, *BigBlueButton* was integrated with the college learning management system Moodle, including the possibility to record and playback the sessions.

4.3 Procedure

The survey in our pilot study was conducted after the students had attended the fully online teaching at their college for three consecutive months. The online survey was created in Google Forms and applied from 17th to 25th of June 2020, at the end of teaching in the summer semester of 2019/2020 academic year. The aim of the pilot study was to evaluate the newly developed measurement instrument and investigate how the *BigBlueButton* web conferencing tool performed from the students' viewpoint.

It must be noted that in our survey the students were asked to evaluate the use of *BigBlueButton* at their college in general, that is, the way it performed in all of the courses that they had attended during the lockdown and not only in the three courses (on organizational, managerial and computer-mediated communication) that were selected in the pilot study. Before carrying out the research in our pilot study, the approval of the *Ethics Committee* was obtained. Participation in the online survey was voluntary and anonymous.

5 Results

5.1 Reliability Analysis

To determine if the assessment scales that were developed for the evaluation of the *BigBlueButton* web conferencing system reflect the constructs they were supposed to measure, a reliability analysis was performed. For this purpose, the Cronbach's alpha coefficient was used, with respective alpha values for each scale presented in *Table 1*. The results of the reliability analysis indicate that all of the scales have an acceptable level of reliability. Cronbach's alpha values greater than 0.7 are acceptable for social science research in which the Likert-type scale is used (Gliem & Gliem, 2003). After the intercorrelation of each item with the corrected scale total was inspected, it was also determined that almost all of the items that were included in each of the scales measured the corresponding constructs. In the case of the *Usability* scale, the value of the Cronbach's alpha coefficient, and thus the reliability of the scale, increased significantly (from 0.60 to 0.779) by excluding the item *"I think that I would need to learn a lot of other things before I could get going with using the BigBlueButton system well".* Therefore, this one item was excluded from the *Usability* scale before further data analysis.

Table 1. Cronbach's alpha values for constructs/scales included in the questionnaire (N=193)

Construct label	Number of items in scale	Cronbach's alpha coefficient
Usability (corrected)	7	0.779
System Quality	8	0.827
Information Quality	6	0.878
Service Quality	8	0.836
Cognitive Involvement	8	0.880
Design Appeal	6	0.845
Intention to Use	8	0.904

5.2 Regression Analysis

In this research, a regression analysis was used for the investigation of the relationships between a *dependent* (criterion) variable *Intention to Use* and *predictor* (explanatory) variables: *Usability, System Quality, Information Quality, Service Quality, Cognitive Involvement,* and *Design Appeal*. The regression analysis was employed to determine potential causal relationships between variables that were included in this pilot study. Multiple correlation coefficient (R) is the measure of the strength of association between the *predictor* (explanatory) variables and the *dependent* (criterion) variable. From the results presented in *Table 2*, for the dependent variable *Intention to Use* the obtained R is 0.759, which indicates a strong association between the predictors *(Usability, System Quality, Information Quality, Service Quality, Cognitive Involvement, Design Appeal)* and the dependent variable *Intention to Use*. The R square (R^2) coefficient of determination indicates the percentage of variation in the dependent variable that is shared by predictor variables. More precisely, it indicates the proportion of the variance in the dependent variable that is predictable from the independent variables.

Table 2. Model summary – dependent variable *Intention to Use* (N=193)

Model	R	R square	Adjusted R square	Std. error of the estimate
1	.759[a]	0.576	0.562	0.5212

a. Predictors: (Constant), *Usability, System Quality, Information Quality, Service Quality, Cognitive Involvement, Design Appeal*

To determine which variables were the greatest statistically significant predictors of *Intention to Use* the *BigBlueButton* system, a stepwise regression analysis was performed and its results are presented in *Table 3*. For variables *Cognitive Involvement* and *Design Appeal* the t values were 5.32 and 6.73, respectively, with $p < 0.01$, and are therefore considered as the greatest predictors of the dependent variable *Intention to Use*. The p value for other variables in this regression model was above 0.05. The value of non-standardized coefficients (B) indicates how much the criterion variable *Intention to Use* varies depending on the predictor variables *Cognitive Involvement* and *Design Appeal*. Interestingly, the scales that measured the constructs from the DeLone and McLean IS success model (*System Quality, Information Quality, Service Quality*), as well as the scale that measured *Usabilty*, were not the most influential predictors of *Intention to Use*. This apparently justified the introduction of the scales *Cognitive Involvement* and *Design Appeal* in our pilot study of the use of web conferencing tool *BigBlueButton* for synchronous e-learning. Furthermore, these two scales (that are considered as components of *User Experience*) could be valuable for the evaluation or other web conferencing tools like *Adobe Connect* or *Zoom.*

Table 3. Statistical significance of independent variables and estimated model coefficients (N=193)

Model	Unstandardized coefficients		Standardized coefficients	t	Sig.
	B	Std. error	Beta		
(Constant)	0.569	0.36		1.58	0.11
System Quality	0.044	0.108	0.035	0.41	0.68
Usability	-0.048	0.096	-0.031	-0.50	0.61
Information Quality	-0.013	0.106	-0.01	-0.12	0.90
Service Quality	0.062	0.103	0.048	0.60	0.54
Cognitive Involvement	**0.381**	0.072	**0.374**	**5.31**	**0.00**
Design Appeal	**0.448**	0.067	**0.431**	**6.73**	**0.00**

a. Dependent variable: *Intention to Use*

By calculating the F value shown in *Table 4* we examined how well the overall regression model corresponds to the data set used in this pilot study. From these results it is evident that independent variables from the model statistically significantly predict the dependent variable *Intention to Use* since $F(0.562) = 42.077$, $p < 0.0005$, which means that the regression model is well suited to the data set. As was previously mentioned, stepwise regression analysis was used to predict the dependent variable *Intention to Use* of the *BigBlueButton* system from predictor variables which were statistically significant ($p < 0.01$) – *Cognitive Involvement* and *Design Appeal.*

Table 4. Determining the statistical significance of the model (N=193)

Model	Sum of squares	df	Mean square	F	Sig.
Regression	68.582	6	11.43	42.077	.000[b]
Residual	50.527	186	0.272		
Total	119.109	192			

a. Dependent variable: *Intention to Use*

b. Predictors: (Constant), *Usability, System Quality, Information Quality, Service Quality, Cognitive Involvement, Design Appeal*

5.3 Students' Evaluation of the Web Conferencing Tool *BigBlueButton*

In our pilot study the students were asked to evaluate various aspects of the *BigBlueButton* system by the use of assessment scales that were developed on the basis

of the *DeLone and McLean IS success model*, as well as on literature on *Usability* and *User Experience*. It must be noted that for the students in our convenience sample the *BigBlueButton* system was used in the range from 2 college courses to as many as 6 or more courses (depending on the students' major and year of study) during the lockdown from 16th March 2020 until our survey was started on 17th June 2020. Also, most of the students (69.4%) stated that they had attended a *BigBlueButton* web conference on average 3-4 times a week during this period. Also, most of the students (76.2%) stated that they had spent on average a total of 3-6 hours per week using *BigBlueButton* for all of the courses that they were enlisted in during the summer semester of the 2019/2020 academic year.

The general evaluation of the students' satisfaction with the *BigBlueButton* system and teaching with the use of *BigBlueButton* is presented in *Figure 1*. The Likert-type scale ranging from *"1 – I am exceptionally dissatisfied"* to *"5 – I am exceptionally satisfied"* was used for this purpose. As can be concluded from the data presented in *Figure 1*, as many as 89.7% of students were generally satisfied with the use of the *BigBlueButton* system.

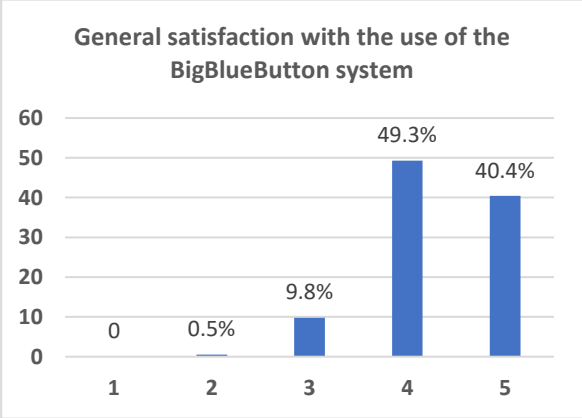

Figure 1. Students' general evaluation of their satisfaction with *BigBlueButton* and teaching with this system; N=193; response scale: from *"1 – I am exceptionally dissatisfied"* to *"5 – I am exceptionally satisfied"*

Students' average responses to selected items of the scales in our online survey/questionnaire which can be used for detailed evaluation of the *BigBlueButton* system are presented in *Table 5*. In all of the ratings of individual items the same five-point Likert-type response scale was used ranging from "1 – *I don't agree at all*" to "*5 – I totally agree*". The average ratings in *Table 5* indicate that, regarding the *Usability* construct, most of the students mastered the use of *BigBlueButton* without difficulties (M=4.62) and many of them found the various functionalities to be well integrated (M=4.21). It must be emphasized that in the continuation of this paragraph, only selected items from the scales in the survey instrument used in our pilot study will be included in *Table 5*.

Table 5. Average responses of subjects to selected items from the scales of the survey instrument (N=193)

Construct	Example of item(s)	Mean	Std. deviation
Usability	I mastered the use of the *BigBlueButton* system without any difficulties.	4.62	.6108
	I find that the various functionalities in the *BigBlueButton* system are well integrated.	4.21	.7830
System Quality	***BigBlueButton* is a reliable system that works without difficulties and errors.**	**3.86**	.899
	In my experience, *BigBlueButtom* is well designed for teacher-student interaction.	4.42	.710
Information Quality	The *BigBlueButton* system made it possible to obtain accurate and relevant information.	4.47	.757
	There was no loss of information when using the *BigBlueButton* system.	**3.98**	.946
Service Quality	**The *BigBlueButton* system worked equally well regardless of the time of its use and the number of concurrent users.**	**3.92**	1.070
	The educational processes in which I participated were very well supported by the *BigBlueButton* system.	4.38	.762
Cognitive Involvement	At all times, I felt that the *BigBlueButton* system would respond quickly and in the right way if I wanted to manage its functions.	4.10	.944
Design Appeal	I like the visual interface design of the *BigBlueButton* system.	4.27	.842
	The technical aspects of using the *BigBlueButton* system seem interesting to me.	4.11	.846
Intention to Use	**I hope to be able to use the *BigBlueButton* system in the future as much as possible.**	**3.78**	.987
	I will strive to get to know well and successfully master all the important functionalities of the *BigBlueButton* system for future use.	4.06	1.008

When selected items from the *System Quality* construct are observed, it must be noted that, while somewhat lower average evaluation was given by the students to reliability and performance without difficulties and errors (M=3.86), the design of *BigBlueButton* for

teacher-student interaction (M=4.42) was rated more favorably.

Having in mind certain items that measure the *Information Quality* construct, the evaluation of potential loss of information was rated less favorably (M=3.98) than the possibility to obtain accurate and relevant information (M=4.47).

When two of the items which are part of the scale designed to measure the *Service Quality* construct are observed, it can be concluded that the support of the educational processes in which the students participated was evaluated with a greater average value (M=4.38) than the performance of the system regardless of time and the number of concurrent users (M=3.92).

The average response to the presented item from the *Cognitive Involvement* scale indicated that students perceived the system as manageable at all times in the way they wanted it to perform (M=4.10), while the average responses to the *Design Appeal* scale suggested that the students liked the visual interface (M=4.27) and found the technical aspects of using the system as interesting (M=4.11).

Finally, regarding the selected items of the *Intention to Use* scale, it is noticeable that the intention to get to know well and successfully master all the important functionalities of the *BigBlueButton* system for future use received a rather high average evaluation (M=4.06), while the item that reflected hope to be able to use the *BigBlueButton* system in the future as much as possible received a somewhat lower average response (M=3.78), which may partly be accounted for by the wording in this item (i.e. "as much as possible" could have been perceived by the students as an overstatement).

It is obvious from the data in *Table 3* that there was a total of 51 items in all of the scales that measured constructs related to *IS success model*, *Usability* and *User Experience* that were included in the survey instrument for our pilot study. However, because of the limited number of pages for this paper, only the average ratings for 13 selected items from those scales are presented in *Table 5*. Still, it can be concluded that the average responses above 4.0 for the items in *Table 5* can be considered as favorable evaluations. This includes the evaluation of the usefulness of the *BigBlueButton* system for teaching/education activities, as well as its technical possibilities and design. Slightly less favorable, but still ranging between M=3.86 and M=3.98, were the evaluations associated with its reliability and working without errors/difficulties, potential for loss of information and stability regardless of time of use and number of concurrent users. In fact, when the students in the survey were asked about the *quality of their internet connection* and potential problems when using the *BigBlueButton* system, a considerable number stated that occasionally the speed of the internet connection was sometimes poor and that they had problems when using the system. In fact, the authors of the pilot study in this paper also experienced occasional brief loss of the audio signal during students' presentations, faculty meetings and responses of students during oral exams using *BigBlueButton*. This was predominantly attributed to slow internet connection of those speakers whose vocalizations were occasionally disrupted with noise and information loss in audio transmissions.

6 Discussion of Results

The pilot study that is presented in this paper was designed with the aim of creating a measurement instrument (survey/questionnaire) for the evaluation of web conferencing tools that can be used for synchronous e-learning like *BigBlueButton*, *Adobe Connect* and *Zoom*. The evaluation of such systems in practical educational use became very important during the lockdown of universities due to the COVID-19 pandemic. According to the Croatian Bureau of Statistics, in the winter semester of 2018/2019 academic year there were 158 thousand students (Croatian Bureau of Statistics, 2019) enlisted in higher education institutions in Croatia and in the academic year 2019/2020 there were more than 12 thousand teachers working in higher education (FTE – *full time equivalent*) on employment contract and contractual agreement basis (Croatian Bureau of Statistics, 2020). It must be emphasized that all Croatian students and their teachers were forced to convert to distance education after March 16th 2020.

At the University of Zagreb, the *BigBlueButton* web conferencing system prevailed at institutions that used Moodle because it could be integrated with this LMS. Therefore, for the pilot study that is presented in this paper the evaluation of measurement scales was performed in relation to *BigBlueButton*. These assessment scales for an online survey were designed according to literature on (a) the *DeLone and McLean IS success model*, (b) *Usability* and (c) *User Experience.* As can be concluded from the data presented in *Table 1*, all of the scales adapted for the evaluation of the *BigBlueButton* system manifested acceptable internal consistency (Cronbach's alpha were in the range from 0.779 to 0.904) and were considered appropriate for data collection and analysis.

As presented in *Table 2* and *Table 3*, a *stepwise regression analysis* was performed with predictor variables (scales) that measured potentially useful constructs for the evaluation of web conferencing tools in synchronous e-learning *(Usability, System Quality, Information Quality, Service Quality, Cognitive Involvement, Design Appeal).* Their association with *Intention to Use* as a *dependent* variable was investigated. In fact, stepwise regression analysis was used to identify the *most influential* predictor variables. Interestingly, when the results of the stepwise regression analysis are observed, the variables from the *DeLone and McLean IS success model* and *Usability* turned out to be of lesser predictive value than *User Experience* variables measured by the newly constructed scales labelled *Cognitive Involvement* and *Design Appeal.* Even though data analyses of the initial application of our measurement instrument indicated that it could be improved for a more detailed forthcoming study (which would include *Zoom* and/or *Adobe Connect* for comparison purpose), it is the

opinion of the authors of this paper that even this early version of the survey (questionnaire) has applicative and scientific value.

The practical use of our 'battery' of scales for the evaluation of web conferencing tools in the educational setting is proven by the data presented in *Table 5*. It specifies how in our pilot study the *BigBlueButton* web conferencing system was evaluated although, due to the limited length of this paper, only average responses of students to *selected items* from the scales of our measurement instrument could be presented as an example of a possible means of evaluation of a distance learning technology. It is common knowledge that many instructional design models that are used in e-learning imply or recommend an *evaluation phase*. Having in mind the number of higher education students and teachers that were forced to use some form of distance learning in Croatia during the summer semester of the 2019/2020 academic year, as well as the likely necessity to repeat the extensive use of e-learning technology at least in a part of the 2020/2021 academic year, evaluation of distance learning technology that was (or can be) used for that purpose should be regarded as an imperative. Our findings regarding how the *BigBlueButton* web conferencing tool performed at one higher education institution in the northwestern Croatia (after the analysis of average students' responses presented in *Table 5*) indicate that it is both applicable and useful, with only minor disadvantages due to a slow internet connection of some users. Firstly, average students' responses to selected survey questions presented in *Table 5* were rather high and, secondly, an inadequate speed of internet connection that some students and teachers experienced from their home is not an issue that a higher education provider could easily compensate for.

7 Conclusion, Limitations of Study and Future Research

Due to the regional onset of the COVID-19 pandemic, at the beginning of the summer semester of the 2019/2020 academic year in Croatia "emergency remote teaching" (ERT) was introduced as a temporary change of the means of instructional delivery in the classroom to an alternate delivery online mode. One of the opportune means for immediately replacing traditional teaching with distance education is the use of web conferencing tools. In our pilot study we demonstrated that this replacement was rather successfully performed in the segment where the web conferencing tool *BigBlueButton* was used as a substitute for classroom teaching at one college in the northwestern part of Croatia. In addition to that, a preliminary version of a measurement instrument with acceptable internal consistency of constituent scales was developed, based on relevant research literature, that could be used for the evaluation of other web conferencing tools (*Adobe Connect*, *Zoom*, etc.) as well as for the evaluation of diverse e-learning tools if properly adapted/modified. Finally, the results of our stepwise regression analysis of predictors of *Intention to Use* indicated that, from the perspective of their successful adoption in the educational settings, web conferencing tools that are used for synchronous distance education could benefit from *User Experience* qualities, e.g. possessing attributes associated with *Design Appeal* and stimulating *Cognitive Involvement* of students.

No relevant limitations of this research were identified by the authors if it is regarded as a pilot study aimed at the evaluation of the *BigBlueButton* web conferencing system in educational settings and creation of an initial version of a survey instrument with scales designed to measure constructs associated with *DeLone and McLean* IS *success model, Usability* and *User Experience*. However, in further research that would aim to reach beyond a pilot study framework a more representative sample of subjects from different higher education institutions should be used.

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