

Exploring the antecedents of the perceived ease of use of an online learning platform during the pandemic

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ABSTRACT

The pandemic generated by the coronavirus COVID19 forced universities to go online. A consequence of the shift to exclusive online education is the intensive use of online learning platforms which brings in front usability aspects. The perceived ease of use is a usability characteristic but also an important driver of technology acceptance. Taking a technology acceptance perspective gives a broader view of the usage of online platforms in the context of the educational process. The objective of this paper is to explore the antecedents of the perceived ease of use of an online learning platform during the pandemic. A model that is featuring content suitability, ease of access, and facilitating conditions as antecedents of the perceived ease of use has been specified and tested on a sample of Romanian university students. The results show that ease of access has the most important influence on the perceived ease of use.

Keywords

Online learning platform, pandemic, perceived ease of use, content adaptation, ease of access, facilitating conditions.

ACM Classification

D.2.2: Design tools and techniques. H5.2 User interfaces.

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INTRODUCTION

The pandemic generated by the coronavirus COVID19 forced universities to go online and shift to online teaching and learning. Although it enabled a safe continuance of the educational process, exclusive online education has many disadvantages, such as lack of face-to-face interaction, lack of motivation and engagement, frustration, and stress [1, 8, 22].

The shift to online education brought in front online platforms. Although most universities already had an LMS (Learning Management System), this was mainly used for the distribution of assignments and additional learning content.

From the point of view of usage, exclusive online teaching and learning have two main consequences. First, students are usually dealing with two platforms: one for online teaching and exams (e.g. Zoom, Microsoft Teams) and another for online learning and assignments (e.g. Moodle, Google Classroom). Second, although most of them were familiar with online educational platforms, exclusive online education leads to more intensive use. Therefore, providing an easy-to-use e-learning system becomes an important

challenge for universities that has an impact on the adoption and actual use [24, 25].

The *Technology Acceptance Model* (TAM) has been used on a large variety of systems and technologies in education, becoming a framework for the acceptability of technology in education institutions [13]. Technology acceptance is driven by various factors, among which the main drivers are the *perceived ease of use* and the *user's motivation* [9]. Apart from those main drivers, TAM may include various external variables, as antecedents of the perceived ease of use and motivation [13, 15, 16, 28, 29, 30].

Perceived ease of use has been defined as a belief that using technology will be free of effort [9]. This suggests focusing on the features that enable an individual to exploit a tool or a device that does not claim an intense effort, being also not bothersome during its use [17].

From the software product quality point of view, ease of use represents a usability characteristic [18]. Perceived ease of use could be analyzed from two perspectives: usability, by using evaluation methods (such as usability inspection or user testing), and technology acceptance, by using model testing.

Taking a technology acceptance perspective gives a broader view of the usage of online platforms in the context of the educational process. Since technology is designed to support an activity, using an online learning platform means learning with the platform, so the perceived ease of use is not limited to the ease of operating the user interface. Rather, it refers to the ease of learning with that platform or more general, to the ease of learning with educational technology. However, especially during the COVID-19 pandemic period, perceived ease of use became one of the most important variables related to the acceptance of technology for teaching and learning [3].

The purpose of this research is to explore the antecedents of the perceived ease of use of a Moodle online learning platform. To do this, a model featuring content suitability, ease of access, and facilitating conditions as antecedents of the perceived ease of use has been tested on a sample of Romanian university students. The next section presents the theoretical background and conceptualization. Then the model testing results are presented and discussed.

BACKGROUND AND CONCEPTUALIZATION

Related work

A recent review on TAM in an educational context has been published by Granic & Marangunic [13]. Their study argued that TAM is a credible model to analyze various

learning technologies. The authors noticed several gaps in the existing research: a lack of focus on the social and cultural contexts, few external variables incorporated into the model, and few measures of actual usage. They also suggested considering other categories of users (teaching staff) and to focus on external variables to better explain students' motivation.

The relationship between HCI and TAM has been the subject of relatively few research papers. Davis [10] analyzed the evolution of TAM in the context of current HCI research and argued that these two streams of research offer complementary perspectives.

A more detailed analysis between technology acceptance and user experience has been done by Hornbaek & Hertzum [15]. They noticed that many studies are neglecting factors related to the system, users, and organizational context. Another remark was that most of the studies are discussing the constructs in conjunction with the intention to adopt the technology and very few in conjunction with the actual use.

Despite the importance of including external variables in TAM models, there are very few papers analyzing the antecedents of the key beliefs: perceived ease of use and perceived usefulness.

The first study addressing this issue has been carried out by Venkatesh and Davis [28]. They analyzed the influence of computer self-efficacy and objective usability in relation to the hands-on experience with the system through three experiments. They found that while computer self-efficacy has been always significant, objective usability had an influence only after the hands-on experience. Later on, Venkatesh and Davis [29] extended the TAM model to TAM2, by including several antecedents of the perceived usefulness: image and subjective norm, output quality and job relevance, and result demonstrability.

Arpaci [5] analyzed the antecedents and consequences of cloud computing adoption in education. Since the analysis has been done in the context of achieving knowledge management, the model included three antecedents of the perceived usefulness (knowledge creation and discovery, knowledge storing, and knowledge sharing) and two antecedents of the perceived ease of use (innovativeness and training & education). The results showed a high influence of two antecedents: knowledge sharing and innovativeness.

Recently, Huang et al. [16] investigated the antecedents of perceived ease of using the Internet for learning. They selected five antecedents: computer self-efficacy, perception of external control, perceived enjoyment, facilitating conditions, and technological complexity. Only the first three antecedents had a significant influence on the perceived ease of use. The highest influence had the computer self-efficacy ($\beta=0.79$) and then the perception of external control ($\beta=0.21$).

The perceived usefulness and ease of use have been explored since Learning Management Systems became platforms strongly involved in recording students' dynamic of learning and monitoring their learning engagement, even though such platforms were considered (in the beginning) as complementary teaching and learning instruments. In this respect, Juhary [19] underlined that students with

positive perceived usefulness and ease of use developed proper and favorable attitudes towards using the LMS. Taking into account those attitudes, it was expressed that students had serious behavioral intentions to use LMS.

In recent work, Pal & Vanijja [25] analyzed the perceived usability of the Microsoft Teams platform using a dual approach: system usability scale (SUS) and TAM. They found similar results between SUS [7] and the perceived ease of use and advocated for interchangeable use of the two constructs which may give useful insights.

SUS has been criticized by Borsci et al. [6] for its lack of unidimensionality and proposed as an alternative a two-factor model.

In another paper [26], two short scales used in HCI research have been examined: UMUX [11] and UMUX-LITE [21]. The analysis highlighted several shortcomings as regards conceptualization, dimensionality, and validity. The perceived ease of use from TAM has been proposed as a better alternative to UMUX and UMUX-LITE since it could reveal useful insights when combined with other related TAM constructs.

Almayah et al. [2] explored the challenges and factors that influence the online learning platforms usage during the pandemic. They found three categories of challenges that relate to financial support, change management, and technical issues. As regards the factors, they distinguished four main drivers of adoption: system quality, self-efficacy, culture, and trust.

From a psycho-pedagogical perspective, the adaptation of the content, educational resources, and teaching methods to the specifics of the online teaching-learning process represents a basic condition for the success of the instructive activity and for stimulating the students' motivation. [24]

The accessibility features and facilities of a learning platform represent important variables in the online environment, and the lack of such features may generate fatigue, frustration, stress, and learning difficulties [22], due to their non-compliance.

Research model and measures

The research model is presented in Figure 1 which includes three antecedents of the perceived ease of use: content adaptation, ease of access, and facilitating conditions.

Content adaptation addresses two important issues: selection and reorganization of content in such ways considered relevant to the field and attractive to students, but also the transposition of the content into a new context-specific digital format.

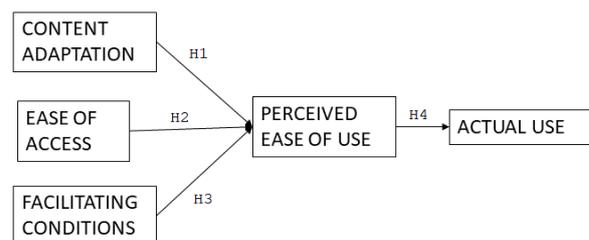


Figure 1. The research model

In the online format, the teacher does not deliver educational content to students similar to teaching in the traditional format but adapts it in a way that allows interaction with students and facilitates the learning process. More specifically, content adaptation refers to the suitability of content for online presentations and the suitability of assignments for online learning. It is expected that the better adapted the content for online learning and teaching the easier it to use will be the learning platform [2, 4, 20].

In the didactic process, in most cases, the use of technology is not an end in itself, but a mean that facilitates content transmission and communication. Therefore, it is important for a learning platform to be easily accessible and to offer multiple facilities that can be capitalized on without too much effort. Ease of access refers to the ubiquitous access and ease to log on to the online learning platform.

Facilitating conditions refer to the availability of resources, such as computer, Internet access, and account on the online platform as well as the knowledge needed to use the online platform. It is expected that students having the conditions to log on and use the platform will perceive it as easy to use [2, 8, 20].

The perception of the ease of access related to a digital platform influences the behavior in using such an environment: students prefer a technology that is fast and easy to use. The ease of access to a learning platform requires several preconditions, mainly the user's developed digital skills.

The following hypotheses are tested in this study:

[H1] Content adaptation has a positive influence on the perceived ease of use (CA → PEU).

[H2] Ease of access has a positive influence on the perceived ease of use (EA → PEU).

[H3] Facilitation conditions have a positive influence on the perceived ease of use (FC → PEU).

[H4] Perceived ease of use has a positive influence on the actual use (PEU → U).

The variables used in this study are presented in Table 1.

Table 1. Variables (N=156)

| Item | Statement |
|------|---|
| CA1 | The content is adapted to online presentation |
| CA2 | Students' assignments received are adapted for the online learning platform |
| EA1 | I can access the online learning platform anytime from anywhere |
| EA2 | Logging on the online platform is easy |
| FC1 | I have the resources to use the online learning platform |
| FC2 | I have the knowledge to use the online learning platform |
| PEU1 | Using the online learning platform is simple |
| PEU2 | My interaction with the online platform is clear and understandable |
| PEU3 | I believe I became productive quickly using the online platform |
| U1 | I log on daily to the online learning platform |
| U2 | I use frequently the online learning platform |

The constructs have been operationalized by adapting the measures from the literature [9, 16, 20, 30].

Method and sample

A questionnaire has been administrated in the second semester of the year 2021/2022 to students from the Valahia University of Targoviste. Students have been asked to answer some general questions such as demographics (age, gender) and enrollment (university, faculty, year of study), then to evaluate items on a 5-points Likert scale.

The model was analyzed with Lisrel 9.3 for Windows [23], using the maximum likelihood estimation method. The analysis has been done in a two-step approach: testing the measurement model (relationships between construct and indicators) for construct validity and then the structural model (relationships between constructs) for model fit and hypotheses checking.

The following criteria have been used to assess the validity of the measurement model: scale reliability by examining the convergent validity through the composite reliability (CR) and average variance extracted (AVE), discriminant validity by comparing the square root of AVE with the correlations between constructs [12], and fit of the model with the data.

Based on the recommendations from the literature [14], the following goodness-of-fit indices were used to assess the model fit: chi-square (χ^2), normed chi-square (χ^2/df), comparative fit index (CFI), goodness-of-fit index (GFI), standardized root mean square residual (SRMR), and root mean square error of approximation (RMSEA).

A total of 161 questionnaires have been received out of which 5 have been eliminated for incomplete data thus resulting in a working sample of 156 observations (46 male students and 110 female students). All students are third-year undergraduates.

EMPIRICAL STUDY

Measurement model

The descriptive statistics, composite reliability (CR), average variance extracted (AVE), and factor loadings are presented in Table 2.

Table 2. Descriptives, convergent validity, and factor loadings(N=156)

| Factor | CR | AVE | Item | M | SD | Loadings |
|--------|------|------|------|------|------|----------|
| CA | .765 | .620 | CA1 | 3.97 | 1.08 | 0.85 |
| | | | CA2 | 3.97 | 1.17 | 0.72 |
| EA | .850 | .742 | EA1 | 4.38 | 1.07 | 0.75 |
| | | | EA2 | 4.38 | 0.99 | 0.96 |
| FC | .924 | .859 | FC1 | 4.40 | 1.02 | 0.87 |
| | | | FC2 | 4.32 | 1.04 | 0.98 |
| PEU | .888 | .729 | PEU1 | 4.27 | 1.02 | 0.93 |
| | | | PEU2 | 4.22 | 1.07 | 0.93 |
| | | | PEU3 | 3.98 | 1.13 | 0.69 |
| U | .867 | .767 | U1 | 3.52 | 1.17 | 0.76 |
| | | | U2 | 3.85 | 1.06 | 0.99 |

Measurement model testing indicated a very good fit of the proposed model with the data: nonsignificant $\chi^2=47.02$, $DF=34$, $p=0.0679$, $\chi^2/DF=1.382$, $CFI=0.989$, $GFI=0.949$, $SRMR=0.0368$, $RMSEA=0.050$.

All observed scores are over the neutral value of 3.00, which shows a positive perception of using the online learning platform. Ease of access was the highest-rated construct with a latent variable mean of 4.38, then the facilitating conditions (4.37), and perceived ease of use (4.16).

All constructs have a very good convergent validity since CR and AVE are much over the thresholds of 0.7 and 0.5 [14]. Based on the recommendations of Fornell and Larcker [12], the discriminant validity has been assessed by comparing the correlations between constructs with the square root of AVE, in Table 3.

Table 3 Discriminant validity (N=156)

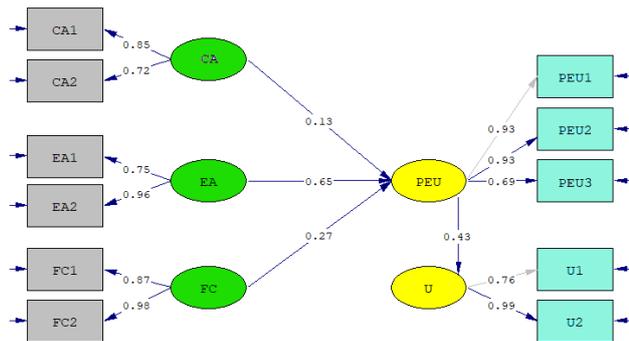
| | CA | EA | FC | PEU | U |
|-----|--------------|--------------|--------------|--------------|--------------|
| CA | 0.788 | | | | |
| EA | 0.340 | 0.861 | | | |
| FC | 0.495 | 0.863 | 0.854 | | |
| PEU | 0.513 | 0.626 | 0.742 | 0.927 | |
| U | 0.145 | 0.370 | 0.440 | 0.350 | 0.876 |

Note: The bold diagonal numbers represent the square root of AVE

As it could be noticed, the constructs have good discriminant validity since, with one exception, the square root of AVE is greater than inter-factor correlations.

Structural model

The structural model estimation results are presented in Figure 2. The goodness of fit indices (GOF) indicate a very good fit of the model with the data: nonsignificant $\chi^2=48.46$, $DF=37$, $p=0.098$, $\chi^2/DF=1.309$, $CFI=0.990$, $GFI=0.948$, $SRMR=0.0404$, $RMSEA=0.045$.



Chi-Square=48.46, df=37, P-value=0.09841, RMSEA=0.045

Figure 2. Model estimation results (N=156)

The hypotheses H1, H2, and H3 are supported since the paths from CA to PEU ($\beta=0.13$, $p=0.026$), EA to PEU ($\beta=0.65$, $p=0.000$), and FC to PEU ($\beta=0.27$, $p=0.000$) are significant. The most important contributor to the perceived ease of use is the ease of access, then the facilitating conditions.

The perceived ease of use has a significant positive influence on the actual use ($\beta=0.43$, $p=0.000$) so hypothesis H4 is also supported.

The model explains 82.6% variance in the perceived ease of use and 18.8% in the actual use of the platform.

Gender analysis

Since the sample is relatively small, it is not possible to analyze gender differences by multi-group confirmatory factor analysis. Table 3 presents the descriptives by gender for the items of the perceived ease of use and its antecedents.

Table 2. Descriptives by gender (N=46/110)

| Item | Male | | Female | |
|------|------|------|--------|------|
| | M | SD | M | SD |
| CA1 | 4.11 | 0.99 | 3.92 | 1.11 |
| CA2 | 4.17 | 1.12 | 3.88 | 1.18 |
| EA1 | 4.09 | 1.28 | 4.50 | 0.95 |
| EA2 | 4.20 | 1.20 | 4.45 | 0.88 |
| FC1 | 4.26 | 1.10 | 4.46 | 0.98 |
| FC2 | 4.04 | 1.19 | 4.44 | 0.95 |
| PEU1 | 4.07 | 1.22 | 4.35 | 0.92 |
| PEU2 | 4.00 | 1.23 | 4.25 | 0.98 |
| PEU3 | 3.89 | 1.18 | 4.02 | 1.11 |

Male students scored higher on the content adaptation items while female students scored higher on the rest of the items. A one-way ANOVA (1,154,155) shows that the differences are statistically significant for EA1 ($F=4.979$, $p=0.027$) and FC2 ($F=4.731$, $p=3.903$).

The higher mean values scored by female students could be explained by the higher importance of the perceived ease of use for technology adoption [27].

Discussion

This study contributes to a better understanding of the perceived ease of use, an important driver of technology acceptance, and suggests ways to improve it. According to TAM, perceived ease of use is an antecedent of perceived usefulness and perceived enjoyment. As such, it may have both direct and indirect effects on the adoption and usage of a given technology.

The effects of the ease of use may go beyond the pragmatic issues and impact the user experience. As shown in a recent study, access issues and the lack of suitability of assignments lead to frustration, fatigue, stress, and learning difficulties [22].

The model testing results show that content adaptation, ease of access, and facilitating conditions are three relevant antecedents of perceived ease of use. These variables together account for more than 80% of the variance explained in the perceived ease of use.

The most important antecedent is the ease of access, which is consistent with the results of several studies that mentioned easy and ubiquitous access to educational activities and learning resources as an advantage of online education [2, 8, 20]. Facilitating conditions is the next

important antecedent and its influence on the ease of use has been also noticed by other studies [16, 20].

The mean values over 4.00 (with one small exception) on a five-point Likert scale show that students have a high perception of both the perceived ease of use and its antecedents. The analysis of mean values shows that content adaptation is the lowest rated construct.

From the psycho-pedagogical perspective, in an effective teaching-learning process, the teacher must select the methods, teaching aids, resources, and contents, and adapt them to the context, personalities, and needs of learners. Such conditions are even more evident in the online environment.

Making content accessible in an online environment requires more attention and effort from teachers: clear and additional information, detailed instructions (accompanied by audio or video support), and willingness to respond to student requests with prompt and accurate feedback.

E-learning is seen as an important part of the teaching-learning process nowadays and in the near future [1, 24, 25], and modern models of education integrate the paradigm and exploit it due to the real benefits that it brings.

There are several limitations of this exploratory study. First, there are inherent limitations of the cross-sectional data. Second, the sample of the research is relatively small and not representative at a national level since students are from only one university and have been enrolled in the same year of study. Third, the antecedents are measured with only two indicators. Another limitation is the gender unbalanced sample suggesting interpreting with caution the results of gender analysis.

CONCLUSION AND FUTURE WORK

The rapid and unexpected changes in education during the pandemic brought in front the online teaching and learning platform as a pre-condition for continuity in education. The facilitating conditions and ease of access of teachers and students to online platforms became critical factors for usage. Moreover, in a short time teachers had to adapt the teaching methods and redesign the educational content to be suitable for online presentations and online learning. In this new context of use, the analysis of antecedents of the perceived ease of use sheds light on specific aspects of the learning process and suggests ways for improvement.

Future research directions will revise the scales and extend the study of external variables of the TAM model, by including antecedents of the perceived usefulness and perceived enjoyment.

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