Acceptance of Pedagogical Agent (PA) enhanced eLearning communities by software engineering students in Southern Africa.

Chikasha, Samuel
KULeuven, Belgium

Van Petegem, Wim
KULeuven, Belgium

Goeman, Katie
KULeuven, Belgium

Valcke, Martin
University Of Ghent

Mbiza, Servious
Zimbabwe Open University

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ABSTRACT

Covid19 outbreak has seen eLearning becoming a viable alternative to the traditional face-to-face teaching globally. Software Engineering education has not been an exception to these changes. The use of multimedia enhanced eLearning communities is also on the increase in the teaching of software engineering. However, there is limited research on the acceptance of such technologies by African learners. Some of the multimedia being used to enhance these learning communities includes animated pedagogical agents (PAs) combining text, animation, audio, and video. Considering learner differences and aiming to achieve personalized learning, there is a need for institutions to understand how such technologies are being accepted by learners and the factors that influence the acceptance. This study focuses on the acceptance of pedagogical agent enhanced eLearning communities by Southern African learners in the teaching of Software Engineering. The aim of the study is to identify the factors that influence the acceptance of such communities. This will help eLearning designers to try and address the needs of learners in different contexts to achieve personalized learning. This study involved 137 software engineering students from South Africa and Zimbabwe who were being introduced to eLearning community enhanced with PAs. The unified theory of acceptance and use of technology2 (UTAUT2) was used in this study. The study revealed that only performance expectancy, and hedonic motivation constructs had an effect on behavioral intention to use these eLearning communities enhanced with PAs.

1 INTRODUCTION

Imagine an online software engineering course in which students learn the content being presented online using a combination of narrated slides, and pedagogical agents (PAs) on the screen, which is are human-like characters intended to facilitate instruction [1] and the learner's learning [2]. The PAs engage in a variety of activities, such as role-playing as characters in a case study or as a fellow learner, helping learners solve problems, asking and answering questions or even providing encouragement. The use of PAs has been on the increase in education. This is due to the increase in the need to animate and keep the learners engaged [3]. Pedagogical agents are frequently integrated in online learning environments because they may be capable of providing cognitive support to the learner and being able to enrich socially the learning experience [4]. Lane, [5] suggested that properly designed and deployed pedagogical agents have a small, but significant impact on learning while [6] said PAs do not improve learning]. With these kinds of conflicting findings on the effect of PA integration, it shows that this area of educational research still needs to be explored further. Other researchers suggested that future research should include the deployment of agents in naturalistic contexts and open-ended environments, and investigation of agent outcomes and implications in long-term interventions [3].

With the technological advancement having led to the development of many efficient methods for innovative pedagogies in the field of education [7], these technological

advancements have seen the adoption of eLearning communities in institutions that used to be face-to-face, and lecturer centered dominated. That traditional teaching was found to have no ability to meet the needs of students' comprehensive practical ability [8]. There is a shift from the traditional approach to a student centric approach in which the learner plays an active role in the learning process. That shift has been taking place at a slower pace prior to 2020, but the emergence adoptions of eLearning due to COVID-19 changed everything. A survey by [7] on engineering education depicts that there is a change in the teaching and learning process from teacher-centric education to learner-centric education.

On learning technologies to support learner centric education, reaerch pointed out that the learning technology might be poorly adopted, discontinued or rejected by learners, due to a number of reasons [9]. This raises the need to investigate acceptance issues associated with the introduction of new technologies in different educational contexts.

There is limited research evidence on adoption of these learning technologies in Southern Africa. As the issue of learner motivation and engagement remain topics of interest for researchers [10], there is need for such research even so in the African context and in the study domain of software engineering.

With the shift towards technology driven education for the achievement of personalized learning, a lot of innovative ideas are being implemented in higher education to try and address educational challenges. Some of these initiatives include the use of eLearning communities that are integrated with multimedia in the form of pedagogical agents which may be capable of providing cognitive support to the learner and social enrichment to the learning experience [4]. The acceptance of these technologies needs to be investigated in the context and different study domains to achieve the intended objectives.

The use of these animated pedagogical agents APAs in the study of software engineering requires that acceptance and impact of such technologies be investigated in the context of African learners, hence the focus of this study. The concept of one size fits all approach does not apply when it comes to predicting academic success of technology usage in education [11]. Therefore, there is need to investigate different students' contexts without generalizing using the findings from a different environment.

In the context of student-centered learning in which students are made to realize that it is their responsibility to engage, absorb, and retain while the instructor's job is to prepare an environment in which that can happen [12]. In an attempt to achieve personalized learning in which learning environments are expected to enhance the learning experience by providing tailor-made services based on learner preferences [13], several questions can be asked when technologies are being introduced. Behavioral intention to use blended learning was found to have an effect on the actual usage [14]. The link between behavioral intention and acceptance requires that acceptance be investigated when introducing new technologies in education.

This study focuses on the acceptance of PA enhanced eLearning communities by Southern African learners in the study of software engineering. This study seeks to answer the following key questions:

- Are communities enhanced with PAs accepted by software engineering students?
- What are the factors that influence the software engineering students' behavioral intention to use eLearning communities enhanced with PAs as an elaboration of multimedia?

2 THEORETICAL FRAMEWORK

The theoretical model employed in this research is based on the widely used models of technology acceptance. In particular, this study was based on the UTAUT2 model of [15]. The use of the UTAUT2 model is still scarce when studying learning technology acceptance in higher education contexts [16].

In the interest of selecting an appropriate model covering all constructs in determining Southern African students' intention to use and adoption of eLearning communities enhanced with multimedia in the form of PAs, the UTAUT2 has been found to be the most appropriate theoretical framework for the conceptual model to be used in this study. Following [15], Figure 1 below shows the main constructs in the model, which were proposed as direct determinants of behavioral intention to use Technology.

Very few studies have used UTAUT2 model to investigate the factors that influence the intention to use new technologies in higher education. Some of the studies that used UTAUT2 include [16],[17], however most of these studies were carried out with students outside the African continent.

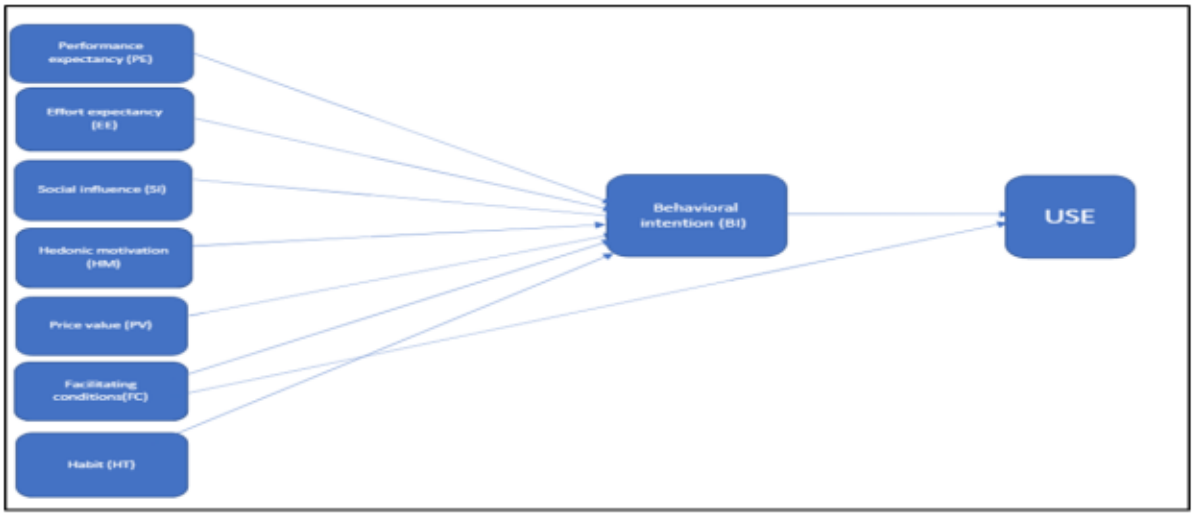

Fig. 1 The UTAUT2 model (Venkatesh et al. 2012)

From the UTAUT2 model two factors namely behavioral intention (BI) and facilitating conditions (FC) were seen as key predictors of adoption behavior [15]. The

discussion of the model's constructs and how they contribute to the study is given below.

Performance expectancy (PE) is a key construct and the strongest predictor of BI to use a technology [15]. In this study, it has been defined as the degree to which students perceive that using eLearning communities enhanced with PAs will enable them to achieve improved performance in their studies.

Effort expectancy EE was found to be a determinant influencing people to BI, [18] and [19]. Wang and Wang [20] also found that constructs associated with EE will be stronger determinants of personal intention to use new technology. This study operationalised EE as the level of easiness related to using the eLearning environment enhanced with PAs.

Social influence (SI) has been operationalized in this study to refer to a student's belief in what significant others expect them to do.

Facilitating conditions (FC), in this study has been thought of as the degree to which students believe there is sufficient organizational and technical infrastructure, to support the use of PA enhanced learning environments in their studies.

Hedonic motivation (HM) is operationalized to mean perceived enjoyment. It refers to the fun, pleasure or enjoyment resulting from the students' use of the technology [21]. Previous research reported that perceived enjoyment significantly influences technology acceptance and use for learning [20].

Price value (PV), was found to be a predictor of Behavioral Intention to use a new technology. That was in other research where it could be operationalized like adoption of mobile phone [22]. PV could not be operationalized in this study because the students were expected to just use this environment for free without any direct costs linked to their use.

Habit (HT) considers results of previous experiences with community usage [15]. However, in this study the learners did not have any previous usage experience of such communities.

Behavioral intention (BI) was found to be a significant determinant behind the actual use of technology in different intention models [15]. In this study it refers to the extent to which students intend (and continue) to use environments enhanced with PAs.

USE behavior (USE), construct was not covered by the scope of this study because this study only focused on the acceptance of the environment. The study is being conducted during the initial stages of introduction to assess how the learners are receiving the new approach.

PV, HT, and Use having them operationalized as the stated above, these construct were excluded from some of previous studies [23],[24]. Although the constructs were also included during data collection. Due to students not being able to cognitively compare the enhanced environment with the financial cost that could be associated with using such an environment [15], and a lack of a lot of experience to talk of habitual behavior, meant that the construct HT could also be dropped. Although data

was collected using all the constructs, it was left for the data analysis to confirm if those constructs were to be dropped or not.

The process of finding the appropriate model that fits the current study confirmed that the three constructs were supposed to be dropped. Model fit was only achieved after dropping the three constructs and a few items from the other PE and BI. This could be because of some challenges in operationalizing those constructs in this study as stated earlier and that could be due to the different circumstances of the learners.

Dropping those suggested constructs meant that the finally adopted model for the study reported in this paper was as shown in figure 2.

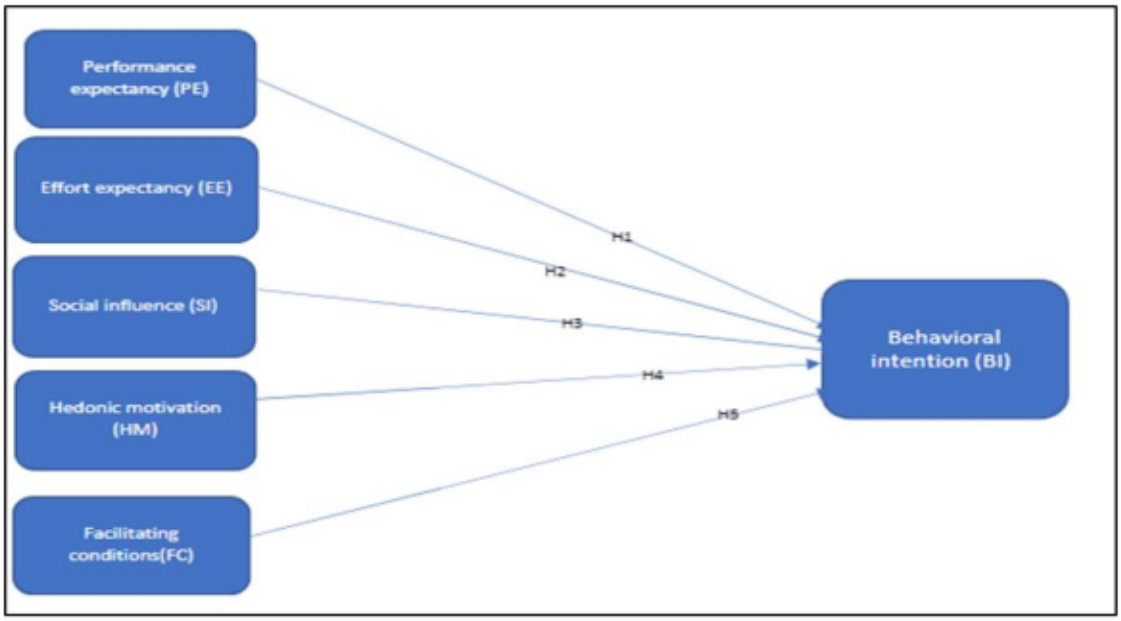

Fig2: Adopted model for the study.

3 HYPOTHESES

Using the given research evidence and according to Fig. 2, for the purpose of this study, the following hypotheses were formulated and tested:

H1: PE has an effect on software engineering students' BI to use PA enhanced eLearning communities.

H2: EE has an effect on software engineering students' BI to use PA enhanced eLearning communities.

H3: SI has an effect on software engineering students' BI to use PA enhanced eLearning communities.

H4. FC has an effect on software engineering students' BI to use PA enhanced eLearning communities.

H5: HM has an effect on software engineering students' BI to use PA enhanced eLearning communities.

4 METHODOLOGY

4.1 Participants and procedure

The sample consisted of 137 software engineering students from universities in South Africa and Zimbabwe as shown in Table 1. A questionnaire was completed by second year students studying at different universities. The participation in the survey was voluntary. The ethical standards of the institutional research committee were followed. The students were informed that the questionnaire is anonymous, and the data collected will be used solely for research purposes (confidentiality and privacy issues were followed). Students who accepted were placed in a WhatsApp group where the link for the questionnaire was posted. Anonymity was guaranteed because no personal information was added when students were submitting their responses.

4.2 The research instruments

The data were collected using the UTAUT2 questionnaire as described by [15]. The same items were operationalized to the context of this study. The questionnaire consisted of two parts. The first part consisted of 32 questions (items) to collect the data about the different constructs. Of the 32 items, 4 items measured PE, 4 items measured EE, 3 items measured SI, 4 items measured FC, 3 items measured HM, 3 items measured PV, 4 items measured HT, 3 items measured BI, and 4 items measured USE behavior. In responding to the items, the students were rating their views on a 5-point Likert-type scale (1 = strongly disagree to 5 = strongly agree). The second part of the survey question 33 and 34, were designed to collect demographic data namely gender and social category. The questionnaire was created and distributed using survey monkey link as well as hard copies. A total of 200 questionnaires we distributed and 148 were returned, 11 of them were not properly completed and were discarded.

The content validity of the questionnaire was evaluated by eleven experts and lecturers in the field of software engineering and information systems development, and blended learning. The questionnaire was found to be reliable; the questionnaire's Cronbach's alpha coefficient was calculated, and it was (0.936).

4.3 Data analysis

In terms of the demographics of the participants, of the 137 students participating in this study, 72.3% were female and 27.7% were male.

The validity of the model was assessed using Amos for both Convergent validity and discriminant validity. For convergent validity, the FL, CA, CR and AVE values were calculated. FL in all items were higher than 0.70. For all constructs, the CA reliability coefficients were higher than 0.70. In addition, the CR and AVE indexes were above 0.70 and above 0.50 respectively for all constructs. The results showed that convergent validity was at an optimal level. The index was evaluated using the square roots of the AVE. The square roots of AVE of factors were found to be greater than the correlational coefficient of the factors; because of that we could

state that there was an excellent discriminant validity. The excellent model that emerged had the values CMIN/DF 1.794, CFI 0.936, SRMR 0.060, RMSEA 0.076, PClose 0.011

Structural Equation Modeling (SEM) was used to analyze the study hypotheses. The significant level was set at P ≤ 0.05. The results of the structural model test are as presented in fig 3 below. The PE (β = 0.144, P = 0.069), EE (β = 0.128, P =0.273), SI (β = 0.080, P = 0.249), FC (β = 0.164, P = 0.216) and HM (β=0.368, P≤ 0.01).

In this model only HM constructs had a significantly positive effect on the students' behavioral intention to use eLearning community enhanced with pedagogical agents. PE was found to be at the borderline considering a P value of 0.05.

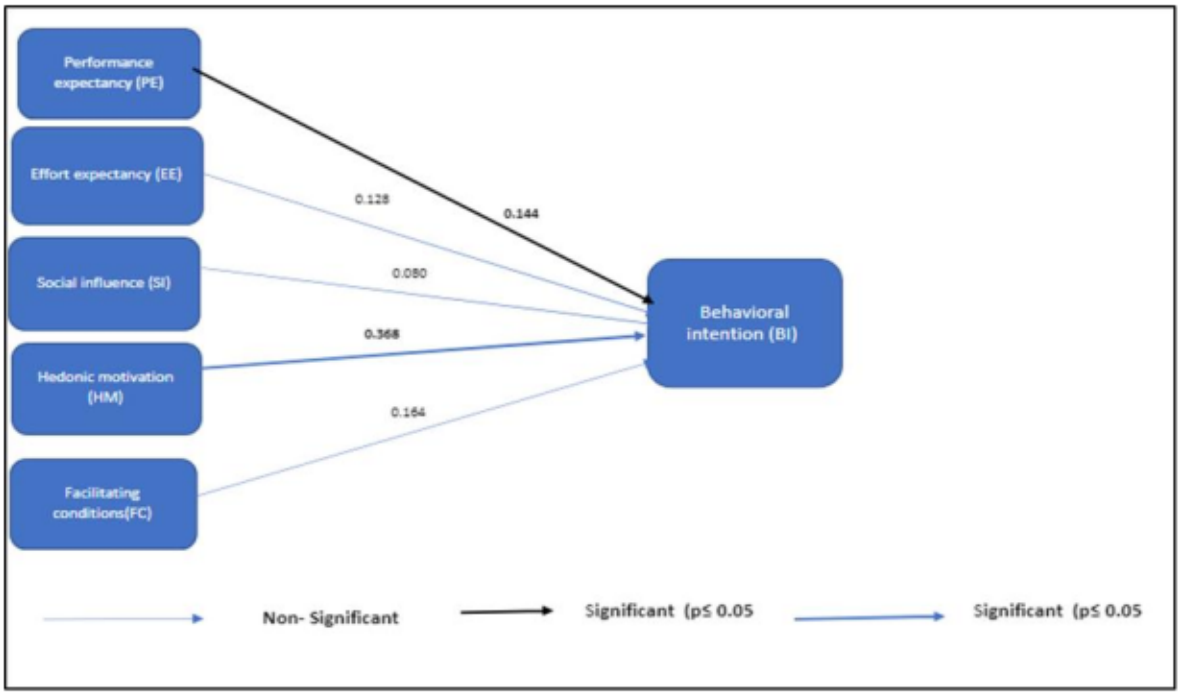

Fig 3: Structural model results

5 DISCUSSION

The results revealed that performance expectancy (PE) had a positive effect on the students' behavioral intention to use such PA enhanced communities. Although this was a border liner, this could be due to the sample size, since only 137 learners were used in this study, this finding was in line with [16] and [17].

The study revealed a significantly positive effect of HM on the students' behavioral intention to use eLearning communities enhanced with PAs. This finding was also in line with findings of [16].

However, EE had no effect on the students' behavioral intention to use communities enhanced with pedagogical agents. These results were in line with other studies that found no effect of EE on behavioral intention to use a new technology [17].

Also, social influence had no effect on the students' behavioral intention to use such communities. This was consistant with [16],[17] who also found the same results.

The findings of this study showed that software engineering students are willing to use eLearning communities that are enhanced with pedagogical agents as an elaboration of multimedia.

This study was not without limitations, some of which include the use of a self-reporting scale to assess the behavioral intention to use the community.

Having found the factors affecting intension to use PA enhanced communities, our suggestions for future work include investigation of the influence of other factors such as gender and social categories on the acceptance of such communities. We therefore recommend investigations to find if the usage of such communities will translate into some forms of educational benefit for the learners.

Caution must be taken when trying to generalize the findings to the whole of African learners and for all study domains, since only software engineering students from South Africa and Zimbabwe universities were involved.

6 CONCLUSION

This study revealed that the model emerged from the unified theory of acceptance and use of technology 2 (UTAUT2) is applicable for studies that seek to investigate the factors influencing the acceptance of eLearning communities designed using alternative elaborations of multimedia in different study domain.

Only PE, and HM, constructs had an effect on behavioral intention to use eLearning communities using pedagogical agents.EE, SI, FC, PV, and HT constructs have no effect on the software engineering students' intention to use such communities. Our findings were consistent with other studies.

This study can be used as a good reference for other studies researching on eLearning community design, multimedia integration, and eLearning acceptance in other study domains.

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