Can Clicking Promote Learning? Measuring Student Learning Performance Using Clickers in the Undergraduate Information Systems Class

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Abstract

Purpose – The purpose of this paper is to explore the impact of factors such as attention, preparation, participation, feedback and engagement on the student learning performance.

Design/methodology/approach – Students of an undergraduate business course of a British university took part in the survey. The survey questionnaire was distributed to students during the revision week of the course and a total of 61 valid responses were gathered from them. The linear regression analysis using SPSS was performed to analyse the data.

Findings – The results indicated the significant relationships for all six hypotheses. The model explains a variance of 43.2% in learning performance, which indicates that independent constructs contribute significantly on the research model's performance.

Research limitations/implications – First, the sample only provide the students' views about the use of clickers in the classroom setting. Second, the sample size for the gathered data is small. Third, the variance explained by the research model is reasonably moderate and hence can be improved further.

Originality/value – This is the first study to explore the impact of factors such as attention, preparation, participation, feedback and engagement on the student learning performance in the UK educational setting.

Keywords: Clickers, Engagement, Feedback, Participation, Attention, Preparation, Learning Performance, Student

Paper Type Research paper

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1. Introduction

Active learning has been an extensively discussed topic in higher education (Freeman et al., 2007; Knight and Wood, 2005; Udovic et al., 2002). The art of teaching uses numerous forms, methods, and techniques, all with the goal of guiding the students through the learning process. One of which, and perhaps the most common, comprises of instructors discussing some type of material in the classroom setting and asking students a series of questions related to the material. The instructor asks a question, the students respond followed by the discussion on the question (Bain and Przybyla, 2009). The enhanced level of discussion and interactivity between students and instructor has become possible only because of such pedagogical technologies. Examples of some of these technologies that have been adopted by educational institutions and that have received widespread attention in prior research include WebCT, Blackboard, Tablet PCs, and instant messaging.

In this study, we focused on clickers that have gradually become an essential part of the student learning experience in some educational institutions and offer a high potential for learning performance improvements (Blasco-Arcas et al., 2013). Within the broad area of study on clickers, various aspects prevent researchers to fully understand their impact on student learning (Kay and LeSage, 2009; Rana et al., 2016). First, current knowledge comes primarily from qualitative analysis where studies largely provide sound guidance and advice about the use of clickers in the educational context. However, such studies provide little direction for understanding the mechanisms through which clickers impact on the student learning process. There is a lack of quantitative research based on strong theoretical development, which would help us better understand the role of clickers in student learning and related performance outcomes (Blasco-Arcas et al., 2013; Fies and Marshall, 2006; Kaleta and Joosten, 2007). Second, there is a lack of reliability and validity that is related to the analysis of the measurement instruments that makes it difficult to have a thorough

understanding of the phenomenon (Kay and LeSage, 2009). Third, although the studies have generically identified how clickers help students improve their attention, course and exam preparation, individual participation, feedback, engagement, learning, etc., none of the studies have empirically explored these factors that influence the students' learning performance.

Only the study by Blasco-Arcas et al. (2013) made an effort to develop a conceptual framework based on interactivity, active collaborative learning, and engagement as the underlying forces that explain the positive influence and benefits of clickers in improving student learning performance. Realising that none of the clickers-based studies have quantitatively analysed the impact of these more commonly used factors (i.e. attention, preparation, participation, feedback, and engagement) to understand students' learning performance, this research is a step forward to fill the existing research gap.

Addressing this gap, our main objective is to examine the influence of clickers on student learning performance. We developed a conceptual model where we found various mechanisms behind the effect of clickers on students' learning performance. We propose that better preparation of the course material and more attention on the instructor's discussion and explanation of the course content during the lecture positively influences the student receiving feedback on their understanding of the lecture content, which eventually leads to their overall learning performance. Similarly, improved student participation leads them to better engage with the course and their superior learning performance.

The data was collected from the second level undergraduate students of a business course, particularly from the two courses on information systems: namely, Business Information Systems and E-Business taught in a similar way by using clickers with the same instructor. Through the current research, we aim to bridge this gap and contribute to existing clickers' research that offers noteworthy implications about the use of clickers for student learning.

2. What are Clickers? Benefits and Drawbacks

Clickers are advanced electronic devices that allow students to instantly respond to questions that are presented in the class. When students respond to a question, a clickers' code appears on the screen and the student knows that his/her response has been recorded straightaway. The software summarises all responses from the students and the results are automatically displayed; usually through a histogram. Responses can be anonymous or linked through a particular student through the unique clicker ID. This allows the instructor to understand who gave the correct or incorrect answers (Blasco-Arcas et al., 2013; Premkumar and Coupal, 2008; Stowell and Nelson, 2007).

Clickers provide significant benefits to both instructors and students (e.g. Bergtrom, 2006; Bullock et al., 2002; Simpson and Oliver, 2007; Yourstone et al., 2008) alike. Through the use of clickers, the instructor benefits from the fact that he or she can measure during the lecture the level of learning that is taking place by students in the classroom setting. The instructor can change his or her presentation style based on the immediate feedback obtained by students during the class to ensure that students better understand the lecture content (Blasco-Arcas et al., 2013; Yourstone et al., 2008). Moreover, using the clickers, the instructor can also capture the proportion of the entire class in terms of who understands which part of the lecture, who does not understand, and who is absent from the class responses (Yourstone et al., 2008).

Clickers are also very effective in promoting interaction among students, providing them immediate feedback on the understanding of the lessons, and helping in the active participation in the learning process through discussing the answer among them and with the instructor (Caldwell, 2007; Martyn, 2007; Stowell and Nelson, 2007). With the clickers system in place, the student recognises that the clickers will be used in every upcoming lecture. This knowledge may lead students to better prepare for the future class as well

(Yourstone et al., 2008). As per Stowell and Nelson (2007), the most apparent benefit of using clickers is the enhanced honesty of student feedback. They further stated the other advantage of clickers as an avenue for interaction with students who feel too shy to speak or even raise their hands in response to any questions or deliberations in the classroom.

Despite these significant benefits, clickers also possess some drawbacks as well. First, even though the price of technology has declined over the years, clickers may still characterise a significant economic cost for some of the educational institutions (Blasco-Arcas et al., 2013; Gagne, 2011). Second, most clickers are limited to multiple-choice questions, which might not be appropriate for obtaining students' views on subjective answer-type questions. Finally, clickers can also generate frustration and dissatisfaction due to their technical glitches like failures and bugs (Blasco-Arcas et al., 2013; McArthur and Jones, 2008) at times. Overall, the significant benefits identified lead us to expect a positive influence of clickers on student learning performance (Blasco-Arcas et al., 2013; Mayer et al., 2009; Stowell and Nelson, 2007; Yourstone et al., 2008).

3. Research Model Development and Hypotheses Formulation

In this study, we postulate a research model (see Figure 1) that classifies key mechanisms through which the use of clickers influences students' learning performance. We propose that student perceptions of giving more attention and better preparation will lead them to attain positive feedback on the course materials during the lecture. Similarly, improved participation and positive feedbacks obtained during the lecture help students to better engage with the course material. Finally, we propose that the positive feedback obtained by the students and their affirmative engagement during the lecture will lead them to an overall learning performance (Blasco-Arcas et al., 2013; Yourstone et al., 2008).

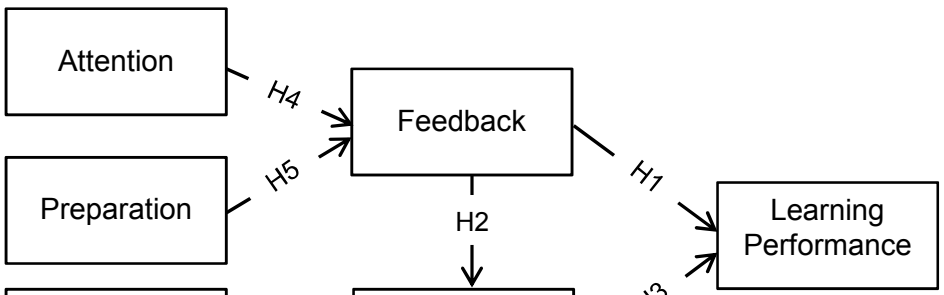

Figure 1. Proposed Research Model

3.1. Hypotheses Development

As illustrated in Figure 1, six hypotheses are proposed based on the relationships between six constructs.

3.1.1. Feedback

Feedback is identified in many learning theories as a key component to successful learning (Hedgcock and Rouwenhorst, 2014). Clickers are superior to the alternative classroom feedback tools or techniques (such as flashcards or hand-raising) in obtaining students' honest responses as they provide both anonymity and accountability (Stowell and Nelson, 2007). This is why they provide the instructor with more accurate feedback about the students' state of knowledge (Buyukkurt et al., 2012). Virtually, clickers collect and categorise student responses to multiple-choice questions, summarise them in accordance with the instructor-provided answer, and provide an instant feedback to the instructor regarding the class's performance. If the students are positive in their responses to a specific question and found out that they opted for the correct answer, the supplied feedback would provide an indication to them that they sufficiently understand the particular topic. On the contrary, if students provide an incorrect response and receive a clear indication that they have yet to master the course content, they invest more effort in learning the material (Chui et

al., 2013; Dunnett et al., 2011; Eastman et al., 2011). Yourstone et al. (2008) also found that the use of immediate feedback using a technology like clickers can have a positive impact on student learning performance as measured by their test scores. It was also argued that the most significant gains in learning can be achieved with more immediate feedback obtained by the students allowing the instructor to better align the delivery of the lecture (Simpson and Oliver, 2007).

Moreover, clickers are believed to enhance student engagement by having students anonymously respond to, and receive feedback on, the questions posed by the instructor (Dunnett et al., 2011). Immediate feedback offered by clickers has been shown not only to engage students more actively in the classroom but also improve their learning performance (Crossgrove and Curran, 2008; Shaffer and Collura, 2009; Stowell et al., 2010; Yourstone et al., 2008). Boyle and Nicol (2003) showed that students reported enhanced engagement when they received positive histogram feedback. From the above discussions about the feedbacks received by students using clickers-based lectures, the following hypotheses can be formulated:

H1: Positive feedbacks received by the students during the lecture enhance their overall learning performance.

H2: Positive feedbacks received by the students during the lecture allow them to better engage with the course content.

3.1.2. Engagement

Engagement has been recognised as a research priority in the learning literature (Fredricks et al., 2004). Currently, a number of authors have acknowledged the multifaceted nature of engagement. While Gallini and Moely (2003) consider dimensions including community, academic and interpersonal engagement, Fredricks et al. (2004) identify behavioural, emotional and cognitive components. This research will consider both approaches defining engagement as the perception of the student that results from his or her attention, interaction,

and personal relationship with peers and instructor during the learning experiences that generates involvement with the course material studied (Anderson, 2003; Fredricks et al., 2002; Gallini and Moely, 2003). Students learn better when they engage in proper cognitive processes (Mayer et al., 2009). High engagement is considered as an accurate and reliable predictor of the learner's achievement and overall performance (Baker et al., 2004; Shernoff and Hoogstra, 2001). On the basis of this discussion, it can be concluded that the use of clickers generates student engagement, which is a significant driver of student learning performance (Blasco-Arcas et al., 2013). Therefore, we hypothesise:

H3: Higher engagement due to the use of clickers in the classroom results in improved student's learning performance.

3.1.3. Attention

The literature constantly suggests that interactive technology (such as clickers) can be very useful in gaining student attention and interest as it provides them the opportunity to share their ideas anonymously (Eastman et al., 2011; Taylor, 2007; Terreri and Simons, 2005). Oswald and Rhoten (2014) reinforced that enhanced attention in the classroom leads to better feedback obtained by the student, which ultimately results into enhanced learning. In a literature review of studies on clickers, Keough (2012) found that clickers helped students to maintain their attention during the class. However, no studies have explored how this attention can impact on the student receiving positive feedbacks on the questions related to the course material during the time of the lecture. We believe that improved attention to the discussion on the course content would lead students to get better feedback in the class. Therefore, we hypothesise:

H4: Proper attention given by students in the clicker-based lecture allows them to receive better feedback on the course material.

3.1.4. Preparation

Clickers offer the efficient way to hold all students accountable for pre-class preparation. Students who are regularly quizzed on the comprehension of the course material prepare more for class (Caldwell, 2007). MacGregor (1990) noted that the interactive technology-based class shifts the student's role from listener and observer to active problem solver and contributor. A clickersbased lecture creates a learning environment with higher expectations for student preparation prior to and after class (Bain and Przybyla, 2009; MacGregor, 1990; Mazur, 1997; Trees and Jackson, 2007). We believe that better preparation of the course material before and after the class not only helps students in better understanding of the course material but also allows them to receive positive feedback on the content covered during the lecture. Such feedback enhances students' overall confidence and contributes positively to their learning experience. Based on the above discussion, the following hypothesis can be formulated:

H5: Student's better preparation for the course material in the clickers-based class results in him/her receiving positive feedback of his/her understanding of the course content.

3.1.5. Participation

Clickers have been found to enhance student participation and engagement in the classroom. The meaning of participation might vary depending on the context in which it is used. Learners and instructors tend to agree that participation in the classroom is a benign concept despite the absence of research into why and how students become engaged (Heaslip et al., 2014). It is usually assumed that learners are engaged simply by being involved in the learning process (Kay and LeSage, 2009). In the literature, participation is often discussed in relation to five distinct elements including preparation, contribution to discussion, group skills, communication skills, and attendance (Dancer and Kamvounias, 2005). Siau et al. (2006) described interactivity as the vigorous involvement and participation of the students in the class. We believe that contribution to discussion (through interactivity) and communication skills are something which constitute a constructive participation in the

multi-cultural classroom setting like the one used in the current research context. Realising the significance of the interrelationship between and given the lack of research that has examined the causal relationship between participation and engagement, we posit the following hypothesis:

H6: Higher student participation in the clicker-enabled class leads students to better engage with the discussion of the course material.

4. Research Methodology

The sample for this study was gathered from level two undergraduate business students of a British university from two similar modules: Business Information Systems (BIS) and E-Business with the class strength of 33 and 51 students respectively. The university gave clickers to every student at the time of their admission. The students primarily used this device for their attendance across all the modules. However, they were also used as an effective tool for teaching and learning across different modules. Clickers use Microsoft's Office PowerPoint in building the content of the module using the TurningPoint application and allows embedding of various multiple-choice questions related to the topic of teaching to enhance student learning.

The sample for this research was obtained from the students of both BIS and E-Business courses. As one author was involved in the teaching of both these modules using the same teaching and delivery style and both these modules are similar in nature, we decided to combine the samples together to validate the proposed research model. We conducted a paper-based questionnaire survey to understand students' perceptions on the 23 various items related to six constructs including attention, preparation, participation, engagement, feedback, and learning performance (see Appendix A). The survey items were measured using the five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). We conducted this survey during the last week of a revision session to achieve the maximum number of students. We distributed this questionnaire to 66 students who attended the revision sessions.

However, five questionnaires were removed from the sample as they were found to be incomplete during the final inquiry. This resulted in the final size of the sample as 61, which made the basis for further data analysis. This research is based on the linear regression analysis of the proposed research model that represents six relationships between five proposed constructs.

5. Results

As per the questionnaire response of the overall 61 responses, male students accounted for 52.5% of the sample whereas 47.5% were female students. In answer to a question asking whether they participated more because their answers are anonymous when using the clickers, 75% of the students said 'yes'. We also asked them whether they would recommend the use of clickers in class lectures to other students and 77.5% students said 'yes' to this question. The findings from these two questions indicate that they want to remain anonymous but also learn more from the use of clickers and so would like to recommend it to the other students. The remaining sections will present the descriptive statistics, regression analysis of the relationships between constructs of the proposed research model.

Descriptive Statistics

Table 1 presents the mean, standard deviation, and Cronbach's Alpha for each construct used in the proposed research model. The mean values for the majority of constructs (except preparation) were found to be close to four on the Likert scale of [1-5] with '5' representing 'strongly agree'. A relatively low mean value (i.e. 3.13) and high SD (i.e. 0.97) for the construct *preparation* indicates that students' overall response for whether clickers encourage them to prepare for the course material was just above the 'neutral' (represented by the value '3' on the Likert scale [1-5] with the greater divergence in the responses. This indicates that users responded favourably about the clickers at large.

Table 1. Mean, Standard Deviation (SD), and Cronbach's Alpha (α) (N=61)

Construct	Mean	SD	Cronbach's Alpha (α)
Attention	4.08	0.58	0.931
Preparation	3.13	0.97	0.844
Participation	3.64	0.57	0.837
Engagement	3.77	0.61	0.848
Feedback	3.85	0.68	0.919
Learning Performance	3.98	0.64	0.932

A reliability analysis was performed for determining the reliability of the scale which provides an indication about the internal consistency of the items measured for the same construct (Hair et al., 1992; Zikmund, 1994). Cronbach's Alpha was computed for reliability analysis and was found beyond the value of 0.80 for all its constructs, which is above its threshold value of 0.70 (Hair et al., 1992; Nunnaly, 1978). Therefore, alphas imply strong reliability for all constructs.

Hypotheses Testing

Table 2 presents the output for the linear regression model analysed using SPSS 20.0. The linear regression analyses were performed on each one of the three dependent variables (e.g. *feedback*, *engagement*, and *learning performance*) separately. The analyses presented in Table 2 supported all six hypotheses. First, constructs *feedback* and *engagement* explain 43.2% (adjusted R^2) variance in student *learning performance*. Since the overall model is significant ($F=15.839$, $p<0.001$), the significance of the independent constructs was further examined. The independent constructs *feedback* ($\beta=0.387$, $p=0.010$) (i.e. hypothesis H1) and *engagement* ($\beta=0.389$, $p=0.010$) (i.e. hypothesis H3) were found to exert positive and significant impacts on student *learning performance* at the 5% significance level.

Second, constructs *attention* and *preparation* explain 30.8% (adjusted R^2) variance in *feedback*. Since the overall model is significant ($F=9.668$, $p<0.001$), the significance of the independent constructs was further examined. The independent constructs *attention* ($\beta=0.332$, $p=0.039$) (i.e. hypothesis H4) and *preparation* ($\beta=0.342$, $p=0.034$) (i.e. hypothesis H5) were found to have positive and significant influence on *feedback* at the 5% significance level.

Finally, constructs *feedback* and *participation* explain 32.6% (adjusted R^2) variance in *engagement*. Since the overall model is significant (F=10.432, p<0.001), the significance of the independent constructs was further examined. The independent constructs *feedback* (β=0.365, p=0.022) (i.e. hypothesis H2) and *participation* (β=0.325, p=0.040) (i.e. hypothesis H6) were found to significantly influence *engagement* at the 5% significance level. The t-values greater than 1.96 for all relationships presented in Table 2 also indicate that all regression coefficients are significant.

Table 2. Regression Coefficients and Hypotheses Testing

Constructs' Relationship	Standardised Coefficients (β)	t-Value	Significance (p)	Hypothesis-Supported (YES|NO)
FDB→LP	0.387*	2.717	p=0.010	H1-YES
FDB→ENG	0.365*	2.386	p=0.022	H2-YES
ENG→LP	0.389*	2.732	p=0.010	H3-YES
ATN→FDB	0.332*	2.142	p=0.039	H4-YES
PRP→FDB	0.342*	2.203	p=0.034	H5-YES
PTP→ENG	0.325*	2.127	p=0.040	H6-YES
R^2(FDB)	0.308	[Legend: p: Significance: *p<0.05, **p<0.01, ***p<0.001]		
R^2(ENG)	0.326			
R^2(LP)	0.432			

Figure 2 shows the validated research model with regression coefficients and the significance of each relationship. It also demonstrates the variance of the model shown on each of the three dependent variables (i.e. *feedback*, *engagement*, and *learning performance*).

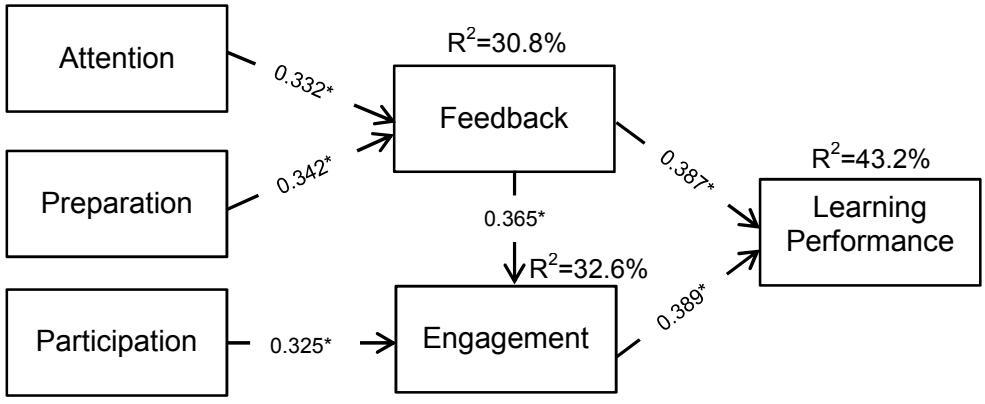

Figure 2. Validated Research Model

A moderately acceptable variance shown by the model on *learning performance* (i.e. 43.2%), *engagement* (i.e. 32.6%), and *feedback* (i.e. 30.8%) indicates that the fundamental

combination of variables used in this research model is adequately significant and determines a reasonable proportion of relevant constructs in the proposed research model.

6. Discussion

Despite the recent research on the impact of clickers in the student learning process, several research gaps remain that prevent us from having a thorough understanding of the phenomenon (Blasco-Arcas et al., 2013). The current research is a step forward toward filling this research gap. The hypotheses testing outcomes indicated that there are moderately acceptable and significant associations between all six relationships in the proposed research model. The regression coefficient outcomes indicated that student feedback and engagement are the positive and significant determinants of their learning performance. Similarly, student feedback is positively influenced by their attention to and preparation of the course material. Also, student engagement is positively impacted by their constructive participation and obtaining encouraging feedback on the course material being taught in the classroom setting.

It is evident from the above analysis that the *feedback* received by the student has a positive and significant impact on his/her *learning performance* (i.e. hypothesis H1) and *engagement* (i.e. hypothesis H2). The prior studies (Draper and Brown, 2004; Higgins et al., 2002; Trees and Jackson, 2007) have argued that feedback provided to students eventually enhances their learning performance. Guthrie (1971) showed that feedback helped student learning when the answer was wrong. A more recent study suggests that when the answers are wrong, it helps the student to break their misconceptions (Tanner and Allen, 2005). We reinforce that irrespective of the case, a student tends to learn more through the instant feedback on the course content being taught by the instructor. If the answer is wrong, the student gets immediate feedback about it and he/she learns it instantly through the logical discussion on why the answer he/she thinks is not correct. If he/she has given the correct answer, his/her learning experience and understanding are going to improve anyway by positively engaging

in the discussion thereafter. The significant impact of feedback on engagement can also be argued on the same line. If the feedback received by the student is not the one he/she thinks, he/she will be more curious to know what the correct answer is and why. Moreover, if the feedback received by the student is the same as it is expected, he/she would be more engaged in discussing it with his/her peers and instructor at large. Boyle and Nicol (2003) have established the correlation between these two variables in their research.

A positive and significant impact of engagement on learning performance (i.e. hypothesis H3) indicates that high engagement is considered as an accurate predictor of continuing motivation, commitment, and overall learning performance (Shernoff and Hoogstra, 2001). Ahlfeldt et al. (2005) argued that higher student engagement improves the richness of the student learning environment that leads to a better student performance in the class. In a recent research, Blasco-Arcas et al. (2013) established the causal relationship between engagement and learning performance and found that higher student engagement leads to their enhanced learning performance.

The positive and significant impact of *attention* on *feedback* (i.e. hypothesis H4) indicates that more focused and improved attention would allow the students to receive positive and encouraging feedback. Although the prior research (e.g. Oswald and Rhoten, 2014) has emphasised that enhanced attention would lead to improved feedback, it is not yet proven through a causal relationship of these constructs. For example, although Cain et al. (2009) established that strategically placed clickers' questions throughout the lectures might help students maintain attention, stay motivated, and receive feedback from instructors, they did not explore how such attention can influence student feedback. Based on the significance of the relationship between *attention* and *feedback*, we argue that the students' improved attention will get them better feedback in the class.

Similarly, the positive and significant relationship between *preparation* and *feedback* indicates that students' preparation (i.e. hypothesis H5) of the class material also helps them to obtain positive and constructive feedback on it. Some of the prior research studies (e.g. Bain and Przybyla, 2009; MacGregor, 1990; Mazur, 1997; Trees and Jackson, 2007) have discussed the importance of student preparation of the class material before and after the class, but its causal relationship on student feedback has not been examined yet. Based on the results, we believe that preparation of the course materials by the students prior to and after the class enhance their knowledge on the topic and make them confident and well-prepared for the positive participation in the class. In such cases, they are certainly expected to receive the positive and constructive feedback on their understanding of the course and making sure that they have developed a similar understanding as expected by the instructor.

Finally, establishing higher student participation leading to better engagement (i.e. hypothesis H6) indicates that the more involved the students are in understanding and discussing the course material the better engaged they would be with it. Prior studies (e.g. Addison et al., 2009; Dunnett et al., 2011) have analysed how clickers allow students to better participate and engage to the course material. However, this is the first research which analyses the causal relationship between these variables. Based on the findings of this research, we argue that the students' better interactivity (through involvement and participation) with the instructor and the students' peers allows them to remain engaged in the class.

6.1. Implications for Theory

This study has some implications for the existing research on clickers in general. First, this is the first proposed research model of its type, which has explored the causal relationships of constructs such as *attention* and *preparation* on *feedback*, *feedback* on *engagement* and *learning performance*, and *participation* on *engagement*. The use of these constructs in the proposed research model will allow researchers to understand the causal relationships

between these constructs with some of them (e.g. *attention* and *preparation* on *feedback* and *participation* on *engagement*) being investigated for the first time through this research. Second, the empirical testing outcomes of the constructs' relationships will allow the researchers to understand the interrelationships of these variables in the other classroom settings as well. Finally, the outcomes of this study using clickers in an information systems context will allow researchers to comparatively understand the impact of such technology in some traditional disciplines (i.e. arts, science, psychology, etc.).

6.2. Implications for Practice

The results of this study will also provide important implications for the instructors of the clickers-oriented courses and management of the university at large to better implement this technology to enhance student learning performance. A relatively moderate though significant impact of feedback on student learning performance indicates that in addition to provide the instant feedback, the instructor should also provide the individual student an electronic feedback through their student ID. This will allow students to go through it later and retrospect if they have made any mistakes. The school/university management has a dedicated group of officials who track the student's attendance using the clickers system. After tracking the presence of the system, the feedback for all the questions should be recorded and compiled together to send it to each student who happens to be present in the particular class. This process will help the student to better understand and retrospect their learning experience during the lecture. The similar regression coefficient and significance provided by *engagement* on *learning performance* indicates that student engagement needs further advancement to improve the overall learning of the students. The instructors should use more examples and pictorial or diagrammatic representations to discuss the course material to students. Such explanation will keep the students motivated toward the discussion.

For consistency, the clickers-based question slides should be kept after every few slides of teaching and discussions. Such technique will not allow the students from digressing away too long from the course content.

The moderate though significant impact of *attention* and *preparation* on *feedback* indicates that students should be given the course slides well in advance to make them fully prepared with the course material to be taught in the class. We believe that the level of attention during the lecture and prior preparation can be expedited by awarding students a fraction of the overall marks for their attempt to better prepare themselves, which would eventually be reflected through their feedbacks and learning outcomes. Similarly, the reasonable impact of *participation* on *engagement* indicates that the school/university management should encourage students to constructively participate in their respective lectures to enhance their overall learning. The school management should arrange some seminars/tutorials to encourage students to organise and participate in such ventures to overcome their problem of shying away from presenting themselves in a confident manner. The management can also make provisions to award those students who stand good and present the topic well during these occasions. Organising such programmes and encouraging students to participate will create more competition among them and motivate them to learn more and perform well during the lecture as well.

7. Conclusion

This study performs the quantitative research on the use of clickers to understand students' learning performance. The study proposed a research model consisting of six constructs and the same number of relationships. The linear regression analysis was performed using SPSS, which found all six hypotheses significant at the levels of 5%. Moreover, the model explains a variance of 43.2% on its core dependent variable called *learning performance*. This clearly indicates that the independent constructs contribute significantly on the model performance.

The theoretical and practical implications provided by this research will help researchers, instructors, and university/school management to constructively use clickers to improve the overall learning of students at different disciplines and levels.

7.1. Limitations and Future Research

First, our sample consists only of students from two different information systems courses and hence only provides students' views about the use of clickers in the classroom setting. Future research can consider both students' as well as teachers' views on its use. Secondly, the sample size gathered to analyse the data was relatively small (i.e. only 61) as this research was mainly focused on the use of clickers in the two relatively small classes on information systems where the methods and techniques of clickers use and teaching were exactly the same as both of these modules were taught by the same instructor. Future research can test the model using an even larger sample. Thirdly, although the variance explained by the model on learning performance (i.e. 43.2%) was reasonably moderate, it would be worth testing this proposed research model with some other learning-oriented variables including motivation, anonymity, attitude, etc. Fourthly, the findings of this research are only limited to the outcomes of the responses provided by the second year undergraduate students in the School of Management at a British university. Future research can test the proposed research model on any other disciplines and levels. Finally, the proposed research model could be further integrated with additional variables including innovativeness, infrastructure and cost to improve its robustness. The future research can include these additional variables along the proposed research model to see how it performs.

References

Addison, S., Wright, A., & Milner, R. (2009). Using clickers to improve student engagement and performance in an introductory biochemistry class. *Biochemistry and Molecular Biology Education*, 37(2), 84-91.

Ahlfeldt, S., Mehta, S., & Sellnow, T. (2005). Measurement and analysis of student engagement in university classes where varying levels of PBL methods of instruction are in use. *Higher Education Research and Development*, 24(1), 5–20.

Anderson, T. (2003). Modes of interaction in distance education: recent developments and research questions. In M. G. Moore, & W. G. Anderson (Eds.), *Handbook of Distance Education* (pp. 129–144). Mahwah, New Jersey: Lawrence Erlbaum Associates Inc.

Bain, L. Z., & Przybyla, J. (2009). The impact of student response systems on student behavior and performance in a management information systems course. *Issues in Information Systems*, *10*(1), 1-12.

Baker, K. Q., Spiezio, K. E., & Boland, K. (2004). Student engagement: transference of attitudes and skills to the workplace, profession, and community. *The Industrial Organizational Psychologist*, 42(2), 101–107.

Bergtrom, G. (2006). Clicker sets as learning objects. *Interdisciplinary Journal of E-Learning and Learning Objects*, *2*(1), 105-110.

Blasco-Arcas, L., Buil, I., Hernández-Ortega, B., & Sese, F. J. (2013). Using clickers in class. The role of interactivity, active collaborative learning and engagement in learning performance. *Computers & Education*, *62*, 102-110.

Boyle, J. T., & Nicol, D. J. (2003). Using classroom communication systems to support interaction and discussion in large class settings. *Research in Learning Technology*, *11*(3), 43-57.

Bullock, D. W., LaBella, V. P., Clingan, T., Ding, Z., Stewart, G., & Thibado, P. M. (2002). Enhancing the student-instructor interaction frequency. *The Physics Teacher*, *40*(9), 535-541.

Buyukkurt, M. D., Li, Y., & Cassidy, R. (2012). Using a classroom response system in an introductory business statistics course: Reflections and lessons learned. In Proceedings of *Informing Science & IT Education Conference*.

Cain, J., Black, E. P., & Rohr, J. (2009). An audience response system strategy to improve student motivation, attention, and feedback. *American Journal of Pharmaceutical Education*, 73(2), 1-7.

Caldwell, J. E. (2007). Clickers in the large classroom: Current research and best-practice tips. *CBE-Life Sciences Education*, 6(1), 9-20.

Chui, L., Martin, K., & Pike, B. (2013). A quasi-experimental assessment of interactive student response systems on student confidence, effort, and course performance. *Journal of Accounting Education*, 31, 17-30.

Crossgrove, K., & Curran, K. L. (2008). Using Clickers in Nonmajors- and Majors-Level Biology Courses: Student Opinion, Learning, and Long-Term Retention of Course Material. *CBE-Life Sciences Education*, 7, 146-154.

Dancer, D., & Kamvounias, P. (2005). Student involvement in assessment: a project designed to assess class participation fairly and reliably. *Assessment & Evaluation in Higher Education*, 30(4), 445-454.

De Gagne, J. C. (2011). The impact of clickers in nursing education: A review of literature. *Nurse Education Today*, *31*(8), e34-e40.

Draper, S. W., & Brown, M. I. (2004). Increasing interactivity in lectures using an electronic voting system. *Journal of Computer Assisted Learning*, 20, 81–94.

Dunnett, A., Shannahan, K., Shannahan, R., & Treholm, B. (2011). Exploring the impact of clicker technology in a small classroom setting on student class attendance and course performance. *Journal of the Academy of Business Education*, 12, 43-56.

Eastman, J. K., Iyer, R., & Eastman, K. L. (2011). Business stu- dents' perceptions, attitudes, and satisfaction with interactive technology: An exploratory study. *Journal of Education for Business*, 86, 36-43.

Fies, C., & Marshall, J. (2006). Classroom response systems: a review of the literature. *Journal of Science Education and Technology*, 15(1), 101–109.

Fredricks, J. A., Blumenfeld, P. B., Friedel, J., & Paris, A. (2002). Increasing engagement in urban settings: an analysis of the influence of the social and academic context on student engagement. *Annual Meeting of the American Educational Research Association*. New Orleans.

Fredricks, J. A., Blumenfeld, P. C., & Paris, A. H. (2004). School engagement: Potential of the concept, state of the evidence. *Review of Educational Research*, 74(1), 59-109.

Freeman, S., O'Connor, E., Parks, J. W., Cunningham, M., Hurley, D., Haak, D., Dirks, C. & Wenderoth, M. P. (2007). Prescribed active learning increases performance in introductory biology. *CBE-Life Sciences Education*, 6(2), 132-139.

Gallini, S. M., & Moely, B. E. (2003). Service-learning and engagement, academic challenge, and retention. *Michigan Journal of Community Service Learning*, 10, 5-14.

Guthrie, J. T. (1971). Feedback and sentence learning. *Journal of Verbal Learning and Verbal Behavior*, 10(1), 23-28.

Hair, J. F., Anderson, R. E., Tatham, R. L., & Black, W. C. (1992). Multivariate data analysis with readings (3rd ed.). New York, NY: Macmillan.

Heaslip, G., Donovan, P., & Cullen, J. G. (2014). Student response systems and learner engagement in large classes. *Active Learning in Higher Education*, 15, 11-24.

Hedgcock, W. H., & Rouwenhorst, R. M. (2014). Clicking Their Way to Success: Using Student Response Systems as a Tool for Feedback. *Journal for Advancement of Marketing Education*, *22*(2), 16-25.

Higgins, R., Hartley, P., & Skelton, A. (2002). The conscientious consumer; reconsidering the role of assessment feedback in student learning. *Studies in Higher Education*, 27(1), 53–64.

Kaleta, R., & Joosten, T. (2007). Student response systems: A University of Wisconsin system study of clickers. *Educause Center for Applied Research Research Bulletin*, 10(1), 12.

Kay, R.-H., & LeSage, A. (2009). Examining the benefits and challenges of using audience response systems: a review of the literature. *Computers & Education*, 53, 819–827.

Keough, S. M. (2012). Clickers in the classroom: A review and a replication. *Journal of Management Education*, 36, 822-847.

Knight, J. K., & Wood, W. B. (2005). Teaching more by lecturing less. *Cell Biology Education*, 4(4), 298-310.

MacArthur, J. R., & Jones, L. L. (2008). A review of literature reports of clickers applicable to college chemistry classrooms. *Chemistry Education Research and Practice*, 9(3), 187-195.

MacGregor, J. (1990). *Collaborative learning: shared inquiry as a process of reform*. In New directions for teaching and learning: the changing face of college teaching, Edited by: Svinicki, M. 19–30. San Francisco, CA: Jossey-Bass.

Martyn, M. (2007). Clickers in the classroom: An active learning approach. *Educause Quarterly*, 30(2), 71-74.

Mayer, R. E., Stull, A., DeLeeuw, K., Almeroth, K., Bimber, B., Chun, D., et al. (2009). Clickers in collage classrooms: fostering learning with questioning methods in large lecture classes. *Contemporary Educational Psychology*, 34(1), 51–57.

Mayer, R. E., Stull, A., DeLeeuw, K., Almeroth, K., Bimber, B., Chun, D., Bulger, M., Campbell, J., Knight, A., & Zhang, H. (2009). Clickers in college classrooms: Fostering learning with questioning methods in large lecture classes. *Contemporary Educational Psychology*, 34(1), 51-57.

Mazur, E. (1997). *Peer instruction: a user's manual*, Upper Saddle River, NJ: Prentice Hall.

Nunnaly, J. (1978). *Psychometric theory*. New York, NY: McGraw- Hill.

Oswald, K. M., & Rhoten, S. E. (2014). Improving Classroom Clicker Practices: Effects of Incentives and Feedback on Retention. *North American Journal of Psychology*, 16(1), 79-88.

Premkumar, K., & Coupal, C. (2008). Rules of engagement-12 tips for successful use of "clickers" in the classroom. *Medical Teacher*, 30(2), 146-149.

Rana, N. P., & Dwivedi, Y. K. (2016). Using Clickers in a Large Business Class Examining Use Behavior and Satisfaction. *Journal of Marketing Education*, 38(1), 47-64.

Rana, N. P., Dwivedi, Y. K., & Al-Khowaiter, W. A. (2016). A review of literature on the use of clickers in the business and management discipline. *The International Journal of Management Education*, 14(2), 74-91.

Shaffer, D., & Collura, M. (2009). Evaluating the Effectiveness of a Personal Response System in the Classroom. *Teaching of Psychology*, 36(4), 273-277.

Shernoff, D. J., & Hoogstra, L. (2001). Continuing motivation beyond the high school classroom. *New Directions in Child and Adolescent Development*, 93, 73-87.

Siau, K., Sheng, H., & Nah, F. (2006) Use of a classroom response system to enhance classroom interactivity. *IEEE Transactions on Education*, 49(3), 398-403.

Simpson, V., & Oliver, M. (2007). Electronic voting systems for lectures then and now: A comparison of research and practice. *Australasian Journal of Educational Technology*, 23(2), 187–208.

Stowell, J. R., & Nelson, J. M. (2007). Benefits of electronic audience response systems on student participation, learning, and emotion. *Teaching of Psychology*, 34(4), 253-258.

Stowell, J. R., Oldham, T., & Bennett, D. (2010). Using Student Response Systems ("Clickers") to Combat Conformity and Shyness. *Teaching of Psychology*, 37(2), 135-140.

Tanner, K., & Allen, D. (2005). Approaches to biology teaching and learning: Understanding the wrong answers—teaching toward conceptual change. *Cell Biology Education*, 4(2), 112-117.

Taylor, P. S. (2007). Can clickers cure crowded classes? *Maclean's*, 120(26/27), 73.

Terreri, A., & Simons, T. (2005). What are they thinking? *Presentations*, 19(2), 36.

Trees, A. R., & Jackson, M. H. (2007). The learning environment in clicker classrooms: student processes of learning and involvement in large university-level courses using student response systems. *Learning, Media and Technology*, 32(1), 21-40.

Udovic, D., Morris, D., Dickman, A., Postlethwait, J., & Wetherwax, P. (2002). Workshop biology: demonstrating the effectiveness of active learning in an introductory biology course. *Bioscience*, 52(3), 272-281.

Yourstone, S. A., Kraye, H. S., & Albaum, G. (2008). Classroom questioning with immediate electronic response: Do clickers improve learning? *Decision Sciences Journal of Innovative Education*, 6(1), 75-88.

Zikmund, W. G. (1994). Business research methods (4th ed.). New York, NY: Dryden Press.

→:Appendix [A]:←

The following questions were asked to respondents on Likert scale [1-5] where [1]=Strongly Disagree and [5]=Strongly Agree: [Legend: ATN: Attention [Eastman et al., 2011]; EN: Engagement [Han and Finkelstein, 2013]; FDB: Feedback [Heaslip et al., 2014]; LP: Learning Performance [Blasco-Arcas et al., 2013; Han and Finkelstein, 2013]; PRP: Preparation [Bain and Przybyla, 2009]; PTP: Participation [Bain and Przybyla, 2009]]

EN1. Having to respond to clickers' questions and feedback improved my attention
EN2. The use of clickers' feedback encouraged me to be attentive to classes
EN3. When using clickers' feedback used in a class I felt more involved
EN4. Using the clickers, I felt that my opinions have been taken into account in this course

EN5. Using the clickers in this course, my peer and faculty interactions made me feel valuable
EN6. Using the clickers, this course has favoured the personal relationships with my peers and teachers
LP1. The use of clickers has improved my comprehension of the concepts studied in class
LP2. The use of clickers has led to a better learning experience in this module
LP3. The use of clickers has allowed me to better understand the concepts in this module
ATN1. Clickers help me pay more attention on what is going on in lecture
ATN2. Clickers are a fun way to review class materials
ATN3. Clickers made me feel more comfortable participating in the course
PTP1. Clickers encourage me to listen during lectures
PTP2. Clickers encourage me to ask questions in class
PTP3. Clickers encourage me to take notes during class
PTP4. Clickers should be used for class participation
PRP1. Clickers encourage me to read the material BEFORE class
PRP2. Clickers encourage me to read the material AFTER class
PRP3. The clicker questions help me prepare for the exams
FDB1. I receive feedback in class on my understanding of the course materials
FDB2. I receive feedback from the lecturer during the class
FDB3. I can gauge whether I am following the course materials during the class
FDB4. I can assess my understanding of the course materials with respect to other students during the class