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Interactively, Active Collaborative Learning, and Learning Performance: The Moderating Role of Having Fun by Using Personal Response Systems

Abstract

The aims of this study were to examine the relationships between interactivity, active collaborative learning, and students' learning performance and to determine whether these relationships were moderated by the level of fun students experience when using personal response systems (PRSs). The participants were 247 undergraduate students studying business at a Hong Kong university. The results indicated that active collaborative learning mediated the relationship between interactivity and students' learning performance. Additionally, high levels of fun experienced as a result of using PRSs strengthened the association between interactivity and students' learning performance.

Keywords: personal response systems, interactivity, fun, active collaborative learning, learning performance

1. Introduction

Academic institutions are continuously integrating new technologies with teaching practices and developing new combinations of information systems to aid teaching and learning. Recently, the use of personal response systems (PRSs) in the classroom has become increasingly popular in academic institutions (Dong, Hwang, Shadiev & Chen, 2017; Dudaite & Prakapas, 2017; Hubbard & Couch, 2018; Katz, Hallam, Duvall & Polsky, 2017). PRSs are widely acknowledged to be a useful tool for enhancing students' usage and learning effectiveness (Rana & Dwivedi, 2018; Wang, 2017). They offer a platform for students to respond to questions and receive feedback for learning and teaching purposes (Latham & Hill, 2014). PRSs not only give teachers a way to deliver content innovatively, but also involve changes to education delivery at various levels.

Empirical studies have found that the use of PRSs helps to increase students' attention and participation, improve their attendance, and enhance their learning performance (Hedgcock & Rouwenhorst, 2014). Blasco-Arcas, Buil, Hernandez-Ortega, and Sese (2013) examined the influence of interactivity, active collaborative learning, and engagement on students' learning performance. Volery and Lord (2000) also found that instructors' characteristics and individual learners' characteristics affect the influence of PRSs on learning performance. Feedback is an important determinant of the effectiveness of PRSs (Lantz & Stawiski, 2014; Rana, Dwivedi, & Al-Khowaiter, 2016). Therefore, the first objective of this study was to examine the relationships between interactivity, active collaborative learning, and students' learning performance.

Researchers have begun to pay attention to other contextual factors that influence the impact of PRSs, offering insights into the key mechanisms underlying

the importance of PRSs to students' learning performance (Blasco-Arcas et al., 2013; Robinson & Kalela, 2006). The motivational roles of enjoyment and fun in learning has become increasingly interested (Manasia, 2015; Tews, Jackson, Ramsay & Michel, 2015). The capacity to experience learning as fun distinguishes superior learners from their less high performing counterparts (Chu, Angello, Saenz, & Quek, 2017). Although having fun while learning is essential (Tews, Michel, & Noe, 2017), there is a need for research work to examine the impact of fun experienced while using PRSs on the relationships between interactivity, active collaborative learning, and students' learning performance. The insights gained into user technology acceptance suggest a new direction for the use of PRSs in academic institutions (e.g. Sun & Zhang, 2006). The second objective of this study was to examine whether students' experience of fun while using PRSs moderated the impact of interactivity on active collaborative learning and students' learning performance.

This study makes two main contributions to the teaching and learning literature. First, this study enriches to the literature of the positive influence of interactivity on students' active collaborative learning and learning performance. The impacts on the role of interactivity to students' learning performance are further examined. Active collaborative learning as a mediator of the role of interactivity and students' learning performance. Second, the study advances the learning and teaching literature on how the level of fun experienced by PRSs may influence the impact of the role of interactivity on students' learning performance. The level of fun students experience by PRSs encourages students to take part in their learning performance (Manasia, 2015). By understanding the interactivity and learning performance relationship, it is important to examine how and why the role of interactivity and the level of fun

experienced by PRSs may influence on active collaborative learning and learning performance.

The following sections report on a literature review conducted to provide a theoretical understanding of the use of PRSs. The relationships between interactivity, active collaborative learning, and students' learning performance are modeled. The section on methodology describes the data collection process and measures used in detail. The results section presents the findings of the study. In the last sections, the findings are discussed and their implications for further research are outlined.

2. Literature Review

Various synonyms have been developed for the term "PRSs," such as "audience response systems," "classroom communication systems," "clickers," "student response systems," and "electronic voting systems." Over the years, however, the term "PRSs" have become prevalent across disciplines such as business, computing, information systems, psychology, mathematics, social work, and engineering (Addison, Wright, & Milner, 2009; Carnaghan, Edmonds, Lechner, & Olds, 2011; Keough, 2012; Lai, Hill, & Ma, 2015; Voith, Holmes & Duda-banwar, 2018; Rana & Dwivedi, 2015). PRSs allow students to respond and interact in classes in a range of disciplines, such as accounting, business, and legal compliance (Eastman, Iyer, & Eastman, 2011; Farag, Park, & Kaupins, 2015). For example, Rana, Dwivedi, and Al-Khowaiter (2016) reviewed a theoretical model and cases of the use of PRSs in the fields of business and management.

Research studies have raised the interest of comparing the design of online courses and the use of PRSs between International and Chinese students (e.g. Wang, 2007; Wong, 2016). Researchers have begun to integrate PRSs to facilitate teaching and learning in Chinese context (Cheung, Wan, & Chan, 2018; Cheng & Wang, 2018; Wang, 2017).

For example, Cheng and Wang (2018) indicated the effect of knowledge in a global economic environment to improve learning performance through classroom response systems in a public university in Hong Kong. Recently, in a sample of Hong Kong students, Wan, Cheung and Chan (2018) explained a deep learning approach to the students' use and acceptance of PRSs. It is believed that promoting interactive activity of using PRSs is promising in the Chinese context.

Masikunis, Panayiotidis, and Burke (2009) examined the changing nature of lectures using PRSs. PRSs benefit students by allowing them to send instant feedback to instructors, allowing instructors to generate responses immediately. PRSs also allow students to respond anonymously to questions in lessons. Students' responses can then be presented in histograms or bar charts (Chien, Chang, & Chang, 2016). Using PRSs, instructors can transform students' responses into material for open discussion during lessons.

PRSs provide support for individual learners by enabling them to share instant feedback (Latham & Hill, 2014), and offer a way of emphasizing new topics (Titman & Lancaster, 2011). Students can participate and learn for their own purposes. They can respond to instructors' questions quickly and anonymously. PRSs encourage students to learn independently and actively contribute to discussion (Boyle & Nicol, 2003). A meta-analysis revealed that PRSs have unique effects on cognition and affect in the classroom (Hunsu, Adesope, & Bayly, 2016). These impacts may be moderated by class size, the use of questions, and knowledge domain (Caldwell, 2007).

3. Hypothesis

3.1 Interactivity and Active Collaborative Learning

Numerous studies have examined the positive impact of interactivity on students' active collaborative learning (Hedgcock & Rouwenhorst, 2014; McDonough

& Foote, 2015). PRSs act as a response tool, facilitating students' interaction in learning. The use of PRSs increases the perceived interactivity of classroom discussion with instructors and peers (Blood & Neel, 2008; Kay & LeSage, 2009). This in turn stimulates and enhances students' interest in collaborative learning. Students gain a better understanding of the learning materials by working at their own pace. Interacting with others through PRSs can dynamically shift students' experience of lessons, encouraging them to learn more proactively.

Interactive learning is an effective two-way learning format that encourages active participation and interaction with others (Shapiro, Sims-Knight, O'Rielly, Capaldo, Pedlow, Gordon, & Monteiro, 2017). During lessons, interactivity motivates students to share information and exchange ideas. Increased interaction gives students more opportunities to contribute to class discussion. After submitting their answers, they receive immediate feedback providing information and correction (Shaffer & Collura, 2009). Interactivity allows instructors to assess students' learning progress, provide feedback, and even reshape the learning format where needed (Draper & Brown, 2004). Instructors can respond to students' input within lessons, promoting more active collaborative learning, engagement, and participation among students. Thus, interactivity is significantly associated with students' active collaborative learning, leading to the following hypothesis.

Hypothesis 1. Interactivity is positively related to students' active collaborative learning.

3.2 Active Collaborative Learning and Learning Performance

Active collaborative learning is a method of encouragement that engages students in active participation in the learning process (McDonough & Foote, 2015; Sun, 2014). It gives students the chance to speak up, listen to others, and reflect on

their own thoughts. To meet high expectations of teaching and learning, students must be clear about their learning goals and the importance of achieving objectives in the learning environment (Bruff, 2009). The use of PRSs is well suited to the sort of format that allows students to work independently. Students benefit from collaborative learning by developing their self-management and interaction skills, self-esteem, and sense of responsibility.

Empirical studies have explored the potential of PRSs to increase students' inclination and ability to respond in class and give them more opportunities to explain and justify the opinions they have raised (Angeli, Valanides, & Bonk, 2003). Kulikovskikh, Prokhorov, and Suchkova (2017) examined the effects of promoting collaborative learning on students' learning performance. Active collaborative learning that encourages students to share their knowledge and experiences definitely fosters a more positive learning performance. PRSs facilitate the process of active collaborative learning and students' contribution to and participation in knowledge creation (Guthrie & Carlin, 2004). Collaborative learning method engages students to work together at various performance levels. When students use PRSs to interact in class, they play an active role in the creation of knowledge. The effect of active collaborative learning on students' learning performance is further enhanced (Stowell & Nelson, 2007; Tlhoaele, Hofman, Naidoo, & Winnips, 2014). Hence the hypothesis below.

Hypothesis 2. Active collaborative learning is positively related to students' learning performance.

3.3 Active Collaborative Learning as Mediator

Research has indicated that interactivity, such as that between teachers and peers, can significantly enhance active collaborative learning and students' learning

performance (Blasco-Arcas et al., 2013). Active collaborative learning encourages students to listen, write, read, and reflect on work together (Han & Finkelstein, 2013). PRSs can keep students alert and provide opportunities for a high level of active learning. Students who actively collaborate in the learning process exhibit greater engagement and attention. They are more engaged with the tasks of responding, synthesizing knowledge, and giving feedback.

PRSs are an innovative learning tool that encourages students to actively engage in classroom knowledge acquisition. Interactivity engenders active collaborative learning and improves learning performance (Yourstone, Kraye, & Albaum, 2008). Students tend to be more active in raising their hands to respond to questions and expressing their views when they receive more attention. When students more actively participate in learning, interactivity is more likely to enhance their learning performance (Blasco-Arcas et al., 2013). Thus, the impact of interactivity on students' learning performance was hypothesized to be mediated by active collaborative learning.

Hypothesis 3. Active collaborative learning mediates the relationship between the role of interactivity and students' learning performance.

3.4 Moderating Effects of Fun Experienced through PRSs

Previous research has reported on the influence of interactivity and active collaborative learning on students' learning performance. However, the antecedents of PRSs and students' learning performance remain unclear (Lucardie, 2014). Fun experienced through PRSs is the extent to which students find the use of PRSs in the classroom fun and enjoyable (Lamm & Meeks, 2009). The use of PRSs can increase students' enjoyment of learning by encouraging them to take part in lessons (Manasia,

2015). Teachers in different classrooms adopt different technological formats and information systems to elicit positive attitudes from students. Lessons are fun when content delivered by PRSs attracts and increases students' attention. Students enjoy the pace and innovativeness of PRSs, and thereby experience their learning as fun (Chu, Angello, Saenz, & Quek, 2017).

In addition, students' preference for PRSs over traditional teaching methods demonstrates the positive relationship between these systems and learning performance. Students who have enjoyed using PRSs are more likely to be motivated to engage in active collaborative learning, enhancing their learning performance (Bolton & Houlihan, 2009). The more fun they have while using PRSs, the more likely they are to engage in active collaborative learning. Students' enjoyment of the learning process and their interaction with others ultimately enhance their learning performance. Experiencing a high level of fun through PRSs helps students to recognize the importance of active collaborative learning, and thus to enhance their learning performance. Hence the following hypothesis.

Hypothesis 4. The positive relationship between interactivity and (a) active collaborative learning, (b) learning performance is stronger when students experience a high level of fun through the use of PRSs.

Figure 1 presents the research model.

Insert Figure 1 about here
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4. Methodology

4.1 Sample and Data Collection

This study collected data from a sample of undergraduate students at the business school of a Hong Kong university. Convenience sampling method was used in the methodology design, which was a type of nonprobability or nonrandom sampling

(Etikan, Musa & Alkassim, 2016). The participants were most suitable when they met the practical criteria for researchers, such as easy accessibility, geographical proximity, availability at a given time or the willingness to participate in the research studies (Dornyei, 2007). Convenience sampling method fit well in the design in targeting university students who were readily available in the lessons with scheduled timetable and in classroom settings. In the current study, the participants are from four classes, who enrolled in management, and human resource management subjects. They were asked to response questions during class time like peer assessment, questions related to course content, revision, by the usage of PRSs in three to four sessions.

The researcher administered the questionnaires during regular classes across a semester and explained the design and purpose of the study to the participants. The participants were invited to spend 15 minutes to complete the questionnaires. They returned the completed questionnaires in class directly, voluntarily, and anonymously. Their responses were kept strictly confidential and the results of the analysis were used for research purposes only.

Of 260 questionnaires distributed to the participants, 247 were returned, with a usable response rate of 95%. Males made up 42% of the sample, and 58.7% and 30% were Year 2 and Year 3 students, respectively. The majority of the participants (87%) had prior experience of using PRSs.

4.2 Measures

The scales used in this study were revised from the literature to fit the context of PRS. Three academic teaching staff helped to review the questions. The researcher collected and incorporated their written comments. A few items in the questionnaire were reworded as a result. Exploratory factor analysis with oblique rotation was used

to assess the construct validity of the independent variables (Hair, Anderson, Tatham, & Black, 1998).

Interactivity. The subset developed by Liu (2003) and McMillan and Hwang (2002) was used to measure interactivity. It comprised four items, with responses given on a scale from 1 (*strongly disagree*) to 5 (*strongly agree*). The items were as follows: "using PRSs in class facilitates interaction with others," "using PRSs in class gives me the opportunity to discuss with others," "using PRSs in class facilitates dialog with others," and "using PRSs in class allows the exchange of information." Cronbach's alpha for interactivity was .85.

Active collaborative learning. So and Brush's (2008) scale was used to measure active collaborative learning. Four items were used, with responses given on a scale from 1 (*strongly disagree*) to 5 (*strongly agree*). The items were as follows: "I felt that I actively collaborated in my learning experience," "I felt that I co-created my own learning experience," "I felt that I had free rein to co-create my own learning experience," and "I felt that I had the freedom to participate in my own learning." Cronbach's alpha for active collaborative learning was .86.

Level of fun experienced through PRSs. Karl, Peluchette, and Harland's (2007) scale was modified to fit the context of PRSs and used to measure the level of fun experienced while using PRSs. Responses to five items were given on a scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). The items were as follows: "this is a fun place to learn using PRSs," "in my classes, we try to have fun when using PRSs whenever we can," "instructors encourage students to have fun using PRSs," "we laugh a lot in my classroom," and "sometimes I feel more like I'm playing than having a lesson." Cronbach's alpha for the level of fun experienced as a result of PRSs was .89.

Learning performance. Learning performance was assessed by technological self-efficacy in PRSs usage. The three items used (1 = *strongly disagree*, 5 = *strongly agree*) (Hollenbeck & Brief, 1987) were "I have mastered the use of PRSs," "I am certain that I use PRSs well," and "I believe that I will be able to use PRSs easily in the future." Cronbach's alpha for learning performance was .89.

Control variables. Gender, year of study, and PRS experience were used as the control variables. Dummy variables were used to represent gender (1 = *male*, 2 = *female*), and whether the participants had PRS experience (1 = *had prior experience*, 2 = *first time using*). Years of study were given as Year 1, Year 2, Year 3, and Year 4.

5. Data Analysis

Means, standard deviations, and correlations for all of the variables are shown in Table 1. Reliability was assessed by computing the internal consistency, the reliability coefficient, for each of the dimensions determined. The coefficients for all six of the factors were above 0.7, indicating an acceptable level of reliability.

Insert Table 1 about here

5.1 Hypothesis Tests

Hierarchical multiple regression was conducted to test the hypotheses, which determined the overall fit (variance explained) of the model and the relative contribution of each of the predictors to the total variance explained. Before the regressions conducted with the control variables into the hypotheses testing, the assumptions of normality, linearity and homoscedasticity were checked among interactivity, level of fun experienced through PRSs, active collaborative learning, and students' learning performance. Also, the multicollinearity of the independent, mediating, and moderating variables has been met, which explains they are not highly

co-related with each other (Hair et al., 1998).

As shown in Table 2, interactivity had a significantly positive influence on collaborative learning ($\beta = .50$, $p < .01$). Thus Hypothesis 1 was supported. Hypothesis 2 predicted that active collaborative learning would be positively related to students' learning performance ($\beta = .47$, $p < .01$). Hypothesis 2 was also supported.

Hypothesis 3 predicted that active collaborative learning would mediate the relationship between interactivity and active collaborative learning. After entering all of the control variables, the independent variable (the role of interactivity) and the mediating variable (active collaborative learning) on dependent variable (students' learning performance) was regressed (Baron & Kenny, 1986). The results showed that interactivity was positively related to active collaborative learning ($\beta = .50$, $p < .01$), meeting the first requirement for mediation. Interactivity had a significantly positive influence on students' learning performance. Therefore, the second requirement for mediation was met. Next, active collaborative learning was entered to test its possible mediating effect on the relationship, as shown in Table 2. Active collaborative learning was found to significantly mediate the relationship between interactivity and active collaborative learning ($\beta = .47$, $p < .01$). After adding the effect of active collaborative learning, the beta of interactivity was less significantly related to students' learning performance ($\beta = .35$, $p < .05$), indicating partial mediation. Hypothesis 3 was partly supported.

Insert Table 2 about here

Hypothesis 4 predicted that the positive relationship between interactivity and (a) active collaborative learning and (b) learning performance would be stronger when the students experienced a high level of fun through PRSs. As shown in Table 2, after

entering all of the control variables, the independent variable (interactivity), and the moderating variable (fun experienced when using PRSs) were added to the model. Interactivity and the level of fun experienced through PRSs had significant interactive effects on (a) active collaborative learning ($\beta = .11$, $p < .01$) and (b) learning performance ($\beta = .12$, $p<.01$). Therefore, Hypothesis 4(a) and 4(b) were supported. The interactive effects of interactivity and fun experienced through PRSs on students' learning performance are plotted in Figure 2. The graphs for their interactive effects on active collaborative learning are largely identical to Figure 2 and are therefore not shown.

Insert Figure 2 about here
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6. Discussion

This study makes two main contributions to the literature. First, the results confirmed earlier evidence of the relationships between interactivity, active collaborative learning, and students' learning performance (Hedgcock & Rouwenhorst, 2014; Hubbard & Couch, 2018). As an instructional method, the use of PRSs engages students in the learning process and provides support for collaborative, cooperative, and problem-based learning (Prince, 2004). Interactivity is in turn enhanced by increasing active collaborative learning, improving students' learning performance. As the cultural differences of open learning and problem-solving learning approaches were existed between Western and Chinese university students, students in the context of Hong Kong were less likely to participate in class discussion (Bista, 2015; Wong, 2016). On the contrary, results indicated that active collaborative learning plays an important role in the role of interactivity to students' learning performance. Students would take a more active role in learning and promote class participation by PRSs, and thereby achieve better learning performance in the Hong Kong context.

Second, this study filled a research gap by exploring the level of fun students experience by PRSs on students' learning performance (Tews, Jackson, Ramsay, & Michel, 2015; Wang, 2007). Consistent with previous studies (e.g. Tews, Michel, & Noe, 2017), the level of fun students experience by PRSs does promote collaborative learning and learning performance. Students experience fun by using PRSs tended to be in a group-oriented learning rather than individual-oriented learning among students in Hong Kong (Wong, 2016). Students will perceive their learning performance by PRSs to be more group-oriented and believe that their academic institutions are more active in collaborative teaching and learning (Dufresne et al, 1996). As research works to support the interest of PRSs were not limited in the context of Hong Kong (Fies & Marshall, 2006), this study provides additional insights into the use of active collaborative learning methods in academic institutions.

6.1 Theoretical and Managerial Implications

In terms of theoretical implications, firstly, this study explains the importance on the role of active collaborative learning between interactivity and learning performance. Results indicated that the relationships among interactivity, active collaborative learning and learning performance are significant. Interactivity is shown to have a significant positive effect on learning, offering an effective approach at different educational levels. This study develops a theoretical model to explain the mechanism between interactivity and learning performance in the context of PRSs.

Secondly, this study contributes to the literature by examining the level of fun experienced by using PRSs between interactivity, active collaborative learning, and learning performance. Results showed the importance of the role of fun experienced by using PRSs to the students in learning performance. The enjoyable use of PRSs seems to arouse positive performance toward learning among students, making them

more willing to perform class activities through active participation and discussion with others. This suggests that instructors should paid more attention to design the content and usage of PRSs in class, and help students to experience having fun by using PRSs in the lessons.

Thirdly, in line with previous studies to collect data from Hong Kong students (Cheng & Wang, 2018; Wan, Cheung, & Chan, 2017), results supported the use of PRSs would increase students' learning performance. The research further validated the impact of interactivity, active collaborative learning and learning performance in the context of Hong Kong. To a large extent, the results were consistent with the research works of PRSs across Western and Chinese students in which students are keen in using PRSs in teaching and learning (Wong, 2016).

In terms of managerial implications, by the usage of PRSs, the role of interactivity can help to prompt students' active collaborative learning and improve their learning performance. Academic institutions would encourage instructors to introduce PRSs in classes. This study provides new insights for instructors that Chinese students are keen on using PRSs. Students are positive to have fun by using PRSs in responding questions in class. Students who participate in learning through PRSs enjoy better learning experiences and performance. Moreover, this study highlights the importance of experienced fun by using PRSs in promoting learning performance. Practitioners and instructors should provide resources and support to create a fun learning environment.

6.2 Limitations and Future Research

The study had several limitations. First, the data were collected from a single source, i.e. self-reported by business students from a Hong Kong university, using a cross-sectional design. The results may not be generalized in different universities and

contents in different subjects, given the culturally specific setting in teaching and learning. Future researchers have to consider the difference in learning styles and preference between Western and Chinese students (Wong, 2016). Second, convenience sample was used as the sampling design in this study. The researchers might be subjective and bias in choosing the participants. It should be acknowledged that a random, larger, and more comprehensive sample of university students in other contexts as future studies would overcome this sampling limitations (Etikan, Musa & Alkassim, 2016). Third, the data were collected from students who had experience of using PRSs in class. Future studies should treat experienced and non-experienced PRSs users as control groups for analysis. Comparing these two groups will aid understanding of the benefits to students of experiencing fun through PRSs. Fourth, the study examined only active collaborative learning as the variable mediating the relationship between interactivity and students' learning performance. Researchers should examine other potential mediators of the influence of interactivity on students' learning performance, such as engagement. Future works should conduct longitudinal research on the impacts of PRSs on students' learning performance.

7. Conclusion

In conclusion, this study provides new insights into the relationships between interactivity, active collaborative learning, and students' learning performance. It shows that experiencing a high level of fun through the use of PRSs strengthened the relationship between interactivity and students' learning performance. Instructors should encourage students to enjoy studying and give them the opportunity to have fun through the use of PRSs for teaching and learning.

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.

Angeli, C., Valanides, N., & Bonk, C.J. (2003). Communication in a web-based conferencing system: The quality of computer-mediated interaction. *British Journal of Educational Technology, 34*(1), 31–43.

Baron, R. M., & Kenny, F. A. (1986). The moderator-mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. *Journal of Personality and Social Psychology, 6,* 1173–1182.

Bista, K. (2015). Asian international students' college experience: Relationship between quality of personal contact and gains in learning. *Journal of International & Global Studies, 6*(2), 38-54.

Blasco-Arcas, L., Buil, I., Hernandez-Ortega, B., & Sese, F. J. (2013). Using clickers in class. The role of interactivity, active collaborative learning, and engagement in learning performance. *Computers & Education, 32,* 102–110.

Blood, E., & Neel, R. (2008). Using student response systems in lecture-based instruction: Does it change student engagement and learning? *Journal of Technology and Teacher Education*, *16*(3), 375–383.

Bolton, S. C., & Houlihan, M. (2009). Are we having fun yet? A consideration of workplace fun and engagement. *Employee Relations, 31*(6), 556–568.

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

Bruff, D. (2009). *Teaching with classroom response systems: Creating active learning environments*. San Francisco, CA: Jossey-Bass.

Buil, I., Catalan, S., & Martinez, E. (2016). Do clickers enhance learning? A control-value theory approach. *Computers & Education*, *103*, 170–182.

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

Carnaghan, C., Edmonds, T. P., Lechner, T. A., & Olds, P. R. (2011). Using student response systems in the accounting classroom: strengths, strategies, and limitations. *Journal of Accounting Education*, *29*(4), 265–283.

Cheng, L.T.W., & Wang, J.W. (2018). Enhancing Learning Performance Through Classroom Response Systems: The Effect of Knowledge in a Global Economic Environment. *Journal of teaching in International Business*, 29(1), 49-61.

Cheung, G., Wan, K., & Chan, K. (2018). Efficient Use of Clickers: A Mixed-method inquiry with university teachers. *Education Sciences*, 8(1), 31-45.

Chien, Y. T., Chang, Y. H., & Chang, C. Y. (2016). Do we click in the right way? A meta-analytic review of clicker-integrated instruction. *Educational Research Review*, *17*, 1–18.

Chu, S. L., Angello, G., Saenz, M., & Quek, F. (2017). Fun in making: Understanding the experience of fun and learning through curriculum-based making in the elementary school classmate. *Entertainment Computing, 18,* 31–40.

Dong, J.K., Hwang, W.Y., Shadiev, R., & Chen, G.Y. (2017). Pausing the classroom lecture: The use of clickers to facilitate student engagement. *Active Learning in Higher Education*, 18(2), 157-172.

Dornyei, Z. (2007). *Research methods in applied linguistics*. New York: Oxford University Press.

Draper, S. W., & Brown, M. I. (2004). Increasing interactivity in lectures using an electronic system. *Journal of Computer Assisted Learning, 20*(2), 81–94.

Dudaite, J., & Prakapas, R. (2017). The experience of teachers in the application of ActivInspire Interactive Evaluation System in classroom: A case of Teachers in Lithuania. *Informatics in Education*, 16(2), 181-195.

Dufresne, R.J., Gerace, W.J., Leonard, W.J., Mestre, J. & Wenk, L. (1996). Classtalk: A classroom communication system for active learning. *Journal of Computing in Higher Education*, 7, 3-47.

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

Etikan, I., Musa, S.A., & Alkassim, R.S. (2016). Comparison of convenience sampling and purposive sampling. *American Journal of Theoretical and Applied Statistics*, 5(1), 1-4.

Farag, D. M., Park, S., & Kaupins, G. (2015). Faculty perceptions of the adoption and use of clickers in the legal studies in business classroom. *Journal of Education for Business*, *90,* 208–216.

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

Hair, J. E., Anderson, R. E., Tatham, R. L., & Black, W. C. (1998). *Multivariate data analysis* (5th ed.). Edgewood Cliffs, NJ: Prentice Hall.

Han, J. H., & Finkelstein, A. (2013). Understanding the effects of professors' pedagogical development with clicker assessment and feedback technologies and the impact of students' engagement and learning in higher education. *Computers and Education, 65,* 64–76.

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.

Hollenbeck, J. R., & Brief, A. P. (1987). The effects of individual differences and goal origin on goal setting and performance. *Organizational Behavior and Human Decision Processes*, *40,* 392–414.

Hubbard, J.K., & Couch, B.A. (2018). The positive effect of in-class clicker questions on later exams depends on initial student performance level but not question format. *Computers & Education*, 120, 1-12.

Hunsu, N. J., Adesope, O., & Bayly, D. J. (2016). A meta-analysis of the effects of audience response systems (clicker-based technologies) on cognition and affect. *Computers & Education*, *94,* 102–119.

Karl, K., & Peluchette, J. (2006). Does workplace fun buffer the impact of emotional exhaustion on job dissatisfaction? A study of health care workers. *Journal of Behavioral and Applied Management, 7*(2), 128–141.

Karl, K., Peluchette, J., & Harland, L. (2007). Is fun for everyone? Personality differences in healthcare providers' attitudes toward fun. *Journal of Health & Human Services Administration, 29*(4), 409–447.

Katz, L., Hallam, M.C., Duvall, M.M., & Polsky, Z. (2017). Considerations for using personal Wi-Fi enabled devices as "clickers" in a large university class. *Active Learning in Higher Education*, 18(1), 25-35.

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

Keough, S. M. (2012). Clickers in the classroom: A review and a replication. *Journal of Management Education*, *36*(6), 822–847. Kulikovskikh, I. M., Prokhorov, S. A., & Suchkova, S. A. (2017). Promoting collaborative learning through regulation of guessing in clickers. *Computers in Human Behavior, 75,* 81–91.

Lai, G., Hill, V., & Ma, Y. (2015) Clickers in the classroom: A business professor's adoption of a classroom response system. *International Journal of Innovation and Learning*, *18*(4), 451–470.

Lamm, E., & Meeks, M. D. (2009). Workplace fun: The moderating effects of generational differences. *Employee Relations, 31*(6), 613–631.

Lantz, M. E., & Stawiski, A. (2014). Effectiveness of clickers: Effect of feedback and the timing of questions on learning. *Computers in Human Behavior*, *31,* 280–286.

Latham, A., & Hill, N. S. (2014). Preference for anonymous classroom participation: Linking student characteristics and reactions to electronic response systems. *Journal of Management Education*, *38*(2), 192–215.

Liu, Y. (2003). Developing a scale to measure the interactivity of websites. *Journal of Advertising Research, 43*(3), 207–216.

Lucardie, D. (2014). The impact of fun and enjoyment on adult's learning. *Procedia—Social and Behavioral Sciences, 142,* 439–446.

Manasia, L. (2015). Enjoyment of learning in upper secondary education: An exploratory research. *Procedia—Social and Behavioral Sciences, 180,* 639–646.

Masikunis, G., Panayiotidis, A., & Burke, L. (2009). Changing the nature of lectures using a personal response system. *Innovations in Education and Teaching International*, *46*(2), 199–212.

McDonough, K., & Foote, J. A. (2015). The impact of individual and shared clicker use on students' collaborative learning. *Computers & Education, 47,* 41–55.

McMillan, S. J., & Hwang, J. (2002). Measures of perceived interactivity: an exploration of the role of direction and communication, user control and time in shaping perceptions of interactivity. *Journal of Advertising, 31*(3), 29–42.

Prince, M. (2004). Does active learning work? A review of the research. *Journal of Engineering Education, 93*(3), 223–231.

Rana, N. P., & Dwivedi, Y. K. (2015). 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. A. (2016). A review of literature on the use of clickers in the business and management discipline. *The International Journal of Management Education*, *14*, 74–91.

Rana, N.P. & Dwivedi, Y.K. (2018). An empirical examination of antecedents determining students' usage of clickers in a digital marketing module. *International Journal of Business Information Systems*, 27(1), 86–104.

Robinson, C. F., & Kalela, P. J. (2006). Creating a space to learn: A classroom of fun, interaction, and trust. *College Teaching, 54*(1), 202–207.

Shaffer, D. M., & Collura, M. J. (2009). Evaluating the effectiveness of a personal response system in the classroom. *Teaching and Psychology*, *36*(4), 273–277.

Shapiro, A. M., Sims-Knight, J., O'Rielly, G. V., Capaldo, P., Pedlow, T., Gordon, K., & Monteiro, K. (2017). Clickers can promote fact retention but impede conceptual understanding: The effect of the interaction between clicker use and pedagogy on learning. *Computers & Education*, *111,* 44–59.

So, H. J., & Brush, T. A. (2008). Students' perceptions of collaborative learning, social presence and satisfaction in a blended learning environment: Relationships and critical factors. *Computers & Education, 51*(1), 318–336.

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.

Sun, H., & Zhang, P. (2006). The role of moderating factors in user technology acceptance. *International Journal of Human Computer Studies, 64,* 53–78.

Sun, J. C. Y. (2014). Influence of polling technologies on student engagement: An analysis of student motivation, academic performance, and brainwave data. *Computers & Education*, *72,* 80–89.

Tews, M.J., Jackson, K., Ramsay, C.M., & Michel, J.W. (2015). Fun in the college classroom: Examining its nature and relationship with student engagement. *College Teaching*, 63, 16-26.

Tews, M.J., Michel, J.W., & Noe, R.A. (2017). Does fun promote learning? The relationship between fun in the workplace and informal learning. *Journal of Vocational Behavior*, 98, 46-55.

Titman, A. C., & Lancaster, G. A. (2011). Personal response systems for teaching postgraduate statistics to small groups. *Journal of Statistics Education, 19*(2), 1–19.

Tlhoaele, M., Hofman, A., Naidoo, A., & Winnips, K. (2014). Using clickers to facilitate interactive engagement activities in a lecture room for improved performance by students. *Innovations in Education and Teaching International, 51*(5), 497–509.

Voith, L.A., Holmes, M.R., & Duda-Banwar, J. (2018). Clicking toward better grades: The use of student response systems in social work education. *Journal of Social Work Education*, 54(2), 239-249.

Volery, T., & Lord, D. (2000). Critical success factors in online education. *The International Journal of Educational Management*, *14*(5), 216–223.

Wan, K., Cheung, G., & Chan, K. (2017). Prediction of Students' Use and Acceptance of Clickers by Learning Approaches: A Cross-Sectional Observational Study. *Education Sciences*, 7, 91-100.

Wang, M. (2007). Designing online courses that effectively engage learners from diverse cultural backgrounds. *British Journal of Educational Technology*, 38(2), 294-311.

Wang, Y.H. (2017). The effectiveness of integrating teaching strategies into IRS activities to facilitate learning. *Journal of Computer Assisted Learning*, 33, 35-50.

Wong, A. (2016). Classroom Response Systems and Student Performance Improvement: Local versus International Students. *Journal of Teaching in International Business*, 27(4), 197-208.

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.

Table 1

Correlations and reliabilities [a, b, c]

Variables	Mean	s.d.	1	2	3	4	5	6	7
1. Gender	1.25	.49	**--**						
2. Year of Study	2.45	.72	-.12*	**--**					
3. PRSs Experience	1.13	.33	-.01	.00	--				
4. The Role of Interactivity	3.63	.68	-.06	-.03	-.03	**.85**			
5. Active Collaborative Learning	3.40	.78	-.06	-.01	-.01	.51**	**.86**		
6. Level of Fun Experienced by PRSs	3.67	.66	-.04	-.03	-.14*	.68**	.45**	**.89**	
7. Learning Performance	3.81	.52	-.09	-.06	-.12	.60**	.66**	.56**	**.89**

Notes:

[a,] n = 247

[b] The correlation coefficients are significant at *P<0.05, **P<0.01.

[c] Reliability coefficients appear along the diagonal.

Table 2

Regression Summary for Mediating Role Active Collaborative Learning on the Interactive Effect of the Role of Interactivity and Experienced Fun by Using PRSs on Student's Learning Performance

Variables	*Active Collaborative Learning*				*Students' Learning Performance*					
	Model 1	Model 2	Model 3	Model 4	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Control Variables										
Gender	-.08	-.04	-.04	-.03	-.10	-.06	-.04	-.06	-.05	-.03
Years of Study	-.11	-.09	-.09	-.09	-.07	-.05	-.01	-.04	-.04	-.01
PRSs Experience	-.01	.01	.03	.04	-.12*	-.10*	-.10*	-.07	-.05	-.07
Independent Variable										
The Role of Interactivity		.50**	.36**	.37**		.59**	.35**	.42**	.42**	.25**
Moderator Variables										
Experienced Fun by using PRSs			.20**	.21**				.26**	.27**	.18**
Interactive Effects										
The Role of Interactivity x Experienced Fun by using PRSs				.11**					.12**	.06*
Mediator Variable										
Active Collaborative Learning							.47**			.44**
N	247	247	247	247	247	247	247	247	247	247
Overall R^2	.01	.27	.29	.31	.03	.38	.55	.42	.44	.57
Change in R^2	.01	.26	.02	.02	.03	.35	.17	.04	.02	.13

Note. $^{*}p < .05$, $^{**}p < .01$

Fig. 1. The model of the role of interactivity with instructors, active collaborative learning, and students' learning performance.

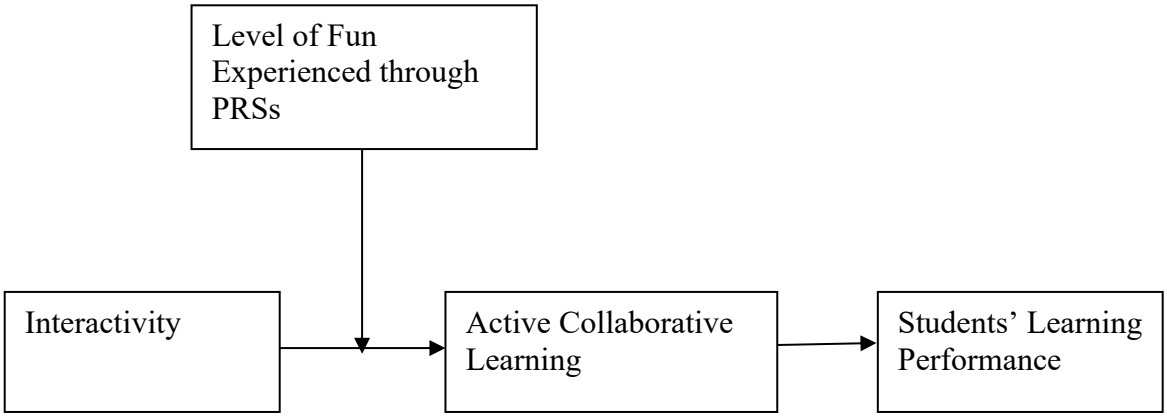

Fig. 2. The Moderating Effect of Experienced Fun by using PRSs on the relationship between the Role of Interactivity and Student's Learning Performance