



## Research article

## Communication preference and the effectiveness of clickers in an Asian university economics course

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## ABSTRACT

In this project a web-based classroom response system (“clickers”) was used in teaching an intermediate level economics course. The main purpose of this project is to find out if the use of clickers is beneficial to students taking economics and examine if students' communication preference (e.g. instant messaging, face-to-face conversations, etc.) has an impact on the effectiveness of clickers in improving learning outcomes. Questionnaires and examination performance were used to assess the effectiveness of clickers. The questionnaire results show that around 75% of students in the treatment (clickers) group generally agreed that clickers allowed them to express their views more freely. We also observed that students who prefer to use instant messaging rather than making conversations are generally more positive towards clickers. The use of clickers also benefits the lecturer – teaching evaluation of the lecturer was significantly better for the clickers group. Comparing the examination scores of the two groups, the treatment group performed considerably better and statistically significant differences were found basing on paired t-tests on the differences. The regression analysis further discovered that the use of clickers has the most significant positive effect on students who prefers to communicate through instant messaging.

## 1. Introduction

In a typical classroom in Asia, it is not uncommon that students tend to be passive in learning and are sometimes reluctant to give an immediate response to questions raised by the lecturer. There are at least two potential reasons for this phenomenon. First, as many Asian countries are influenced by Confucianism, students tend to humble themselves (Li, 2016). Therefore, students tend not to express themselves openly even if they have an answer to the lecturer's question. Second, students might want to avoid getting attention and/or the embarrassment of answering questions incorrectly. Previous research (e.g., Loh and Teo, 2017; Chan, 1999) has provided insight into the peculiarity of the Asian/Chinese learning style. Whatever the reasons are, such phenomenon makes it difficult for lecturers to assess the learning progress of students in class and can inflict a negative impact on the effectiveness of learning and teaching.

Classroom response systems, or “clickers,” are interactive remote answering devices that allow lecturers to gain simple feedback from their students in class in a real-time manner.<sup>1</sup> This helps improve class participation and the implementation of active and co-operative

learning. Clickers have gained increasing popularity among educators. Of the benefits of clickers, a key advantage of particular relevance to the Asian context is that students can express themselves more freely in class because of the anonymity of clickers. The improved response rate and immediacy of response enabled by clickers can help lecturers effectively assess the students' learning progress in class (Kapp et al., 2014). When integrated into traditional lectures, such interactive systems can help, for example, promote active learning, increase student engagement, encourage class participation, and eventually improve student learning outcomes.

A special characteristic of clickers is that it changes the mode of communication between the lecturer and the students. Traditionally, the lecturer and students communicate directly through conversations, which are mostly verbal in nature. Clickers make communication more indirect as the questioning and answering usually occur through the clicker system. Although modern university students are digital natives, not all of them have a strong preference toward the use of indirect communication means. This paper postulates that clickers are more advantageous to students who prefer indirect means of communication.

This paper seeks to answer the following research questions (RQ):

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<sup>1</sup> In this paper, “clickers” is used as an umbrella term that encompasses both hardware-based and software-based classroom response systems.

RQ1: Does the use of clickers affect students' perception of the teacher?

RQ2: Does the use of clickers improve learning and teaching effectiveness?

RQ3: Does a student's communication preference affect the effectiveness of clickers?

The findings of this study provide further evidence of the effectiveness of clickers, particularly in the Asian context. The findings will help educators further understand what circumstances or conditions are more conducive toward the use of clickers to engage students and improve student learning outcomes.

The rest of this paper is structured as follows. Section 2 provides a brief literature review on clickers, mainly in economics education. Section 3 describes the course background as well as the methodology. Section 4 discusses the results and Section 5 concludes.

## 2. Literature review

One of the most important challenges faced by educators is how to encourage student engagement in the classroom. There is an extensive literature that investigates how to engage students in class and improve teaching outcomes. Smith (1977) and McKeachie (1990) found that higher-order learning can be achieved by classroom participation and discussion. Faculty might play less of a direct role in classroom interaction while student-to-student interaction might play a larger role in participation and learning (Fassinger, 1996). Halpern and Hakel (2003) suggested that, from a cognitive psychology perspective, the lecture is not an optimal way to learn. This assertion was supported by Freeman et al. (2014) who indicated that active learning is superior to traditional lecture. Chizmar and Ostrosky (1998) showed that in addition to classroom interaction, having students perform a small writing task at the end of each class to help them reflect on and summarize their learning improved student performance.

With the development of technology, clickers have been introduced to higher education classrooms as a teaching tool to improve student learning outcomes. Kubica et al. (2019) provide a comprehensive investigation into the application of software-based classroom response systems. Research in economics education suggests that clickers can be used in many innovative ways, ranging from detailed simulations (Brouhle, 2011; Bostian and Holt, 2013) and peer instruction (Mazur, 1997; Ghosh and Renna, 2009) to obtaining student feedback and checking on student understanding (Salemi, 2009; Bergstrom, 2009). A large body of education research have evaluated the benefits of clickers in terms of student performance. Studies have addressed the issue on gender (e.g. King and Joshi, 2008), class size (e.g. Sharma et al., 2005) and cultural backgrounds (e.g. Wong, 2016; Fan et al., 2017). Other studies have focused on the differences in subject materials (e.g. Hayter and Rochelle, 2013; Powell et al., 2011; Premuroso et al., 2011). On the other hand, there are also studies that investigate student perceptions on clickers (e.g. Stover et al., 2018; Spinney and Kerr, 2018; Oigara and Keengwe, 2013).

Empirical evidence on the impact of clickers on student performance in economics education is mixed. Stanley (2013) provided the results of two experiments carried out on samples of 229 and 205 students in managerial economics. The regression results showed that student performance improved in terms of attendance and unannounced quizzes. In line with other studies (Liu et al., 2003; Siau et al., 2006), these results point to clickers' effectiveness in promoting and encouraging student participation in the classroom. Middleditch and Moindrot (2015) conducted experiments on two macroeconomics courses taught in a large cohort setting of around 500–600 students and found that the use of clickers can increase student satisfaction, enjoyment, and engagement. Salemi (2009) and Ghosh and Renna (2009) also observed student enthusiasm, as evidenced by multiple choice question response levels, higher attendance rates, and positive exit survey opinions.

However, some researchers found no significant positive impact from the use of clickers on student performance. Liu et al. (2008) suggested that the use of clickers has a modest, statistically insignificant impact on student performance. In their study, two experiments were conducted on 34 students, and clickers were used in a pit market trading game. Hayter and Rochelle (2013) compared exam scores of two mid-sized classes equipped with clickers. Clickers were used in one class for both participation and graded quizzes; in the other class, clickers were used for participation only. Although the survey results confirmed that most students enjoyed using the clickers, their overall performance as measured by quiz and final exam scores did not increase significantly.

Researchers have also investigated the effect of clickers with consideration for the attributes of the students and the characteristics of the subjects. Johnson and Robson (2008) conducted experiments in an introductory microeconomics course and found that simply introducing clickers into a lecture-based course did not result in statistically significant improvements in student performance. The result holds even after controlling for student attributes such as gender, grade point average (GPA), American College Testing (ACT) scores, etc. Green (2016) compared student exam performances among classes with and without clickers, with specific focus on student background as measured by the Scholastic Assessment Test (SAT) score. It was found that the implementation of clickers led to a significant positive increase in student performance, but the degree of improvement depended on students' SAT scores. In particular, students with higher SAT scores benefitted more from the use of clickers. Bares López et al. (2017) conducted a case study at a Spanish university with respect to the usefulness of clickers in detecting gaps in the understanding of course content. The authors also investigated factors affecting students' attitude toward the use of clickers. According to questionnaire results, students generally considered clickers a useful tool for detecting understanding gaps. The regression analysis further showed that student gender and the lecturer's explanations regarding the use of clickers had a positive and highly statistically significant effect on student perception toward the use of clickers.

Fan et al. (2017) compared the impact of clickers on the learning experience of Chinese and Canadian students. While both groups gave positive feedbacks, Chinese students were found to have a much more positive experience with clickers. This points to the potential importance of cultural differences on the impact of clickers. As can be seen from the literature review above, much of the literature on clickers in economics teaching has focused on North American or European universities and little research has been published on the usefulness of clickers in the Asian economic education context. This paper aims to bridge this gap by documenting my use of clickers in teaching economics at an Asian university and investigates whether students' communication preference can influence the effectiveness of clickers.

## 3. Methods

### 3.1. Backgrounds

This study was conducted on a calculus-based intermediate microeconomics course offered in the 2016–2017 academic year at the Hong Kong Polytechnic University.<sup>2</sup> Students who took this course either had a major in investment science or a minor in business economics. As there were two lecture streams in the course, one stream was assigned as the “clickers group” and the other as the control group. Both streams were taught by the same lecturer, and to ensure comparability, identical teaching materials and lecture content were used. Students were not aware of the pedagogical difference between the two lecture streams when they registered for the course, so there should be no selection bias

<sup>2</sup> This research is approved by the School of Accounting and Finance Learning and Teaching Committee of the Hong Kong Polytechnic University. Informed consent was sought from all students who participated in this research.

from student registration. As the majority of students follow the same prescribed study pattern, students in both streams were similar in terms of academic progress, with 82% and 78% of students in their 2nd or 3rd year of study in the clickers and control group, respectively. The gender balance was also similar, with male students accounting for 56–57% of each class.<sup>3</sup>

As a means to encourage class participation and check students' understanding of key concepts, a number of multiple-choice review questions were inserted between major sections of the lectures. When gaps in understanding were identified, clarification and further elaboration of the concepts were given. In the control group, the review questions were projected onscreen as part of the lecture slides, and students were asked to respond to the questions by raising their hands for the correct answer. Taking advantage of the nowadays widespread use of smartphones, Socrative, a mobile-friendly clicker system, was used in the clickers group. The instructor version of Socrative allows lecturers to set up multiple choice, true or false, and short answer questions, which can be shown on the projected screen. Students access the student version of the system for a class by entering a "room number." Once logged in, students can register their anonymous responses to the question being asked. There is no other difference between the clickers group and the control group apart from the way that students respond to the review questions.<sup>4</sup>

### 3.2. Student questionnaire

At the end of the semester, a questionnaire was used to collect students' feedback on their perception toward the teaching and the use of clickers (when applicable). Students were asked to express on a five-point scale their opinion toward the following statements (1 = strongly disagree; 2 = disagree; 3 = neutral; 4 = agree; 5 = strongly agree):

1. "The lecturer tried to encourage students to participate actively in class."
2. "The teaching approach taken by the lecturer was effective in engaging students to participate actively in class."
3. "The use of clickers helped me express myself freely in class."

Only students from the clickers group were asked to respond to statement 3.

To examine the potential impact of communication preference on the effectiveness of clickers, students were asked to indicate their preferred mode of communication among (i) instant messaging, (ii) conversation, or (iii) no strong preference. Out of 42 students, 50% preferred instant messaging while 31% preferred conversations, and 19% had no strong preference for mode of communication.

### 3.3. Student learning outcomes

In this study, we measure student learning outcome from the final examination results. To ensure that the final examination results reflect student achievement in the course learning outcomes, the examination questions were designed around the key learning outcomes as set out in the course outline. If clickers are effective in improving student learning outcome, we expect there to be a noticeable difference in the examination results between the two groups.

As the students' examination results might be affected by factors other than the use of clickers, we further analyze the final examination results with an econometric analysis, which allows us to isolate the impact of the

<sup>3</sup> A regression analysis can help control for the effects of student attributes that could potentially hinder a direct comparison between the two groups. Please refer to Section 3.3 and 4 for details.

<sup>4</sup> Clickers were introduced to the clicker group starting from the week after the midterm test, so the midterm test score can be used to control for the students' study effort in the regression analysis.

clickers (Walberg, 1971). Let *EXAM* be the final examination score, and consider the following reduced-form education production function that explains the students' learning outcome by (i) student ability, (ii) study effort, and (iii) the use of clickers:

$$EXAM = f(\text{ability}, \text{effort}, \text{clickers})$$

We control for student ability with the students' grade point average (GPA). Assuming that students who put more effort in the course performed better in other course assessments as well, we use the students' midterm test score (MT) as a proxy for study effort, which yields the following econometric model specification:

$$EXAM_i = \alpha_0 + \alpha_1 GPA_i + \alpha_2 MT_i + \alpha_3 CL_i + \varepsilon_i \quad (1)$$

where subscript *i* identifies the individual students, *CL* is a dummy variable (1 for the clickers group, and 0 otherwise), and  $\varepsilon$  is an error term. To examine the influence of the students' communication preference on the usefulness of clickers, we further consider the following dummy variables that reflect the students' preferred mode of communication:

*IM* = 1 if the student prefers instant messaging; 0 otherwise

*CON* = 1 if the student prefers conversation; 0 otherwise

*NP* = 1 if the student has no strong preference; 0 otherwise.

Each of the above variables is interacted with *CL*, creating a new set of dummy variables (i.e., *CL\*CON*, *CL\*NP*, and *CL\*IM*). For any individual *i*, at most one of these variables will take the value of 1. The resulting econometric model is

$$EXAM_i = \beta_0 + \beta_1 GPA_i + \beta_2 MT_i + \beta_3 CL*IM_i + \beta_4 CL*CON_i + \beta_5 CL*NP_i + \eta_i \quad (2)$$

## 4. Empirical results

With clickers, students were much more willing to respond to the review questions, with a response rate of over 80% in general, compared to the rate of 20–60% when clickers were not used. An interesting observation was that the response rate of the difficult questions typically tended to be lower than that of the easier questions in the control group. Such inconsistency was not apparent in the clickers group. While the response rate can somewhat be used to assess students' perception toward the questions' difficulty level, this lack of response to the difficult questions posed a challenge to the lecturer in identifying understanding gaps during the lecture.

### 4.1. Student response to questionnaire and teaching evaluation

Students were asked to respond to three questions in the end-of-semester questionnaire.<sup>5</sup> The mean scores for statements 1, 2, and 3 are 3.809, 3.762, and 4.174, respectively. On average, students in the clickers group agreed that the use of clickers helped them express themselves freely in class. This result is not surprising given the anonymous nature of the clicker system. With such a system, students no longer worry about the embarrassment of not knowing the correct answer or making "stupid mistakes." In general students tended to be positive about the lecturer's attempt at and effectiveness in engaging students in class. A closer look at the average ratings of the two groups reveals that students from the clickers group gave higher ratings to both statements 1 and 2. According to the two-sample t-tests of equal means assuming unequal variances, the mean response of the clickers group is higher than that of the control group for both statements. Details of the two-sample t-tests are summarized in Table 1.

<sup>5</sup> The sample size of the clickers group and control group are 23 and 19, respectively.

The use of clickers also appears to have a discernible effect on the students' perception toward the lecturer. As shown in Table 2, students from the clickers group gave significantly higher ratings to the lecturer in the end-of-semester teaching evaluation. Under the same five-point scale as the research questionnaire above, the mean rating differentials ranged from 0.2 to 0.6. Students in the clickers group had a particularly stronger sense that the lecturer was well prepared for class, and they gave a much higher overall rating to the lecturer. This result is encouraging because students at least appeared to appreciate the extra effort made by the lecturer to introduce clickers into the classroom.

4.2. Student learning outcomes

The average examination score of the clickers group was 71.261 while that of the control group was 53.553, which presents a marked difference of 17.708 points or 33.1%. A t-test of equal means confirms that this difference is highly statistically significant, with a p-value of 0.001 for a one-tailed test. Apparently, the use of clickers had a positive influence on student learning.

To disentangle the effect of clickers on students' examination performance from other contributing factors, the regression analysis is performed. Table 3 presents the ordinary least square regression estimates of models (1) and (2). As the students with higher GPA might also perform better in the midterm test, the regression models are susceptible to multicollinearity. However, the pairwise correlation coefficient between the two variables is only 0.55, and the variance inflation factors (VIF) of all of the variables in both models are less than 1.6 (<10). Thus, we can argue that multicollinearity is not a major concern in our regression. We also perform White's test and the Breusch-Pagan (B-P) test for heteroscedasticity. The null hypothesis of homoscedasticity cannot be rejected in either test.

The magnitude of the coefficient estimates and the standard errors of GPA and MT are fairly similar in both models, and the coefficients are statistically significant at least at the 5% level. Unsurprisingly, the students with higher GPA and/or higher midterm scores performed better in the final examination. These results imply the importance of student ability and study effort in achieving the course learning outcomes. More importantly, holding other factors constant, the students from the clickers group scored 7.313 points higher than the students from the control group on average. The coefficient of CL is statistically significant at the 10% level, which points to a positive effect of the use of clickers on the achievement of learning outcomes. Compared to the 17.708 points

Table 1. Two-sample t-tests.

	Statement 1		Statement 2	
	Clickers	Control	Clickers	Control
Mean	4.000	3.579	4.000	3.474
Variance	0.545	0.702	0.455	0.930
Observations	23	19	23	19
Mean difference	0.421		0.526	
p-value	0.048		0.027	

Note: The p-values are based on one-tailed t-tests on the alternative hypothesis that the mean difference is above zero.

Table 2. Teaching evaluation.

Question	Clickers	Control
Overall, I think the staff member is an effective teacher.	4.5	3.9
The staff member was well prepared for class.	4.5	4.0
The staff member gave useful feedback on my work.	4.0	3.8
The staff member encouraged students to ask questions and discuss ideas in class.	4.2	3.8

Table 3. Regression results.

	Model (1)		Model (2)	
	Coefficient	Std.Err.	Coefficient	Std.Err.
Constant	-13.956	12.320	-16.979	12.978
GPA	12.167**	4.636	13.769***	4.888
MT	0.485***	0.124	0.459***	0.127
CL	7.313*	4.029	-	-
CL*IM	-	-	8.365*	4.686
CL*CON	-	-	9.470	6.072
CL*NP	-	-	-0.079	7.010
Adjusted R <sup>2</sup>	0.603		0.599	
White's	0.905		0.917	
B-P	0.685		0.849	

Note: \*, \*\*, and \*\*\* denote significance at 10%, 5%, and 1%, respectively; p-values for White's test and the B-P test are reported.

difference in the mean final examination score between the two groups, the use of clickers contributed a more moderate 7.313 points improvement. Apart from clickers, variations in student quality and study effort played a role in the students' learning outcome. Turning to communication preference, we see that only CL\*IM is statistically significant out of the three interaction terms in model (2), which suggests that clickers provided a statistically significant learning outcome improvement only to students who preferred to use instant messaging as a mode of communication. On average, this group of students scored 8.365 points more than the other students. This result supports our hypothesis that students who prefer a more indirect mode of communication will benefit more from the use of clickers.

5. Discussions and conclusions

In this research, a web-based classroom response system ("clickers") was used in the teaching of an intermediate economics course. Clickers give students a chance to respond to the lecturer's question privately and encourage students who might not typically speak up in class to express their thoughts and opinions. The purpose of this research is to find out (i) if the use of clickers can improve students' perception towards the teacher, (ii) if the use of clickers is beneficial to students taking economics, and (iii) if students' communication preference (e.g., instant messaging, face-to-face conversation, etc.) has an impact on the effectiveness of clickers in improving learning outcomes. An end-of-semester questionnaire and the students' examination performance were used to assess the effectiveness of clickers in this research. According to the questionnaire results, around 75% of the students in the clickers treatment group generally agreed that clickers allowed them to express their views more freely. We observed that students who preferred instant messaging to conversation were generally more positive toward clickers. The use of clickers also benefited the lecturer. The students' rating of the lecturer in the teaching evaluation was significantly higher for the clickers treatment group. In terms of the final examination scores of the clickers treatment group and the control group, the clickers treatment group performed considerably better, and statistically significant differences were found in the paired t-tests on the differences. According to the regression analysis, the clickers group scored 7.313 points more than the control group in the final examination. In separating students based on their preferred mode of communication, we discovered that the use of clickers only had a significant positive effect on students who preferred to communicate through instant messaging.

As presented in this paper, the positive impacts of the use of clickers in an Asian university economics course echo many of the impacts documented in the literature focused on North America and Europe. We believe these positive impacts do not come in isolation. In our application, where clickers were integrated with "checkpoint" review questions,

student participation increased significantly. This is in line with the findings of Salemi (2009) and Ghosh and Renna (2009) where higher multiple choice question response levels, higher attendance rates, and positive student evaluation were observed. Our results are also complementary to those of Bares López et al. (2017), as our application of clickers encourages students (regardless of their ability and understanding of the relevant concepts) to answer the review questions, which in turn helps the lecturer to identify understanding gaps among the students so that timely clarifications can be made when needed. Both teaching and learning efficacy were enhanced as a result.

This study is the first attempt in the literature that examines the influence of students' communication preference on the effectiveness of clickers. In this digital age when people tend to interact more through mobile messaging technologies, the findings of this study act as a yardstick of more structured and large-scale analyses in this area of research. Clickers have gained popularity in the past decades and this trend is continuing, with plenty of universities encouraging the adoption of such systems as a means to promote active learning. In light of the results presented in this paper, instructors and/or university policy makers are advised to take students' preferred mode of communication into account when adopting or promoting the use of clickers in class.

This paper contributes to the literature by presenting empirical evidence of the benefits of clickers in the Asian context. However, this paper is not without limitations. As the sample size in the empirical study is rather small, it potentially reduces the power of the t-tests in the regression analysis and limits the dimension of student attributes that can be incorporated into the study. Future research in this area can explore the use of clickers in a larger cohort at an Asian university. Clickers can also be studied with other aspects of Asian learning cultures and student attributes.

## Declarations

### Author contribution statement

R. Li: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

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### Competing interest statement

The authors declare no conflict of interest.

### Additional information

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