

## **Enhancing Active Learning in Large Classes Using Web Clicker**

**Dereje Engida Woldemichael**

*Universiti Teknologi PETRONAS, Mechanical Engineering Department,  
Centre for Excellence in Teaching & Learning (CETaL), 32610 Seri Iskandar, Perak, Malaysia*

### **ABSTRACT**

This paper presents the use of free web clicker ([webclicker.org](http://webclicker.org)) to enhance active learning in large classroom. Web clicker platform works on any internet accessible device such as phones, pads, PCs, and laptops, without the need to purchase the clicker (hardware). The author used web clicker as pre/during/post lecture activity through concept questions. This helped to conduct formative assessment and identify misconceptions. The students also responded without peer pressure. To assess the effectiveness of using web clicker in enhancing active learning, surveys on two batches of students taking the same course in different time frame was conducted. An online survey with questionnaire consisting of five items on five-point Likert scale was used for which there were 47 respondents out of 127 students in the first batch and 76 respondents out of 151 students in the second batch. In addition, surveys through open-ended questions to get students' perception about the overall teaching and learning process were conducted. The overall result of the surveys was positive and in line with what was reported in literature. Web clicker encourages students to participate in the learning activity and motivates them to study.

*Keywords:* Active learning, clickers, engagement, web clicker

### **INTRODUCTION**

Active learning is one of the student centred learning approaches to engage students

in the learning process through learning activities. It is the process of engaging the students in activities that promote analysis, synthesis, and evaluation of what they learn rather than simply listening or watching passively. There are a number of approaches to engage students in the learning activity, individually and as a team. In addition to the learning activities, it is important to assess students' learning and retention of

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*E-mail address:*

[dereje.woldemichael@utp.edu.my](mailto:dereje.woldemichael@utp.edu.my);

[derejeng@gmail.com](mailto:derejeng@gmail.com) (Dereje Engida Woldemichael)

the studied concept as formative assessment to provide timely feedback. Clickers can be one of the possible options to enhance active learning process in large classrooms where it is difficult to gauge students' perceptions and understanding at a given instant on a certain topic.

It is well-known that active learning leads to better students' attitude, improved students' thinking and writing, improved retention of materials, and motivates students to further study and become lifelong learners (Prince, 2004). But how can we ensure the participation of every student in large classes? How can students receive immediate feedback if there is misconception about a certain topic? How can instructors motivate students to prepare for classes by reading the learning resources and taking ownership of their learning? All these can be addressed by integrating tools such as clickers that can assist in engaging the students in the teaching and learning process without peer pressure.

Clickers are interactive instructional technologies in which students use a hand-held device / transmitter to provide electronic response to a given question. Clickers provide a mechanism for students to participate interactively and anonymously in a learning activity and express their own views and ideas, thus, promoting active learning in the classroom. Once the students respond to questions which are posed, automatically generated graphs illustrate the distribution of their response by providing immediate feedback on their learning and understanding.

Clickers are known with different names in the literature including classroom response system (CRS) (Richardson, Dunn, McDonald, & Oprescu, 2015), personal response system (PRS) (Tlhoale, Hofman, Naidoo, & Winnips, 2014), audience response system (ARS) (Cotes & Cotuá, 2014), electronic response system (ERS) (Blasco-Arcas, Buil, Hernández-Ortega, & Sese, 2013; Brady, Seli, & Rosenthal, 2013), and student response system (SRS) (Beard, Morote, & Volcy, 2013). In terms of devices and associated technologies, there are varieties of clickers in the market such as iclicker (<https://www1.iclicker.com/>), poll everywhere (<https://www.poll.everywhere.com/>) and web clicker system (<http://www.webclicker.org>) to name a few. The iclicker is subscription based while poll everywhere offers free option for limited number of participants (25). The web clicker system at [webclicker.org](http://www.webclicker.org) (Bao, 2012) is free of charge with unlimited number of students and works on any internet accessible device such as phones, pads, PCs, and laptops, without the need to purchase the clicker (hardware). Hence, the author used [webclicker.org](http://www.webclicker.org) platform for the implementation.

The most common type of questions used with conventional clickers are multiple choice and true/false questions. In web clicker short answer questions can also be used. Web clicker can be used pre and post class unlike conventional clickers which can only be used during class. Hence, web clicker can be used to gauge students' understanding before, during, or after a formal lecture.

## LITERATURE REVIEW

Clickers are used to increase students' participation and assist the lecturer to quickly identify misconceptions. King (2011) used clickers to identify points of students' confusion or misconceptions in large classes. It also promotes engagement especially in large classes. Clickers can be used as one of the strategies in active learning to motivate students, make classes more dynamic, rapidly assess students' performance, and ensure more significant teacher-student interaction (Cotes & Cotuá, 2014). There are a number of success stories in the literature where the use of clickers has shown to have a positive impact on students' learning. The study conducted by Blasco-Arcas et al. (2013) investigated the effect of clickers on students' learning performance on social sciences degree students through a survey. Their finding showed that clickers positively influences active/collaborative learning and engagement which in turn improves students' learning performance. Using clickers, which provide immediate response together with cooperative social interaction, has positive impact in motivating students and contribute to understanding the topics covered (Cotes & Cotuá, 2014).

The use of clickers as a means to motivate students for pre-class assignment and preparation for class to promote learning and engagement was studied by Beard et al. (2013). Their study examined whether the student response system could promote learning, encourage participation, and motivate diverse students to prepare for class. The result of their study showed that

the use of clickers motivated the majority of students (67.7%) to prepare for class and complete pre-class assignments.

The study conducted by Tlhoale et al. (2014) on the impact of interactive engagement activities using clickers on a control group to assess students' motivation and performance compared to traditional lecture yielded significant improvement in terms of motivation and performance. In their quasi-experimental study, Brady et al. (2013) found higher performance was observed when clicker was used in combination with instructional strategies, compared to traditional lecture without clickers. In addition, their findings suggest that metacognition from clicker use has a productive influence on the learning process. Another study by Freeman et al. (2014) showed that average examination scores improved by 6% in active learning sections compared to traditional lecturing where the failure rate was 1.5 times more likely compared to students in active learning classes. Hence, active participation of students in the learning process is much better than traditional lecture style teaching where the students are passive recipients of information.

To investigate the effect and benefits of clickers in enhancing the students' learning performance, Blasco-Arcas et al. (2013) proposed a framework that consists of interactivity, active collaborative learning and engagement as the key underlying forces. Accordingly, high level of interactivity using clickers positively influencing active learning and engagement

leading to better performance were observed in their study. Similarly, Richardson et al. (2015) devised an instrument called classroom response system perceptions (CRiSP) questionnaire to evaluate the impact of clickers on students' learning, engagement and usability. A comprehensive set of questions were developed in four phases based on the literature, research team

brainstorming, focus group feedback and factor analysis.

There are a number of studies on the use of clickers in classroom and their effect. The summary of some of the recent studies and their findings are summarised in Table 1. A more comprehensive summary of studies on the use of clickers from previous years starting from 2003, is also available in Richardson et al. (2015).

Table 1  
*Summary of some of the literature on clickers*

Article/ Authors	Evaluation tools and sample size	Method of evaluation	Remark / Notable finding
(Gachago, Morris, & Simon, 2011)	survey (37)	Focus group discussion (30 minutes), 24 questions to record the students' responses	Student engagement where clickers grab students' attention through simplicity, novelty, and fun element
(Efstathiou & Bailey, 2012)	survey (110 & 85 in two rounds)	18 to 30 multiple choice questions, using a 7-point Likert scale	Clickers increased discussion among students and awareness of their level of knowledge with peer activities
(Brady et al., 2013)	survey (198)	A quasi-experimental design, 5-point Likert scale, multiple groups, and data triangulation	Metacognition from clicker use had a more productive influence on the learning process
(Han & Finkelstein, 2013)	Four-semester long project (74 professors and 5459 students)	Clicker Assessment and Feedback Questionnaire (CAF-Q), seven items and two main variables to assess learning and engagement	CAF-Q was used to assess and investigate students' perceptions of clicker assessment and feedback tools
(Beard et al., 2013)	Survey (36)	Nine items on 4-point Likert scale	The use of clickers motivated some students to complete assignments
(Tlhoale et al., 2014)	class tests and questionnaire (71)	pre- and post-test to evaluate students' performance scores between experimental and control groups	The interactive engagement (IE) activities with the help of clickers had a significant impact on students' performance compared to traditional lectures
(Freeman et al., 2014)	Secondary data from literature (225)	Heterogeneity analyses mean and SD comparison between well-controlled versus less-well-controlled studies.	This study support active learning and empirically validated the teaching practice in regular classrooms setting.

## Implementation

Dynamics is a three credit hour core course in mechanical engineering programme for second year second semester students at Universiti Teknologi PETRONAS. On average there are about 100 students enrolled for this course every semester. In the course delivery, the author used active learning methods for lecture classes and cooperative learning for tutorial sessions. The overall teaching and learning activities were divided into three main parts as lecture, tutorial and guided learning activities (GLAs). The lecture and tutorial sessions were face-to-face and the GLAs were done by the students outside classroom. Among the variety of active learning approaches in the literature, think-pair-share (TPS), two-minute paper, concept questions, and closure review (Felder & Brent, 2009) were implemented. Web clicker was used to handle the concept questions. None of the students had used clicker before. It was the first time they were introduced to clicker and its use.

The author set up the course on web clicker (<http://webclicker.org/>) and each student subsequently registered with the course code. In pre-class setting, the theoretical aspect of the course in the form of lecture material and/or recorded video was posted on e-learning platform for the students to go through the material and study before they come to class. Once they completed, they used web clicker to answer pre-class concept questions. The concept questions were carefully crafted to spot misconception in the theory. Before the

lecture, the responses from the web clicker were reviewed and used to prepare a ten-minute summary lecture addressing critical issues and misconceptions.

During lecture, bookend approach (Smith, Sheppard, Johnson, & Johnson, 2005) was used, where after every ten to fifteen minutes of formal lecture the students were asked to discuss what they were learning in informal cooperative learning groups and respond to questions posed using web clicker. Informal cooperative learning groups also ensured that misconceptions, incorrect understanding, and gaps in understanding were identified and corrected, and that learning experiences were personalised. Furthermore, after completing the formal lecture, the students were encouraged to answer further concept questions as post-lecture activity using web clicker. The level of difficulty for post-lecture questions was higher than the pre-lecture concept questions. The post-lecture questions were used to assess knowledge retention.

## RESULTS AND DISCUSSION

### Using Web Clicker as Feedback Mechanism

As mentioned in the previous section, the author used clickers to get quick feedback on students' misconceptions. A sample pre-lecture concept question which the students were asked to respond to after reading the lecture note is shown in Figure 1(a). The pre-lecture web clicker response is shown in Figure 1(b). The same question was posed after going through the lecture at the end

of the lecture class to recap the concept on web clicker and the students' response is shown in Figure 1(c). As can be seen from pre-lecture response, there is considerable variation in students' choices. The in-class response shows significant improvement, with 90% of respondents getting the right

answer compared to pre-lecture (58%). However, there were still respondents who did not answer correctly after going through the lecture and other learning activities. Without the web clicker, it would be nearly impossible to get such immediate feedback from all the students in a class.

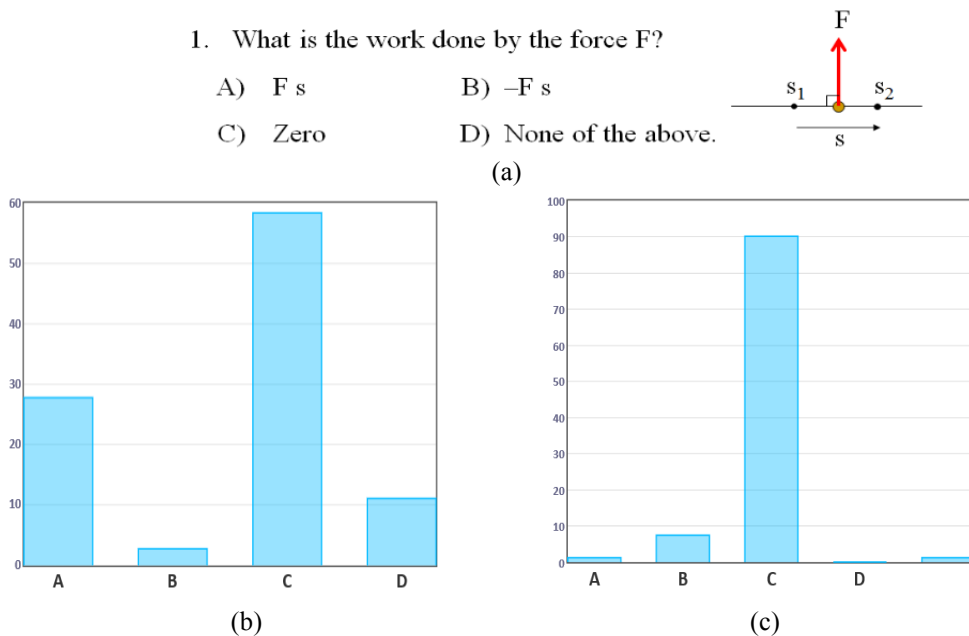


Figure 1. Sample Web Clicker Question and response (a) concept question; (b) pre-lecture response (n=36); (c) in-class response (n=81)

### Survey Results

The author conducted surveys on the use of clickers after students completed the course using web clicker. The survey items were prepared to assess the effectiveness of web clicker in enhancing active learning and to know the students' perception. The questions were adopted from Richardson et al. (2015). The questionnaire consisted

of five items with five-point Likert scale ranging from strongly agree to strongly disagree. The items are:

1. Web Clicker made me read more before class.
2. Using Web Clicker helped me to think more deeply about course materials.
3. Web Clicker used in this course motivated me to learn.

4. I found this method of interaction between students and lecturer to be effective.
5. I would recommend Web Clicker to be used in other courses.

The questionnaire was sent to all students taking the course via email using Google form. A convenient sampling method was used for the response. Accordingly, there were 47 respondents out of 127 registered for the course (September 2015 semester) in the first survey and 76 respondents out of 151 registered students (May 2016 semester) in the second survey. In terms of

demography, there were 78.7% male and 21.3% female respondents in the first survey while 76.3% males and 23.7% females in the second survey. Most of the respondents were Malaysians (83% in the first survey, 94.7% in the second survey) whereas the remaining were international students. The data was coded and analysed using Statistical Package for Social Sciences (SPSS) version 22. The descriptive statistics mean values and standard deviation were used for the analysis. The descriptive statistics mean values and standard deviations of both surveys are shown in Table 2.

Table 2  
*Summary and comparison of descriptive statistics for both surveys*

	Survey I (n=47)		Survey II (n=76)	
	Mean	SD	Mean	SD
Web Clicker made me read more before class	3.79	1.041	3.64	0.93
Using Web Clicker helped me to think more deeply about course materials	3.66	.984	3.54	0.84
Web Clicker used in this course motivated me to learn	3.6	1.035	3.63	0.74
I found this method of interaction between students and lecturer to be effective	3.72	1.036	3.91	0.89
I would recommend Web Clicker to be used in other courses	3.36	1.241	3.55	1.1

The objective of the survey was to gauge students' perception and experience on the use of web clicker and its use in active learning process. The results from the first survey indicates that the students showed more positive attitude towards the application of web clicker in active learning, which can be evidenced by the mean and standard deviation in the above table. The highest mean (3.79) proves that web clicker

really helped students read more before classes and the second highest mean (3.72) illustrates that students found web clicker as source of interaction between students and the lecturer. Students showed similar level of responses in terms of mean such as 3.66 and 3.6, in the application of web clicker that helped them think more deeply about the course materials as well as motivated them to learn. From the first survey, the

least interest was shown in recommending the use of web clicker in other courses. As continuous quality improvement and to address the concerns from the students on their workload, the number of web clicker questions, especially the post lecture questions were reduced in the second-round of implementation.

The second survey from May 2016 semester students was carried out to compare with the previous batch of students and continuously evaluate the effectiveness and students' perception on the use of web clicker. The results improved in two dimensions - for instance, students showed more interest in recommending the use of web clicker to other courses, which can be seen from the new mean (3.5), compared to the previous mean score of 3.36 in survey I. This could be due to the reduced number of web clicker activities compared to the first round. Moreover, students gave much importance to the web clicker, which is a very useful source through which the students and lecturer can interact with each other. This is also proven by the new mean of 3.91 in survey II as compared to the previous one which was 3.72. In other cases, even though the mean reduced, the standard deviation of the second survey was better compared to the first, showing some consistency in the response. The mean values of all items were within the range of 3.3 to 3.9. It means that a large majority of students had preference to use web clickers. In conclusion, both the surveys have shown that web clicker is an effective means to engage students in the learning process.

In addition to the survey questionnaire, the author used open-ended questions to get students' feedback on overall course delivery. Sample students' feedback is shown in the following snippet.

Question: In teaching this course, what do you want me to continue?

Responses:

- the usage of web clicker is good to learn the fundamental concepts of the subject ...
- web clicker, tutorial and all of them
- pre & post-class quizzes; they really get the students to engage with the subject
- continue web clicker because it helps me to get the point of lecture before going to class
- the web clicker questions. It gives me the initiative to read the slides and try to understand them before class.
- pre & post-class quizzes; they really get the students to engage with the subject

These forms of feedback are similar to what was pointed out by Mayer et al. (2009) where clickers encouraged students to participate and engage in the learning process, especially in large classrooms.

## CONCLUSIONS

Web clicker has been used to enhance active learning in a large classroom. Web clicker was used to motivate the students to prepare for class using pre-lecture concept questions, in class activities and post lecture concept



questions. Web clicker can be used to pinpoint misconceptions and give formative feedback. The students use their smart phones or laptops to respond to questions posed in classes. It can also be used to take attendance. Surveys were conducted to assess the effectiveness of web clicker in enhancing active learning and gauge students' perception. The overall response from the surveys were positive. Web clicker encourages students to participate in the learning activity and motivate them to study.

This research is limited to only mechanical engineering students taking Dynamics course and studying at Universiti Teknologi PETRONAS. Further studies can be conducted with large sample from different disciplines and other universities. In future, the mixed methods approach may be used for more in-depth research on the use of web clickers.

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