Introducing a personal response system to one engineering technology course for enhancing student learning and engagement

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Abstract

For many years, the back-to-basic conventional education method (CEM) is still primarily used in engineering technology classrooms. The students are given lectures and expected to take notes and memorize the content. The instructor evaluates the students' learning and engagement by taking answers from a small number of students for a question periodically in class. Due to the small sample size, the evaluation results may carry major errors and disguise the real learning level of the questioned concepts. Meanwhile, since the old-fashioned way replies on repetition and memorization of information to educate students, the students typically will lose their attention after 15 mins of a continuous lecture. Intentionally breaking the lecture into discrete segments may be an effective way to draw the students' attention back and improve the students' engagement. Most importantly, with the CEM, it is quite challenging to develop critical thinking skills, the highly desired ability for an engineering technology student.

To enhance the student engagement and learning experience and effectively improve their academic performance, conventional clicker-based personal response system (PRS) are initially introduced and used in the classroom for years. To overcome the limitation of conventional clicker-based PRS, a web-based online PRS, Poll everywhere, provides a simple, cheap solution. Poll Everywhere allows all the students to respond simultaneously to the questions by using tablet, smartphone, or computers with no cost. Based on the real-time response, the instructor can access student engagement and performance more accurately and adjust the teaching style and content accordingly.

This paper proposes a case-based study of using Poll everywhere to overcome the drawbacks of typical clicking system, help with catching students' misconceptions, fostering their engagement and improving their academic performance at a medium size classroom for a freshman-level electrical engineering technology course, "electronic principle." An anonymous survey with 21 questions is implemented to collect students' feedback on their feeling and thoughts towards the use of Poll Everywhere. Besides, the correlation between the student engagement (supported by the in-class Poll everywhere responses) and the corresponding academic performance records (equivalent grade for homework, quizzes, and exams) is investigated to assess the effectiveness of using Poll everywhere to improve students' academic performance and learning outcomes. The study shows that the students have no issues of using Poll everywhere in class and find themselves engaging more and learning better. And the positive correlation between student engagement and corresponding academic performance can further validate that using Poll everywhere cannot only enhance student engagement and learning experience but also effectively improve academic performance.

Index Terms — Poll Everywhere, student engagement, learning experience, academic performance, PRS.

I. INTRODUCTION

For many years, the back-to-basic conventional education method (CEM) is still primarily used in engineering technology classrooms. The students are given lectures and expected to take notes and memorize the content. Since the old-fashioned way replies on repetition and memorization of information to educate students, the students typically will lose their attention after 10-15 mins of a continuous lecture according to the documented evidence [1, 2]. Intentionally breaking the lecture into discrete segments may be an effective way to draw the students' attention back and improve the students' engagement [3,4].

To date, to improve student engagement and evaluate the students' learning, the instructor usually poses an oral statement periodically in class and collects the responses from the students by the primary two methods. The first method is to take answers from a small number of students for question response [5]. The second method is to check a show of hands of the students that represent their point of view, such as agree/disagree with the instructor's statement [6]. However, the evaluation results collected by the first method may carry significant errors and disguise the real learning level of the questioned concepts due to the small sample size. The second method may collect a larger sample size as compared with the first method; it can consume much more time counting and sorting the responses and hard to get immediate answers. Besides, both methods suffer from the fact that the student responses are not anonymous. Correspondingly, some students refuse to give their response either because they are not will to disclose their answer or because they are not sure about the answer.

As technology advanced, faculty members from different disciplines all shows a rising interest in adopting a new technology named Personal Response System (PRS) to their courses since PRS shows a significant potential of promoting the interactive learning environment of a class. A typical PRS usually includes a set of hardware, clickers, and software that receives the inputs from clickers and shows immediate results [7, 8]. Many case-based studies were already conducted on their use and impact in classrooms and found that the learning outcomes vary based on the applied disciplines for decades [5, 9-13]. Most research reported that students found themselves more engaged and more confident after adopting PRS in classroom [5, 9-11]. However, the limits of the clickers, such as the purchase and maintenance cost, the malfunction issues, and no or limit typing function [4, 9, 14], are dragging the hind legs and prevent the wildly implement of these PRS. As such, to take the advantage and avoid the drawbacks of PRS, an adapted version of PRS, a web-based PRS namely Poll Everywhere (www.pollev.com) is introduced in this paper and allows students to use their cell phone, tablet or computer as clickers. Poll Everywhere has been invented initially for public presentation purpose but rarely discussed by some researchers for educational purpose [9, 15-19]. Dr. Grasman's team [17] initiated the study of using Poll everywhere in the classroom. And Dr. W. Kappers' s team [15] extended Dr. Grasman's study to use PollEverywhere in the large-lecture classroom settings. Both studies found the student engagement is enhanced after using Poll Everywhere. But the impact of using Poll everywhere in the classroom may varies by different disciplines. As such, a case-based study of using Poll everywhere in the classroom attract raising attention. However, to date, only a few case-based studies for some engineering courses are reported, such as freshman-level engineering graphics course [18], a sophomore-level dynamic course [18] , and a senior-level control system course [18] reported by Dr. Otilia Popsescu's group, a junior-level electronic circuit course [16] presented by Dr. Lulu Sun's group, and a sophomore-level structure and the urban environment course [19]

probed by Dr. Aatish Bhatia's group. Since the impact of using conventional clicker PRS to the course varies by different disciplines, it is necessary to apply the Poll Everywhere to more courses and collect the case-based data for better evaluate the impact of using Poll Everywhere to improve student engagement and learning in class.

This paper proposes a case-based study of using Poll everywhere to overcome the drawbacks of typical clicking system, help with catching students' misconceptions, fostering their engagement and improving their academic performance at a medium size classroom for a freshman-level electrical engineering technology course, "electronic principle." An anonymous survey is implemented to collect students' feedback on their feeling and thoughts towards the use of Poll Everywhere. Besides, the in-class Poll everywhere responses are collected as well and compared with the academic performance records (grade for homework, quizzes, and exams) to assess the effectiveness of using Poll everywhere to improve students' academic performance and learning outcomes.

This paper proposes a case-based study of using Poll everywhere to overcome the drawbacks of typical clicking system, help with catching students' misconceptions, fostering their engagement and improving their academic performance at a medium size classroom for a freshman-level electrical engineering technology course, "electronic principle." An anonymous survey with 21 questions is implemented to collect students' feedback on their feeling and thoughts towards the use of Poll Everywhere. Besides, the correlation between the student engagement (supported by the in-class Poll everywhere responses) and the corresponding academic performance records (equivalent grade for homework, quizzes, and exams) is investigated to assess the effectiveness of using Poll everywhere to improve students' academic performance and learning outcomes.

II. METHOD

"Electronic Principle" is a freshman-level that is designed to familiarize students with basic principles of the transformer, diode, transistors, and essential electric circuit theorems. The students sit in a lecture classroom twice a week for 1 hour and 15 mins first and practice their learned theoretical content in a laboratory section. Assignments and quizzes are assigned to the students regularly. If a student had a misconception of a new concept, they would fail to conduct the hands-on experiment and get meaningful results. And the instructor may not realize until the homework and lab reports are graded after one or two weeks. Sometimes, it may take even longer time around two to four weeks for the instructor to find out this misconception until a quiz or an exam are tested on the content. To get the immediate evaluation of the students' learning, the Poll Everywhere was selected to this course in fall 2018 in a medium size classroom. The total sample size is 33(n=33).

Unlike the conventional clicker-based PRS, as a web-based PRS, Poll Everywhere is very easy to use and can realize a variety number of question types without training, such as multiple choices, truth/false, open-ended question and answer, short answers, word cloud, and even clickable image, and so on. The detailed question types can be found in Figure 1. However, the instructor still needs to create an online account in Poll Everywhere website and edit the questions before the class. Once the account is set up, an ID number together with code and a web link should be assigned to the instructor and keep the same for all the questions as shown in Figure 2. By either text the code to the assigned ID number via cell phone or go the weblink and vote via any devices

with internet access, the students should be able to enroll in the polling system successfully. A free version of Poll Everywhere service is using for this paper. Although it can accept up to 50 responses for the same question, the participants' names are not recorded, in other words, the results are anonymous. However, to better correlate the student learning and engagement with the usage of Poll Everywhere. Students' are required to write down their answers on a paper as well which will be collected after the class. And they can leave blank if they didn't vote for particular questions. The number of participants for each question can be checked on the Poll Everywhere website. As shown in Figure 3, the first question has a total of 24 responses as the second one has 27 responses. Since each participant can only devote one response, the number of responses should equal to the number of participants.

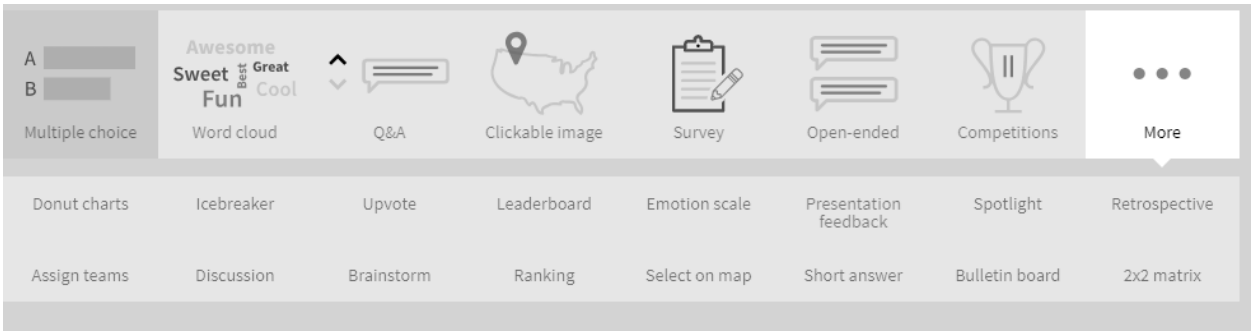


Figure 1. Question types in Poll Everywhere

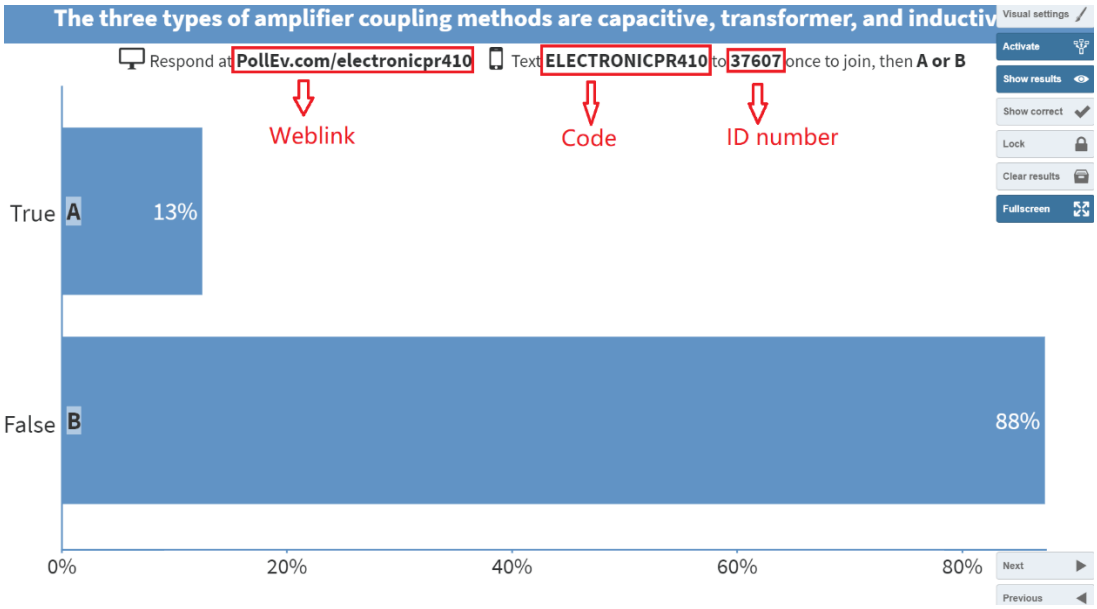


Figure 2. A snapshot of the assigned weblink, ID number and code for the course

Most Poll Everywhere questions are randomly pop up during the lecture to split the continuous course into several discrete segments for effective learning. The design question via Poll Everywhere for this course falls into three categories. First, pre-screening of the students 'background; second, questions are designed to access the students' understanding of a concept that is recently introduced in class; third, other questions related to student feedback of using this PRS. Example of the polling question include: (a) There are only two amplifier classes, A and B. [True/False] (b) what is true about the breakdown voltage in a Zener diode? [Multiple choices] (c) If the ambient temperature rises to 75℃， for every ℃, the max power dissipation decreases by

26.7mW/°C. The power rating is 4W at 25°C. What is the new power rating at 75°C? [Open-ended] and (d) suppose an ac voltage source has a source resistance of 47Ω. For what load resistance is the source stiff? [Q&A] Figure 4 (a), (b), (c), and (d) demonstrate the snapshot of three common types of example questions.

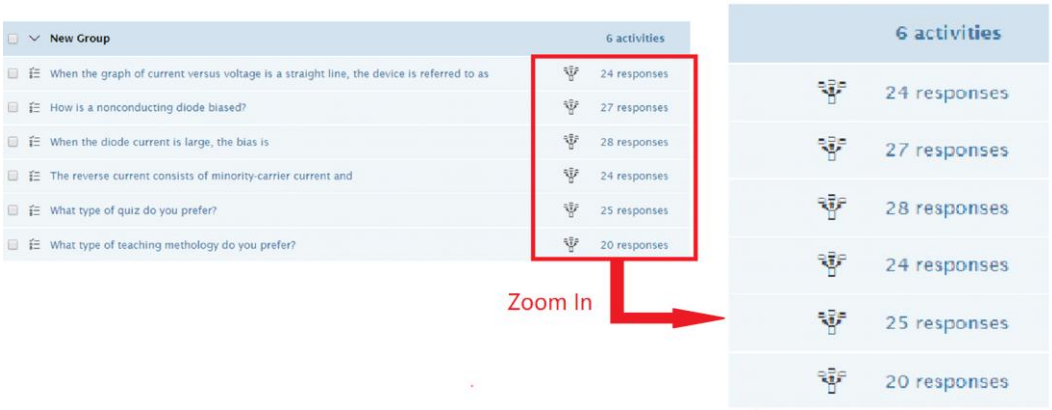
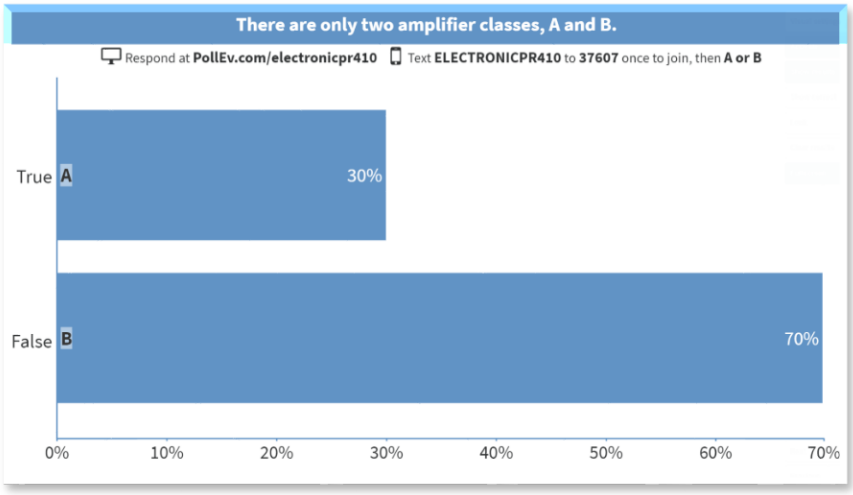
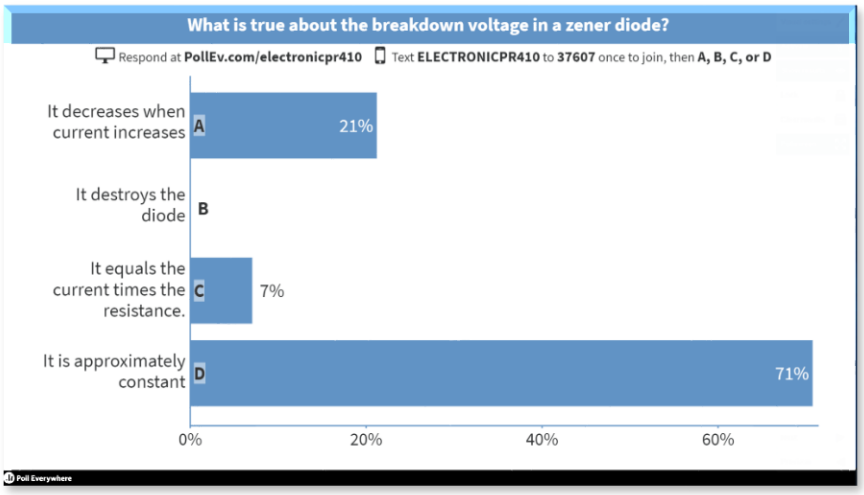


Figure 3. A snapshot of the total responses for different questions



(a)



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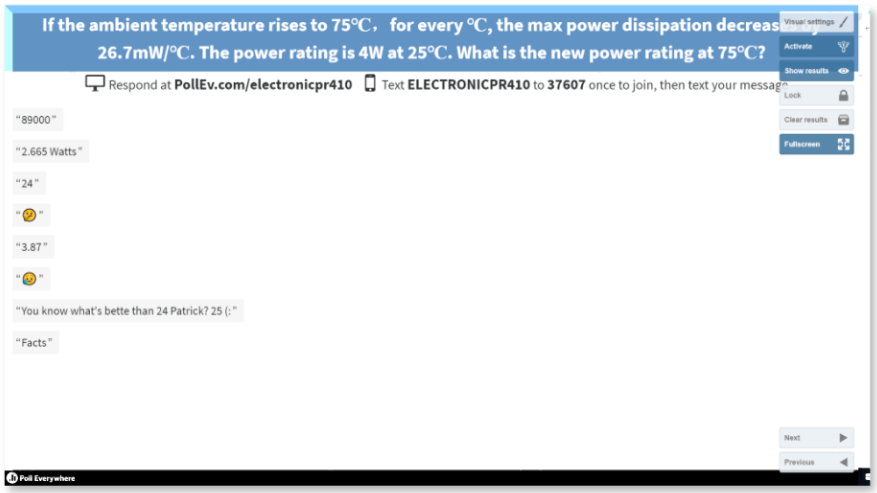

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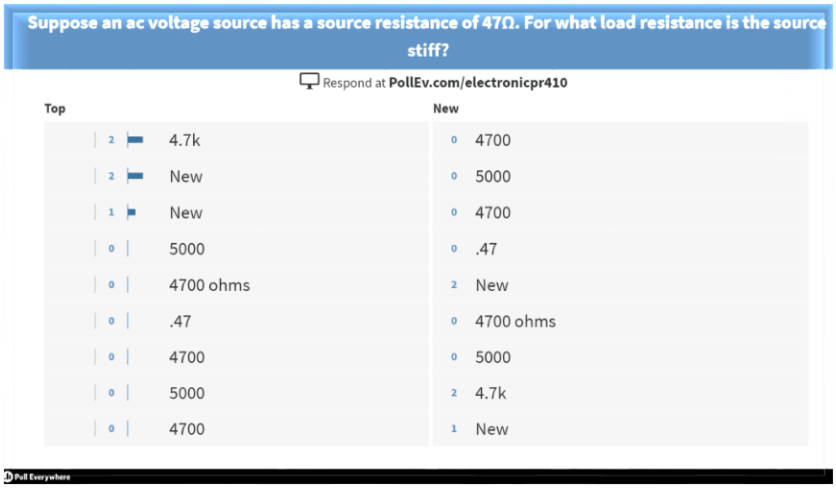

(d)

Figure 4. A snapshot of the commonly used question types:

(a) True/False; (b) Open-ended; (c) Multiple choices; (d) Q&A

III. ASSESSMENT

To investigate the impact of using Poll Everywhere on student engagement and learning experience, by the end of the semester, an anonymous survey including 20 True/False questions and one open-end question was created in Poll Everywhere and shared to the students via email. The questions used in the survey are adopted and modified based on the survey used by Dr. Popescu's group [18]. Regarding the 20 True/False questions, they are divided into four groups for assessing the different objectives, such as the actual use of Poll Everywhere in a classroom, the impact of Poll everywhere on student engagement and learning experience, and the overall preference of using Poll Everywhere. The percentage represents a cumulated number between agreeing and disagree. The open-ended question provides an opportunity for students to put their specific thoughts of Poll Everywhere. Out of 33 students, a total of 29 filled and submitted the form. Table 1 shows a summary of the survey responses for 20 True/False questions from the 29 participating students. A total of seven questions are proposed for evaluating the actual use of Poll Everywhere in the classroom. As shown in Table 2, 89% of participants feel comfortable sharing their response via Poll everywhere and disagree that using Poll everywhere is very time-consuming. 94% of participants don't believe that using Poll everywhere in the classroom is distracting. 78% of the participants find themselves have no difficulties using Poll everywhere in class and feel class time passes more quickly when Poll everywhere is used. Most of the participants (83%) agree that the response graphs provided by Poll everywhere are helpful and feel beneficial from seeing other students' response to a question. According to the results of this group, the students show the use of Poll everywhere is well accepted in the classroom without disturbing the class. Five questions are listed to evaluate the student engagement after using Poll Everywhere. 78% of the participants agree that the use of Poll everywhere increases their classroom participation in other ways, too. 72% of them find themselves still enjoy using Poll everywhere in the classroom after their first-time use. 67% of them admit that they feel more confident to ask questions. 56% of them even feel like to attend more classes when the Poll everywhere is used in class but does not feel motivated to spend more time on preparing the class still. As such, it can be concluded that the use of Poll everywhere in the classroom do promote the students' in-class engagement. However, the self-learning motivation of the students is not enhanced much according to the responses of the questions.

The impact on students' learning experience is accessed by six questions. The responses are also presented in Table 1. Generally, 83% of the participants believe that their understandings of the course content. It is particularly helpful for promoting the understanding of the concepts (89% agree). However, a few students find difficulty using Poll everywhere to learn how to apply the concepts to practice. As such, the percentage of agree drop 11% and becomes 78%. Besides, 56% of participants claim using Poll everywhere helped them better prepare for quizzes and tests. A considerable percentage, 83%, of participants do not think they would do better without using the Poll Everywhere. Overall, the results show that the students find their learning experience was enhanced by using Poll Everywhere. Moreover, 67% of the participants prefer to use more often in this course . 78 % of participants even interested in seeing the implement of Poll everywhere in other classes as well. Therefore, the students' overall experience of using Poll everywhere in this classroom is positive. This can be further validated by the response of a brief polling question

regarding the teaching methodology as posted in Figure 5. Figure 5 indicates that 70% of the students prefer using Poll everywhere other than other teaching methodology.

Meanwhile, the comments for open-end question also supported the results. Some selected positive opinions are shown below:

"Good source to learn from others in the class and remember the correct answers when examining happens."

"Help students who got the answer wrong fix their work and learn."

"I like poll everywhere; I think it helps with understanding concepts and makes discussions more active."

"I like using it the way we've been; it shows the whole class that we all think might be the correct answer to the question and how we can correct it if we're wrong."

"I think it's a fun addition to the class."

Table 1 A summary of the survey responses for 20 True/False questions (N=29)

Assessing objective	**Questions**	**Responses**	
		Agree	**Disagree**
1.Actual use of Poll everywhere	I feel uncomfortable sharing my response via Poll everywhere	11%	89%
	Using Poll everywhere during the class is distracting	6%	94%
	Using Poll everywhere in the class is too time consuming	11%	89%
	I had difficulties using Poll everywhere in class	22%	78%
	Class time passes more quickly when Poll everywhere is used	78%	22%
	The response graphs provided by Poll everywhere are useful	83%	17%
	I benefit from seeing other students' response to a question	83%	17%
2.Impact on student engagement	When we use Poll everywhere my participation increases in other ways too	78%	22%
	At first learning with Poll everywhere was enjoyable but later was boring	72%	28%
	Using Poll everywhere encourages me to spend more time preparing for the class	44%	56%
	Learning with Poll everywhere gives me confidence to ask more questions	67%	33%
	Using Poll everywhere encourages me to attend more classes	56%	44%
3.Impact on learning experience	Learning with Poll everywhere improves my understanding of course content	83%	17%
	Using Poll everywhere helped me better prepare for quizzes and tests	56%	44%
	Using Poll everywhere helped me understand the concepts	89%	11%

	Using Poll everywhere helped me learn how to apply the concepts to practice	78%	22%
	Using Poll everywhere promotes more focused discussing during the class	83%	17%
	I would do better in my class without Poll everywhere	17%	83%
4. Overall preference	I would like to use Poll everywhere more often in the class	67%	33%
	I would like to use Poll everywhere in other courses	78%	22%

"Spending more time going over the slides in class with more clear questions in poll everywhere, allowing more critical thinking and not just a rushed response."

"It could be good for when we solve the example problems. Because we can see how many people are getting the same solution or if people are running into common mistakes rather than wondering why it's wrong and copying the answers we can go over the ones people don't know and go faster through the ones people are getting correct."

"When my class used Poll Everywhere, it did increase participation."

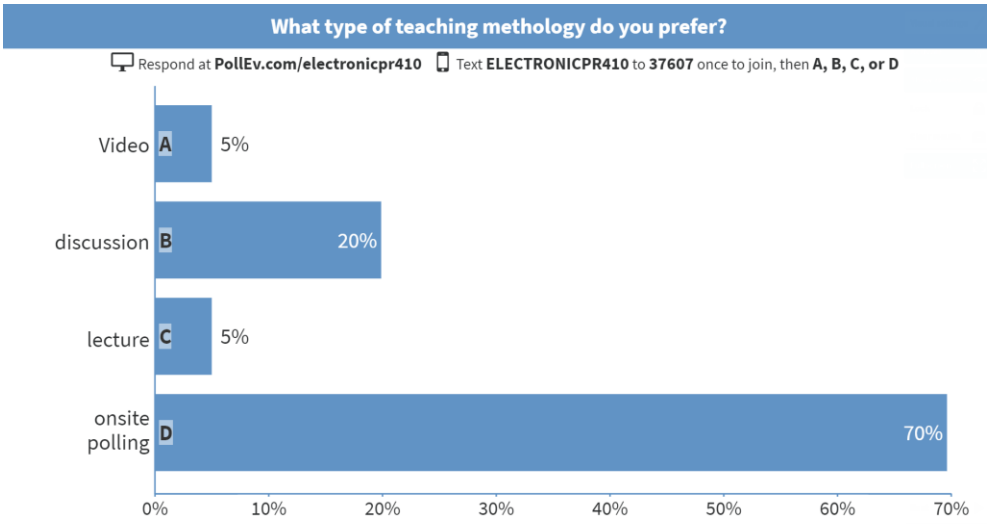

Figure 5. Polling results of the anonymous survey at the end of fall 2018

There is some negative or neutral feedback as well:

"It was essentially problematic from my view. It didn't help me much and often had technical issues. Nothing against it just didn't help much."

"I like the questions where you enter a specific answer instead of multiple choices."

As mentioned in the negative comment, the main drawback of Poll everywhere is that it heavily relies on the internet and existing issues when the internet connection is weak.

To assess the effectiveness of using Poll everywhere on improving students' academic performance and learning outcomes, a total of sixty questions are asked during the lecture.

According to the number of answered questions, the thirty-three participating students are divided into three engagement level: low (*A<20, N=7*), middle (*A=20-40, N=15*), and high (*A>40, N=11*) participation groups, independently. Please note, *A* presents the number of participated questions. *N* means the number of students at this engagement level. After compared the academic performance (represented by equivalent grade of quizzes, homework, and exams) of the students with the corresponding engagement level, the relation between the academic performance and student engagement can be found. Table 2 provides a comparison of academic performance (equivalent grade) and student engagement level. Figure 6 shows the correlation of student engagement level with the equivalent grade of the students. A significant positive correlation was found between these two items. Students with high engagement level better performance as compared to the students at medium and low engagement level ($p<0.001$; $\rho =0.99$). As proved by the results of the survey, the student engagement will enhance by using Poll everywhere; it can be concluded that by the using of Poll everywhere to enhance the student engagement, the students' academic performance will be effectively improved accordingly.

Table II Summary of the participation group and equivalent grade.

Engagement Level	Participation Rate	Sample Size	Equivalent Grade (Mean ± Std)
High	66.7%~100%	N=11	95.2%±4.5%
Middle	33.4%~66.6%	N=15	84.2%±5.9%
Low	0%~33.4%	N=7	71.7%±4.1%

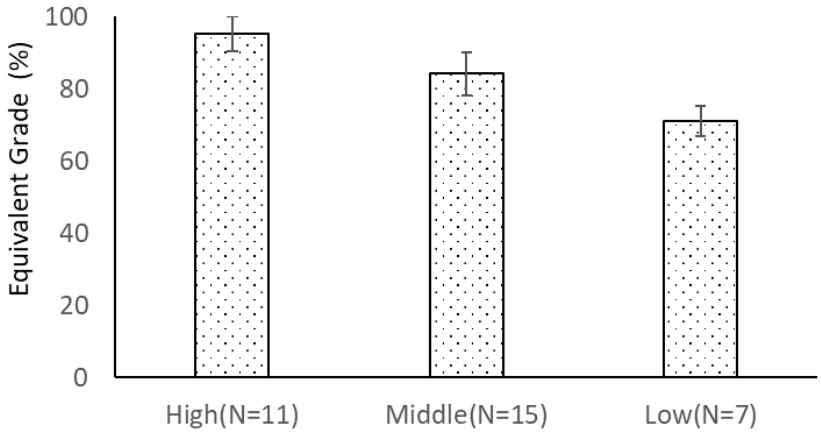

Figure 6. Comparison of the participation group and equivalent grade.

IV. CONCLUSION

This paper proposes a case-based study of using Poll everywhere to overcome the drawbacks of typical clicking system, help with catching students' misconceptions, fostering their engagement and improving their academic performance at a medium size classroom for a freshman-level electrical engineering technology course, "electronic principle." An anonymous survey with 21 questions is implemented to collect students' feedback on their feeling and thoughts towards the use of Poll Everywhere. Besides, the correlation between the student engagement

(supported by the in-class Poll everywhere responses) and the corresponding academic performance records (equivalent grade for homework, quizzes, and exams) is investigated to assess the effectiveness of using Poll everywhere to improve students' academic performance and learning outcomes. The study shows that the students have no issues of using Poll everywhere in class and find themselves engaging more and learning better. And the positive correlation between student engagement and corresponding academic performance can further validate that using Poll everywhere cannot only enhance student engagement and learning experience but also effectively improve academic performance.

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