Elevating Students' Academic Motivations through Peer Instruction

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Ying Yu

Department of Electrical and Computer Engineering

University of Hartford
yyu@hartford.edu

A typical class body consists of students who are fast-learners, slow-learners and those in between. The differences can sometimes be quite significant. Thus, one of the biggest challenges that an instructor always face is how to engage students of every level in the classroom. Well-designed peer instructional methods have the potential to fully engage every student. Whether a student is engaged in "instructing" or "being instructed", s/he will be involved in one-to-one interaction, thus will give and be given full attention. While students who are less informed on a certain topic catching up through the instruction of peer students, the students who are fast-learners will be able to further clarify and better their own understanding of the topic by debating and explicitly articulating their thinking.

"Clickers[1]" is also known as "audience voting system" or "instant polling system". Three basic elements make up a typical audience response system: polling software (similar to Powerpoint, but also let you collect data and organize them), response keypads (similar to small remote controllers, also where the nickname "Clickers" comes from), and a response receiver (also referred to as the base-station, usually a USB plug-in device). It allows audiences and students to participate in presentations or lectures by submitting responses to interactive questions using the keypads. This technology, if incorporated suitably, has the potential to tremendously enhance contact between students and faculty, encourage active learning, give prompt feedback, and communicate high expectations. Due to the "analytical" nature of the engineering and technology classes, the use of "Clickers" needs to be specially adapted.

"Peer instruction" was introduced by Professor Eric Mazur and has become a successful interactive teaching method in physics[23]. It was also shown to improve students' performance in science classes[4]. The method can be described in the following steps: (a) Students are given the "ConcepTests" designed as multiple-choice questions. (b) Students anonymously use "clickers" to input their first-round tentative decided answers through independent thinking. (c) Students are shown the histogram of the voting results of the whole class. (d) Students form groups to include different answers to discuss and debate their choices. (e) Students are given the chance to revise their answers. (f) Final histogram is revealed and the correct answer is explained by the instructor.

Descriptions of the two courses implemented with the peer instruction methods:

A peer instruction method using clickers is implemented in two engineering fundamental courses to demonstrate the effect of healthy "peer pressure" in elevating

students' academic motivations. The two courses are "Digital System Logic for Engineering, Lecture/Lab" and "DC and AC Electrical Fundamentals for Engineering Technology". Both require three lecture hours and three lab hours, have approximately 10~20 students for each session, and are offered every spring and fall semester. "Digital System Logic" has a student body that is generally composed of sophomore students from Electrical Engineering, Computer Engineering and Computer Science majors. Its topics include elementary number systems and codes, Boolean algebra, circuit minimization, combinational and sequential circuit analysis and synthesis, medium-scale integrated circuits, state machine tables and charts, hazards. "DC and AC Electrical Fundamentals" has a student body that is generally composed of freshman students from Electrical Engineering Technology, Computer Engineering Technology and Audio Engineering Technology. Its topics include DC circuits, phasors, sinusoids applied to R, L, C series and parallel circuits, DC and AC source conversions and circuit theorems, mesh and nodal analysis, transformers.

Examples and Practical Implementation Techniques:

Figure 1 (below) is a sample slide from the course "Digital System Logic". It includes the question on the top and three choices below. There is also the bar indicating the number of students that have already sent the answer. It also includes a count-down timer that the instructor can choose to include and set at a specific amount beforehand. It is a pre-voting sample, so the columns of the histogram on the right show zero percentage for the three choices. The example is a very simple fundamental question that the students can answer immediately without complicated calculations if they understand the concept. When the students are engaged in peer-instruction, they can also focus on the concept instead of mathematical calculations. The amount of time allowed for peer-instruction discussion is usually flexible, depending on the progress in general.
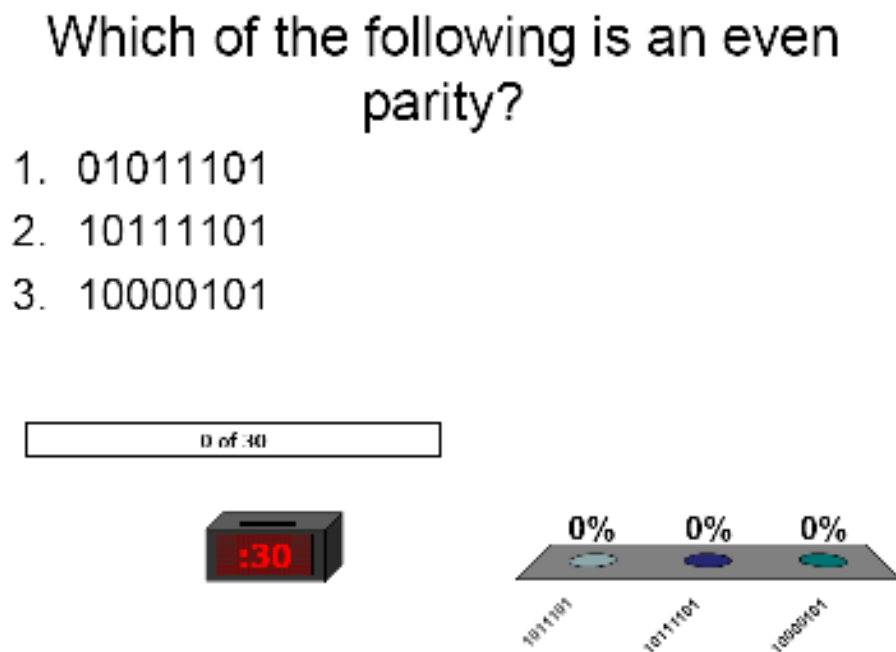

Figure 1: Pre-voting Sample Slide from "Digital System Logic"

Figure 2 (below) is also a sample slide from the course "Digital System Logic". It is one of a series of question slides that compose a relatively more advanced complete problem, which requires the knowledge and understanding of multiple concepts. Due to the fact that only multiple choice questions can be implemented, the author has found it better to break down complicated problems into multiple questions, each involving one or two concepts at most. This gives the students the opportunity to focus on their understanding on one specific concept. On the other hand, this facilitates the instructor's analysis of the students' answers after class and helps identify the students' level of understanding for each individual concept. It also limits the amount of time of each peer instruction discussion session, which the author has found to be crucial in terms of keeping students concentrated and prolonging their attention span. The sample also demonstrates that you can include pictures in the question slide.
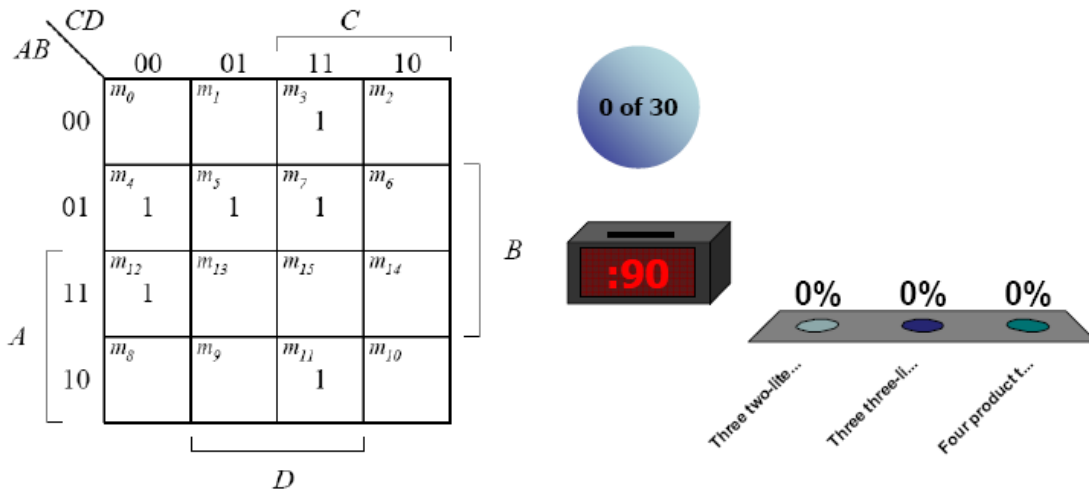

Figure 2: Pre-voting Sample Slide with a Picture from "Digital System Logic"

Assessment and Results:

The students' perceptions and learning experiences were mainly assessed through: one-on-one interviews, focus groups and anonymous student surveys. The statistics showed that all the students surveyed strongly agreed that "Clickers" were easy to use. The instructor also found that the installation of the software and the base station very easy

and the software is very compatible with Microsoft Windows, the transmission system was very reliable, and the batteries lasted adequate amount of time. The hardware and software purchased from "Turning Technologies" were robust, easy to use, and least costly compared to products from other companies.

After trying out different quiz question styles, the author concludes that: due to the "analytical" nature of most of the questions in a technology or engineering class, in order to require students to generate instant responses and review immediately afterwards, the best practice is to break down complicated problems into single-step questions and limit the required time to generate an answer between 30~90 seconds..

More than 50% of the students surveyed agreed that peer instruction using "Clickers" helped them focus better in class, while about 40% remained "neutral". After observing student behaviors during classes and several discussions with individual students, the author concluded that peer instruction using "Clickers" helped students with poor concentration the most while having less effect in this aspect on students who had long attention span to begin with.

About 95% of the students agreed that peer instruction using "Clickers" made them more aware of their levels of performance in comparison with their classmates. This is due to the fact that when using "Clickers" system to complete a quiz or a review session, the students immediately knew the percentage of the students giving the correct answer and how fast other students responded with their answers. Through peer instruction, they got to know each other's way of thinking and level of understanding. This provided a certain amount of healthy peer pressure to students who were lagging behind, while it also propelled the more knowledgeable students to stay ahead and gave them a sense of achievement by instructing others.

About 80% of the students surveyed agreed that peer instruction using "Clickers" made them more aware of the instructor's expectations. The instructor would immediately explain how to derive the correct answer and demonstrate the different approaches possible. Students would realize their mistakes right away and this reinforced their memory and was crucial to solidify their understanding and knowledge. The author also inserted a "countdown clock" for each question slide, which let the students know the expected time frame. This feature definitely helped to emphasize time on task.

About 90% of the students surveyed agreed that peer instruction using "Clickers" provided anonymity and made them more willing to participate in class. The anonymous nature of using the "Clickers" system provided every student the chance to actively engage in class. The author also observed many fewer incidents of text messaging and laptop distractions. Majority of the students surveyed agreed that "Clickers" should be used more often in classes.

The students' learning performances were mainly measured through the instructor's personal experience and test performance comparisons. Due to the lack of standardized tests or parallel same course sessions, the test performance comparisons were mostly conducted against those of past class sessions. Although the student body changed and the tests were updated each year, the author has observed significant overall improvements in students' understanding and their retention of the knowledge.

Conclusions and Future Work:

The peer instruction method using "Clickers" dramatically increased students' active classroom participation and enjoyment of the learning process. Students also reflected that their understanding and retention of the knowledge were improved. Students' academic motivations were elevated due to the healthy peer pressure that was brought out through peer instruction. Peer instruction also encouraged students to frequently interact with each other and thus helped create better learning communities. The author plans to continue to design more and refine the current ConcepTests. It is also imperative to gauge students' performance improvements quantitatively, which is the next step in the near future.

References:

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