Classicle Sticks: An Activity to Improve Student Engagement

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Abstract

A game played in some middle-school classrooms has been adapted for engineering lecture courses with 15-45 students in the classroom and is described in detail. It has been implemented previously in Electrical Engineering at Texas State University in Electronics 1 & 2, Electromagnetics, and Linear Control Systems and those experiences served to improve and fine-tune the activity to its present form. It was measured in Electronics-1 in Electrical Engineering, and in Statics and Strength of Materials and Structural Analysis courses in Engineering Technology. The activity is designed to improve student engagement and attention while making the lecture period more fun. The nature of the exercise gives students an equal opportunity to ask questions. The activity can be used to check understanding and to probe prior or related knowledge before introducing new concepts, and to point out concepts or techniques in which the students are weak. It also gives the instructor the opportunity to learn students' names more quickly. A Likert survey was created and administered to probe facets of the exercise such as level of engagement, level of attention paid, student stress level, and fun in the classroom. The activity accomplished several of the desired outcomes, such as students reporting that they arepaying closer attention, having more fun, and being more engaged. While the Electronics class recorded higher scores for these items, the other two classes also reported mean scores near Agree. The lowest scoring items throughout were the activity being low stress or students looking forward to engaging in the Classicle activity.

Introduction

A student engagement activity using craft sticks in middle school classrooms was modified for college use. It was named Classicle Sticks in recognition of Popsicle® sticks. Each craft stick has a student's name printed on it. A question is asked, a stick is drawn, the question is repeated, and the student is expected to attempt to answer the question. The activity gives each student the opportunity to answer a question and facilitates the checking of understanding.

Background

Education literature has shown the importance of checking understanding of a topic in the teaching environment [1], [2]. This check in can be done in many different ways. Some research has established the relationship between student engagement and learning [3]. This relationship between the student and the teacher can have a positive effect on the student's learning [4]. In the k-12 learning environment, a wide range of techniques have been used to engage with students. Their applicability to the college engineering learning environment is not clear for some techniques. This study looks at the use of popsicle stick activity [5], [6] used in the middle school environment in a college classroom teaching engineering topics. Previous use of popsicle sticks in the engineering classroom has primarily focused use of their physical properties and use as building resources [7], [8].

Preparing The Activity

Procure three containers. Two of the containers must be large enough to hold all the craft sticks. For classes in the range of 15-45 students, this will be the number of craft sticks plus about ten.

Label the two larger containers as follows:

1. Pool (or Next, or Up Next, or On Deck, etc.)
2. Done (or Done For Now, etc.)

Label the third container as Absent (or Jar O' Shame, or Ditched, etc.)

Procure wooden craft sticks. The wider ones (3/4") are easier to write on and are more visible.

Names can be printed upon the craft sticks in several ways. One method is to pass blank sticks out to the class, asking each student to clearly print his or her first and last name on one side of their craft stick. Students are encouraged to print how they prefer to be addressed, e.g., Daniyar prefers to be called Dan. Another method is for the instructor to print the names on the sticks, although this does not always capture how a student may prefer to be addressed. It is important to leave the other side blank regardless of which method is used.

For classes in the 15-45 student range, add the following sticks, again with writing on just one side:

- Up to about six entitled Wild Card
- As many as five with your name (Instructor Sticks)

Wild Cards make for more lively action but also lengthen the time to answer a particular question. Sticks containing your name also make for more lively action while shortening the time spent answering a question. Some experimentation may be necessary to find the best balance for a particular class. Smaller class sizes may require fewer Wild Cards and Instructor sticks.

Conducting the Classicle Activity

Student Sticks

Initially place all the sticks in the container labeled Pool. Ask the class a question giving whatever time to discuss the question with a neighbor or have the student think about it as you normally would then pull out a stick at random and place it under the document camera (or hold it up) for all to see. You cannot start a class period with a Wild Card so if one is drawn, put it back in the Pool and draw again.

Repeat the question after the student's stick is drawn. The student is expected to make a reasonable attempt to answer the question. It is recommended to tell them on occasion that it is perfectly acceptable if they do not know the answer. If they do not know the answer or answer incorrectly, draw another stick while repeating the question, expressing the question a bit differently or with clarification. The second student you have drawn may work with the first student and they can attempt to answer the question together. This statement regarding working together may need to be repeated throughout the semester. If the question is answered correctly both of their sticks are placed into the Done container.

Sometimes two students cannot answer the question. Repeat the question, again with more elaboration or clarification, draw one more stick, and allow the three of them to formulate an answer. If the question is correctly answered then all three sticks go into the Done container. If the three students working together cannot answer the question, the instructor places all three sticks in the Done container and provides the answer and either does a quick review of the concept or notes it for review at some other time. If three randomly chosen students cannot answer a relevant question, this scenario is an indicator that the concept needs to be reinforced.

Instructor Sticks

If after asking the question the instructor's name is drawn then the instructor repeats the question then states the answer. This scenario can be made light-hearted, for example by saying something like, "Whoa! That's a tough question!" or "Hey, I'm supposed to know this," or whatever suits the type of relationship you have with your students.

Wild Card Sticks

If the Wild Card is drawn, then the last student who was called upon gets to choose any student (i.e., not the instructor) in the class to field the question. The last student called upon can answer the question if they wish but students usually choose someone else.

Absences

If a student's stick is drawn but they are absent, his or her stick goes into the Absent container. The exception is for a pre-planned or approved absence in which case the stick goes back into the Pool. When the activity commences during the next class period, the first draws are from the Absent container until either it is emptied or all students previously absent have been called upon. If a student from the Absent container is called upon and he or she is absent, his or her stick goes

back into the Absent container. Once the Pool container is empty, all the sticks in the Done container go back into the Pool.

Methods

A Likert-scaled survey was created and administered to probe various aspects associated with the activity, including: level of engagement, change in paying attention, stress level, and fun. The survey was administered in the second half of the courses (Week 8 of 15) to yield comparative data, as the activity was not conducted in the first half of the course.

The items listed below were used in the survey instrument. The order of the questions was mixed but are grouped below by concept being probed. A five-point Likert scale was used: Strongly Disagree (1), Disagree (2), Neutral (3), Agree (4), Strongly Agree (5). Negatively worded items were reverse scored. A composite score for the seven question areas was calculated by averaging the two items within that area. Students who responded to every survey item with the same response (for instance "Strongly Agree" for both negatively and positively worded statements) were removed from the data set prior to analysis. The survey was administered to three classes, Electronics-1 (n=24), Statics and Strength of Materials (n = 18), and Structural Analysis (n = 22). The first course, Electronics-1, is taught in Electrical Engineering and the other two are taught in Engineering Technology.

Table 1: Survey Items and Groupings

Survey Item	Grouping
Class was more fun when we played classicle sticks than when we did not.	Overall Fun
When the instructor used the sticks, class was less fun than before.	
When the instructor used the sticks I felt less stressed than before.	Low Stress
I felt more stressed in class when the instructor used the sticks.	
I was more engaged in class when the instructor used the sticks.	Engagement
The use of the sticks did not make me more engaged in class.	
I thought more about questions asked by the instructor when sticks were used.	Thinking
When sticks were used I didn't think about the questions as much as before.	
I looked forward to the classicle sticks activity.	Anticipation
I did not look forward to the instructor using the sticks.	
The wild cards made the activity more fun.	Wild Cards are Fun
The activity was less fun when wild cards were drawn.	
I paid closer attention when the instructor used the sticks.	Attention
When the instructor used the sticks I did not pay closer attention than before.	

For each composite scale, descriptive statistics were calculated and the distribution of the scores were compared between classes using Kruskal-Wallis tests. Post Hoc pairwise comparisons explored the source of overall differences in distributions and a Bonferroni correction for multiple tests was used to adjust the significance values for these tests.

The survey also contained a field for students to leave comments. No prompt was given in the survey given Electronics-1. In Statics & Strength of Materials and in Structural Analysis, this survey was embedded in an end of course survey. The comment section of that survey prompted students to ask questions regarding the final exam review and a self-reflection about how well they learned the course material versus their initial expectations. The comments received in those two classes did not address the Classicle game. Of the twenty-four students in Electronics that completed the feedback survey, all left comments pertaining to the Classicle activity.

Limitations

This data relies on the self-reported measures of the Likert scale survey. In this preliminary stage a limited sample size was taken, but a large set of data would be desirable. Like many activities, the instructor's role in the activity could influence the students' overall experience.

Results

Each class's mean response to the topical groupings is presented in Figure 1, which also includes standard error bars. Five of the seven items had statistically significant differences between the Electronics class and the other two courses, with the students in the Electronics course responding more favorably in each of those five scenarios. The two scales that saw similar results throughout were Low Stress and Anticipation, which showed all students to trend towards neutral on these items.

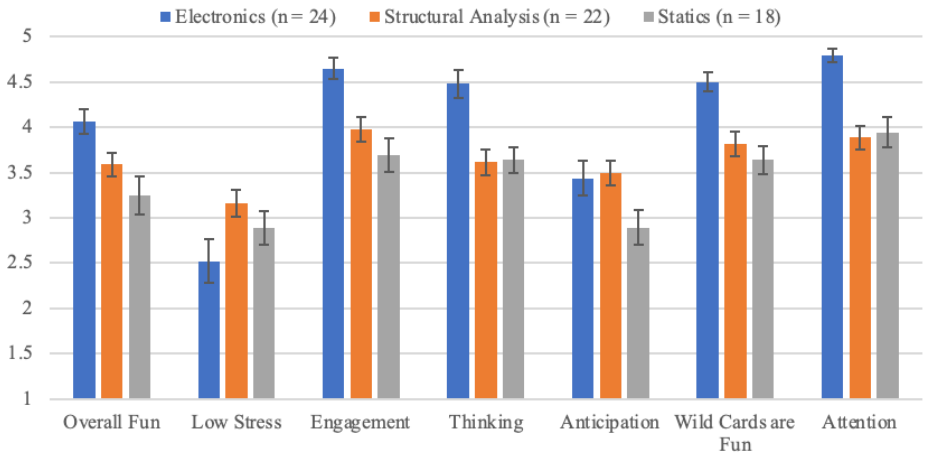

Figure 1: Mean Scores of Each Survey Subscale Item by Course

Kruskal Wallis tests were run to examine the differences in response distribution between each course. While all Kruskal-Wallis results are reported in Table 2, only the statistically significant and moderately significant results of the pairwise tests are reported for clarity. The trend that was graphically observed in Figure 1 is confirmed through these tests: the students in Electronics rated the Classicle stick activity higher in five categories (Overall Fun, Engagement, Thinking, Wild Cards are Fun, and Attention) than the students in either Structural Analysis or Statics & Strength of Materials. The results from Structural Analysis and Statics & Strength of Materials tended to be statistically similar, except for the category of Anticipation, where the average rating from Structural Analysis was moderately higher than the rating from Statics & Strength of Materials.

Table 2: Kruskal Wallis Tests of Distribution Similarity Results

					Kruskal-Wallis		Post-Hoc tests	
	n	M	Md	Range	$X^2_{K\text{-}W}$	p	Group	p*
Overall Fun								
Electronics	24	4.06	4	2.5-5	10.49	.005		
Structural Analysis	22	3.59	3.75	2.5-5			Electronics > Strc'l. An.	.071
Statics & Strength	18	3.25	3.5	1-4.5			Electronics > Statics	.006
Low Stress								
Electronics	24	2.52	2	1-5	5.63	.060	Strc'l An. > Electronics	.058
Structural Analysis	22	3.16	3	2-5				
Statics & Strength	18	2.89	3	1.5-4				
Engagement								
Electronics	24	4.65	5	3-5	21.09	<.001		
Structural Analysis	22	3.98	4	3-5			Electronics > Strc'l. An.	.001
Statics & Strength	18	3.69	3.75	2.5-4.5			Electronics > Statics	<.001
Thinking								
Electronics	24	4.48	5	2.5-5	17.65	<.001		
Structural Analysis	22	3.61	3.5	2.5-5			Electronics > Strc'l. An.	.001
Statics & Strength	18	3.64	3.5	3-5			Electronics > Statics	.001
Anticipation								

Electronics	24	3.44	3.25	2-5	5.54	.063		
Structural Analysis	22	3.50	3.5	2-4.5			Strc'l. An. > Statics	.068
Statics & Strength	18	2.89	3	1-4				
Wild Cards are Fun								
Electronics	24	4.50	4.5	3.5-5	18.59	<.001		
Structural Analysis	22	3.82	4	2.5-5			Electronics > Strc'l. An.	.002
Statics & Strength	18	3.64	4	2.5-4.5			Electronics > Statics	<.001
Attention								
Electronics	24	4.79	5	3.5-5	29.34	<.001		
Structural Analysis	22	3.89	4	3-5			Electronics > Strc'l. An.	<.001
Statics & Strength	18	3.94	4	2-5			Electronics > Statics	<.001

* Post-Hoc Tests used the Bonferroni correction to adjust significance for multiple tests

Note: n = number, M = Mean, Md = Median , $X^2_{K\text{-}W}$ = Kruskal-Wallis test statistic, p = probability this result could occur under a null hypothesis.

Discussion

The activity accomplished several of the desired outcomes, such as students reporting that they are paying closer attention, having more fun, and being more engaged in class. While the Electronics class recorded higher scores for these items, the other two classes also reported mean scores near Agree. The lowest scoring items throughout were the activity being low stress or students looking forward to engaging in the Classicle activity. Anecdotally, the activity tended to slow down the pace of the class versus allowing student volunteers to answer questions. In the first half of the Electronics course, before the activity was conducted, the same set of assertive students would typically answer questions. During the activity conducted in the course's second half, only the individuals called upon were permitted to answer, and this process often took more time. In Structural Analysis and Statics & Strength of Materials the time impact was less noticeable as the instructor typically called on students by name, but did so by looking for whichever students were missing their name signs (a piece of cardstock, folded in half, on which the students had written their preferred names on the first day of class). By asking the question and then giving students 15-30 seconds to talk with their neighbors about it before drawing the Classicle stick, it encouraged all students to think about the answer because they did not know who was being called. As such, the activity acts as a randomizer for calling on students as part of active learning [9].

Across these three courses, there were only two instructors using the Classicle sticks (one instructor taught two of the courses). One instructor who taught Electronics and the other instructor taught the remaining two courses. Based upon the results of each category's mean and the statistical analysis, there were clear differences in the class responses between the two instructors. Further, there were very few differences between the student responses in Structural Analysis and Statics & Strength of Materials, which were taught by the same instructor. As such, it is expected instructor difference is likely to influence the students' perceptions of the activity's fun and engagement. Differences between the Electronics course and the other two courses may have also contributed to differing responses between the two instructors. Statics & Strength of Materials and Structural Analysis were 80-minute lecture courses offered at 11:00am and 2:00pm, respectively whereas Electronics-1 was an 80-minute lecture at 8:00am followed immediately by an 80-minute lab session. It is possible that the classicle stick activity had a greater effect at 8:00am than later in the day. Differences in the courses also exist. Statics & Strength of Materials, and Structural Analysis, likely both include some concepts that students can relate to previous knowledge, whereas in Electronics-1 students must learn a symbolic language to which they have not yet been exposed, and learn to analyze non-linear devices (transistors) for the first time.

Written comments pertaining to the Classicle activity were grouped into categories and tallied. Of these, 20.8% (5/24) wrote that they anticipated possible questions and responses during the activity. A similar number, 16.7% (4/24) of respondents wrote that they read lecture materials in advance to prepare for the activity. Both outcomes are highly desirable and suggest higher levels of cognitive engagement.

Several comments from Electronics students were noteworthy and are reproduced below.

"I really enjoyed playing classicle sticks this semester. I was sometimes stressed coming to class and getting my name drawn, so I ended up reading previous lecture materials in preparation. This exercise also helped me gauge where I was at. When multiple people couldn't answer a question that I was called for and couldn't answer, it made me feel better about where I was at in my education."

"I'm typically a quiet student, who just listens to the instructor and try to make sense of the material. But being part of this experiment I did kinda want to be more interactive with other classmates and trying to figure out what the answer was before the person's name was pulled. This was fun and made making mistakes in front of classmates and professors more acceptable."

"I appreciated the idea of the instructor going over a topic when at least three students could not answer a question when their classicle was drawn, it showed a subject was worth re-visiting."

"The use of the sticks was stressful and I didn't look forward to going to class because I was worried about not knowing the answer to a question, however I did put more effort into getting ahead on the lecture material before class. I often looked at lectures the day before and tried to guess what type of questions would be asked. My exam grade increased by 20-ish points when the sticks were used."

Both instructors who implemented the activity noted that they learned student names more quickly than before. One instructor found they switched to asking more questions with shorter answers to involve as many students as possible in the discussion. For instance, when students were reporting out after working on a problem with their neighbor in a coaching session, the instructor would call on different students for each step of the problem instead of having one group share their whole process. When the number of questions is enough to go through all the sticks about once a week, it increases the likelihood of students being called on and encourages them to pay close attention. Calling students by name to answer questions is one of the simplest ways to implement active learning, because it prevents the most outgoing students from answering all the questions in class while everyone else sits passively. Further, the craft sticks were very easy to implement in class and created randomization in how students were called upon. Coupled with the increased fun and engagement level this activity made for a more enjoyable teaching experience for the instructors.

The improved rate of learning student names was not measured in this study. One way this variable could be measured might be for an instructor to implement the activity in one class but not another (of similar class size) and measure how long it took to learn the names of some number of students.

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