The Stanley Cup of Transport Phenomena

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Abstract

It has been argued that it is becoming more difficult to successfully engage today's engineering student. For example, the standard lecture is popular among faculty but is considered boring to students. In fact, some students have chosen to not even attend class on a regular basis. While it is possible (and often desirable) for students to teach themselves, class attendance has been linked with better performance on exams covering the subject material. A variety of teaching methods (in addition to lecture) must be employed to connect with students that exhibit different learning styles.

As such, this paper describes a semester long, interactive, in-class competition with the goal of increasing student attendance and attention. Students are broken up into one of five teams with the challenge of winning the "Transport Cup." During a break in the class session, a question is asked of a randomly chosen student, who receives participation points for attendance and for providing the correct answer.

The intended consequences of this competition are that:

- It allows the students a short break from notetaking
- It allows the instructor to take attendance on one or two students
- It allows the instructor to give as "prizes" something that he did not want to keep
- The students get a chance to laugh and have some fun while learning
- It allows the instructor a chance to review a concept from the last class
- It recaptures the student's attention after the question and review are over

An unintended consequence of this competition is increased student pride in the performance of their team and encouragement of their "team members" to come to class.

Introduction

Felder and Silverman[1] have studied the subject of learning and teaching styles, and classify a learner by the following categories:

1. What type of information does the student prefer (sensory or intuitive)?

2. Which route allows course information to be most effectively presented (visual or auditory)?
3. By which method is information best organized for the student to learn (inductive or deductive)?
4. How does the student process information (active or reflective)?
5. How does the student progress in their learning (sequentially or globally)?

The teaching style of a course instructor can also be described by the same categories. This paper will focus on an aspect of the fourth classification, active vs. reflective learning.

Studies have shown[2-6] that students typically learn best in an active mode; however, engineering is usually taught as lectures. The use of active learning is underscored in teaching textbooks[2-3] and those intended for the new professor[4] as well as in numerous conference proceedings and engineering education archival publications and conference proceedings. A good listing of references are presented by Smith[5] and by Dyrud[6].

A great deal of information on improving student-teacher interaction through active learning is presented at the National Effective Teaching Institute (NETI)[7] and the Excellence in Engineering Education (ExcEEd)[8] workshops. One former attendee and active learning advocate is Ken Reid (currently an Associate Professor of Electrical Engineering at Indiana University Purdue University Indianapolis) who highlighted the positive experiences in his classroom[9], and summarized simple ways that faculty can increase active and collaborative learning in their lectures and within the laboratory[10].

Improving student motivation may also improve learning, as was recently illustrated by Newell who developed a game based on the reality television show "Survivor" within a material and energy balance course[11]. Newell referenced the student motivation classifications of Biggs and Moore[12]:

1. Intrinsic – learning because of a desire to learn
2. Social – learning to please others
3. Achievement – learning to enhance one's position
4. Instrumental – learning to gain long-term rewards

Within the chemical engineering education literature, a popular way to use active learning within the classroom is through quiz shows such as "Jeopardy" or "Trivial Pursuit"[13], "Hollywood Squares"[14], and professor-created games such as "Green Square Manufacturing,"[15] "True Blue Titanium Game,"[16], and "Chemical Engineering Balderdash"[16]. Although these games usually only address the knowledge or comprehension component of Bloom's taxonomy[17], these games certainly address the social and achievement components of Biggs and Moore. Newell[11] found that the "Survivor" game addressed all four motivation categories and improved student learning. The author of this paper has used a version of "Jeopardy" to improve student involvement and motivation in final exam review sessions for CM3120 Transport / Unit Operations 2, but had been searching for something to use on a frequent basis during the semester. This

is the driving force for the development of a semester long competition for the "Transport Cup."

The Stanley Cup of Transport Phenomena

The week before the start of the semester, the course instructor took the preliminary course roster (of 63 students) and randomly divided the students into five "teams," named after regional professional sports teams with sponsors being important concepts in the area of transport phenomena:

- "Integration by Parts" Packers
- "Method of Least Squares" Lions
- "Separation of Variables" Vikings
- "Boundary Layer Flow over" Red Wings
- "Trial and Error" Tigers

The students were informed of the competition on the course syllabus and during the first class meeting. Students "worked" with their teammates only to win the Transport Cup, and were not obligated to work with them on homework or anything else.

The competition was orchestrated in the following manner:

1. During most class sessions, the instructor called upon a randomly selected student.
2. If the student was present, their team earned two points. If the student was not present, their team received no points and a student from another team was called upon.
3. If the student answered the question correctly, the team received an additional two points and the student won a prize. The prizes were typically items that the instructor had no further use for but did not want to throw in the trash. Typical prize items included music compact discs, pens and pencils, and miniature action figures. If the student did not answer the question correctly, the team received no additional points and a student from another team was called upon.
4. Each team would be called upon once per cycle. This allows each team an equal chance to score points. Thus, if team A, B, and C had already been called upon during the cycle, a random student was chosen from team D and team E before starting a new cycle.
5. An individual student would not be called upon a second time until all students had been called upon once. This was not told to the students. As there were 63 students in the course and about 41 class meetings, some students were never called upon. There were five cycles completed during the semester (25 questions).

To improve student attendance, the points earned in the Transport Cup competition by individual students were counted towards the students' course participation (worth 2% of the final grade). The total number of points earned by each team was carried over into the Transport Cup playoffs, which occurred during the last week of class in the form of a

review session called “Transport Jeopardy.” Teams would “ring in” with their team noise, and their point total would increase by one for a correct answer, and decrease by one for for an incorrect answer. The team with the highest point total at the end of the playoffs was deemed the winner and was awarded the “Transport Cup,” (a baby food jar and drinking cup wrapped in aluminum foil) shown in figure 1 below.

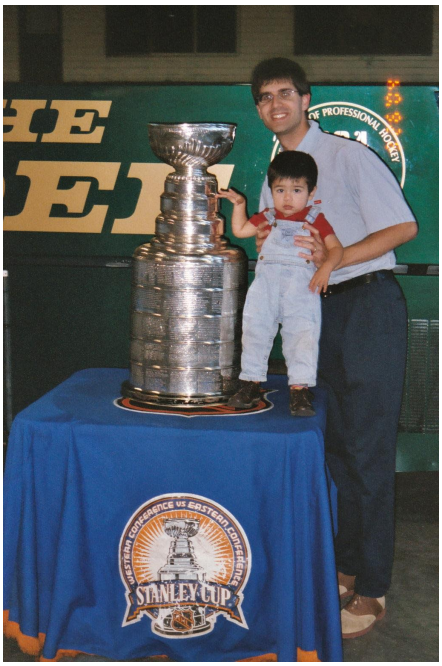

Figure 1. Left: Andrew and Jason Keith with the real Stanley Cup at the Dee Stadium in Houghton. Right: The Transport Cup “engraved” with the 2004 team champion, transport properties, and the Blasius equation.

Instructor Comments on the Competition

This course met Monday, Wednesday, and Friday at 8 am. For the first three years that the instructor taught the course, attendance was sometimes low (estimated at 50% on some Friday meetings). The main driving force of the competition was to develop a mechanism by which students would want to come to class so that they could learn the course material. The instructor did not collect any “data” to see if there was an increase in attendance, but it appeared that attendance increased slightly. This may be attributed to the class participation portion of the course grade. However, using a participation grade of 2% was still probably too low to motivate students to come to class. A value of 5%-10% would probably result in improved attendance.

The question of the day was typically asked at the midpoint of the lecture, although on certain days, when the classroom seemed to be empty, the question was asked at the beginning of lecture. By stopping the class at the midpoint, it gave the students a chance to finish copying the notes and take a short break. The questions were typically in the knowledge or comprehension classification of Bloom’s Taxonomy[17]. The idea was to use the questions as a drill exercise by which students would gain familiarity with some of

the complex jargon used in chemical engineering, and particularly in transport phenomena. For example, a question that was asked at least three times was "What are the units on diffusivity?" but may have been presented as "What are the units on thermal diffusivity?" Knowing the terms within dimensionless groups as well as their physical significance were also popular questions. More advanced questions could also be used.

Students anticipated seeing what the prize would be. The instructor would often crack a joke about his poor choice in music. After the laugh was over, the students seemed ready to learn more of the course material. Sometimes at this break, the instructor would show a slide with the current standings. "Now we're out of first place!" was heard from some students as the semester was nearly over. It was also interesting that some students were upset that their team members were not present in class when called upon. "He is not here, can you ask me the question instead?" This showed that at least some of the students cared about a competition for a baby food jar wrapped in aluminum foil. Perhaps they also cared about learning transport phenomena as a result. This will now be discussed.

Assessment

During the spring semester of 2004, this teaching technique was used in a class of 63 chemical engineering juniors. During the fall semester of 2004, an assessment form was developed and distributed to the students in the senior laboratory. There were 36 student responses (a 57% response rate) to the questions within one of five levels: strongly agree (5.0), agree (4.0), ambivalent (3.0), disagree (2.0), and strongly disagree (1.0). The questions were developed to assess if the intended consequences of using the tool were successful, and are as follows:

1. I found the questions to be a good review of topics that we had covered in a previous class session.
2. I found the questions to be a good break from class.
3. I found the questions to be entertaining.
4. I found the prizes to be entertaining.
5. This teaching tool helped me learn.
6. I felt that because I might be called on I should attend class.
7. I felt that because I might be called on I should be organized.
8. I would prefer other things in class besides the instructor lecturing for 50 minutes.

Responses to these questions are listed in Table 1 below.

In addition to the above questions, there were also three short answer questions. Responses were mostly positive, and some typical answers are listed with the questions below:

1. Name one item that you liked about this teaching tool (gave us a break from lecture, made class fun, felt involved, funny prizes)

2. Name one item that you did not like about this teaching tool (did not call on everyone, felt pressured, might not know the answer, I already owned that CD)
3. Name one way to improve this teaching tool in the future (involve more people, give money as prizes)

Question Number	StronglyAgree	Agree	Ambivalent	Disagree	Strongly Disagree	Average
1	4	26	5	0	1	3.9
2	10	17	8	1	0	4.0
3	5	17	11	2	1	3.6
4	13	19	3	1	0	4.2
5	2	20	12	1	1	3.6
6	8	12	7	7	2	3.5
7	6	16	10	3	1	3.6
8	15	12	5	4	0	4.1

Table 1. Results of the Transport Cup Assessment Survey.

Conclusions

This paper has discussed a method for improving student participation within a transport phenomena course. This is particularly noteworthy as the course tends to be quite theoretical. The students enjoyed participating in the competition and came to class more frequently. The competition could possibly be improved by asking more difficult questions and by calling upon all of the students.

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