AC 2008-911: THE GAMES WE PLAY, QUALITATIVE AND QUANTITATIVE ASSESSMENT FROM A 9-12 ENGINEERING CAMP

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Abstract:

This paper describes the outreach activities that have been effective in educating students about the area of advanced materials as an engineering career, and discusses the impact that our University's Engineers Starters Program has on motivating underrepresented minority students to consider the engineering educational and career paths. The overall goal of the program is to generate or sustain adolescents' interest in engineering and technology and to enhance self-confidence and motivation toward education. The portion of the program developed by the Center for Advanced Materials and Smart Structures (CAMSS) is shaped by a philosophical approach that emphasizes the direct benefit of learning by active methods and by game-play. A classroom voting system, "Qwizdom" software was utilized which enabled the collection of real-time data from students. While reviewing the day's activities, the facilitators could immediately assess student comprehension and generate excitement about the material in a game setting. In addition, answers were viewed by gender and by the number of times the students had attended this summer program. Modules were chosen from the Materials

World Modules (MWM), an NSF-funded inquiry-based science and technology educational program based at Northwestern University. The modules utilized during the summer 2007 program were the Sports Materials Module and the Ceramics Module. In the Sports Materials Module, students explore the materials design and function of a wide variety of balls used in athletics, as well as test and analyze their interactions with many surfaces they come in contact during play. In the Ceramic Module, students study the science of compacting ultra small ceramic particles. The pre and post survey data will be also discussed.

Introduction:

Our University's Engineers Starters Program selects students from area high schools as this is a commuter program. The segment of the two week program developed by CAMSS is shaped by a philosophical approach that emphasizes the direct benefit of learning by active methods and by game-play. The hope is that educating via game play will be motivating underrepresented minority students to consider the engineering educational and career paths. The overall goal of the program is to generate or sustain adolescents' interest in engineering and technology and to enhance self-confidence and motivation toward education. The interactive system that was used is made by Qwizdom, and it transmits signals via radio frequency (RF), allowing for non-line-of-sight two-way communication. RF transmitters hold much promise for the future of in-class response systems, if only because installing the system in a large room is as simple as plugging a small receiver into the USB port of a computer. The company Qwizdom[2] describes the benefit of their product as follows:

> "*Qwizdom's Remote Audience Response System lets you communicate with every individual and each one of them with you! Everyone in the room is given a remote, which sends a response to the instructor immediately. Instructors can then take the electronically gathered information and make informed decisions as to where to guide the discussion or meeting. Polls can be taken, tests can be graded and reports can be generated - all with the press of a button.*
> *Using Qwizdom's versatile software, you can easily create dynamic presentations, quizzes, and games. If you want to add interactivity to your existing materials, Qwizdom now integrates with Microsoft PowerPoint® and ExamView® files.*"

Teachers can become confident in:
- *Tracking adequate yearly progress (AYP)*
- *Documenting student achievement on state standards*
- *Instantly gathering student data*
- *Generating comprehensive student and school reports*
- *Applying data to enhance the learning process*
- *Designing lessons that get 100% student participation*
- *Getting students motivated and excited about learning again*

Camp Summary and Data Presentation:

The Engineers Starters Program met in June of 2007 and 13 young men and 11 young women attended. Of the 24 students, 22 were African-American. The CAMSS staff planned and implemented the 3-day program for the students. Many of the same students attend the camp every year. This camp is an annual event sponsored by the COE. Students apply in late spring and after selection they are required to pay a minimal fee, $100.00 for 2 weeks of the commuter camp. The program always carries a nanotechnology focus but the content varies each year. The 2007 program utilized a PowerPoint presentation on nanoscience and engineering and modules were presented from The NSF funded Materials World Modules (MWM) Program[3]. These are a series of interdisciplinary modules based on topics in advanced materials. Prior to the camp, the team leaders met to discuss the assessment tools to be used for the program. The IRB was already approved and the pre and post survey were discussed.

Pre-Camp Survey
June 2007

Name_____

1) I would like to attend a College or University to study advanced materials or nano-engineering. (If you know where you want to go to school, please indicate on the line below)

☐Believed Before Today ☐Strongly Agree ☐Agree ☐Not Sure ☐Disagree ☐Disagree Strongly

_____

2) I believe that females and males have the same ability to do science/engineering.

☐Believed Before Today ☐Strongly Agree ☐Agree ☐Not Sure ☐Disagree ☐Disagree Strongly

3) I think advanced materials or nano-engineering is boring.

☐Strongly Agree ☐Agree ☐Not Sure ☐Disagree ☐Disagree Strongly

Post Camp Survey
June 2008

1) Please write two to three thoughts you had or facts you learned about nanoscience or materials engineering.

_____

2) Please share with us the activity or experience you most enjoyed during the nanoscience/engineering session.

_____

Please Check One:

3) I would like to do more activities like those we did on nanoscience and engineering.

☐Strongly Agree ☐Agree ☐Not Sure ☐Disagree ☐Disagree Strongly ☐Believed Before Today

4) The sessions on nanoscience and engineering showed me that science and engineering are welcoming career fields for all genders.

☐Believed Before Today ☐Strongly Agree ☐Agree ☐Not Sure ☐Disagree ☐Disagree Strongly

5) I'd tell my friends to attend a camp like this so they could participate in activities like those we did on nanoscience and engineering.

☐Strongly Agree ☐Agree ☐Not Sure ☐Disagree ☐Disagree Strongly

6) The activities on nanoscience and engineering made me more interested in learning science/engineering.

☐Strongly Agree ☐Agree ☐Not Sure ☐Disagree ☐Disagree Strongly

7) The activities on nanoscience and engineering showed me that females and males have the same ability to do science/engineering.

☐Believed Before Today ☐Strongly Agree ☐Agree ☐Not Sure ☐Disagree ☐Disagree Strongly

8) The session on nanoscience and engineering was boring.

☐Strongly Agree ☐Agree ☐Not Sure ☐Disagree ☐Disagree Strongly

9) I would like to attend a College or University to study nanoscience or engineering. (If you know which school, please indicate on the line below)

☐Believed Before Today ☐Strongly Agree ☐Agree ☐Not Sure ☐Disagree ☐Disagree Strongly

The camp surveys were further analyzed by a faculty member with statistical analysis tools and the data are as follows:

Research Question: Did the ESP result in a change in attitudes toward college participation, women in engineering, or the subject of materials science?

Because the evaluation wished to examine change in attitude based on the ESP, for purposes of this analysis, students who responded "Believed before Today" on items where this was an option were deleted from the item analysis. The results of the data analysis show no statistically significant difference between responses on the pre and post

questionnaire items associated with attending college to study engineering or attitudes about men and women studying science and engineering. These results held even when examined by gender and by participation in a previous engineering camp. Generally, the results of the questions indicate that most of the students agreed that there opportunities for both males and females in engineering and the level of agreement did not change based on the ESP. Differences based on the pre-program question associated with interest in materials science topics showed that there were statistically significant differences between students who had participated before and the previous participants. Students who had already participated in an ESP were more adamant in their disagreement with the statement that "material science and nanotechnology is boring".

Research Question: After taking the ESP, did students feel more confident and interested in materials science and engineering?

Interest in material science and engineering were examined by 4 questions. Two were framed positively and two were framed negatively. Results from the evaluation show that student generally agreed with the positively framed questions indicating their interest in engineering and material science had increased and they were more confident. They also disagreed with the negatively framed questions that the subject matter was boring and science jobs were not interesting. There was a statistically significant difference in gender on the item regarding their increased confidence in doing engineering. Consistent with other studies, the female students were less likely to agree with this question than the male students.

Research Question: After taking the ESP, did students feel that engineering had opportunity for both males and females?

Attitude toward gender was measured by two items. In both cases the students tended to agree or strongly agree with positive statements about women's ability to do engineering and that the field was welcoming to either gender. There were no statistically significant differences between responses of the male and female students or based on whether they had participated in the ESP before.

Research Question: How did the students rate their enjoyment of the ESP curriculum?

Enjoyment of the curriculum was evaluated by a 6 point Likert scale response to each of the subject categories covered in the program. Generally, students gave high marks to all topics. Based on the overall average, the ceramics exercise scored the highest marks. However, when examined by gender, the Sports Materials unit was enjoyed most by male students and was much less enjoyed by the female students. There is a statistically significant difference in the rating of that unit. Generally, the female student rated all three activities, on average, lower than the male students. However, only one item was a statistically significant difference.

Research Question: How well did students recall information?

Evaluating student learning was based on student performance on a very engaging and interactive testing device called a "clicker". Students had handheld devices and were told to respond as quickly as possible to a series of multiple choice questions. On average, students answered approximately 64% of the questions correctly. There were no

statistically significant differences in performance based on gender or based on previous enrollment in the course.

Camp days began at 8:00am with activities, snack breaks and then culminated with the game play via Qwizdom. Questions were prepared prior to class and then the students participated in a fast paced game. A snapshot of the summary report is displayed:

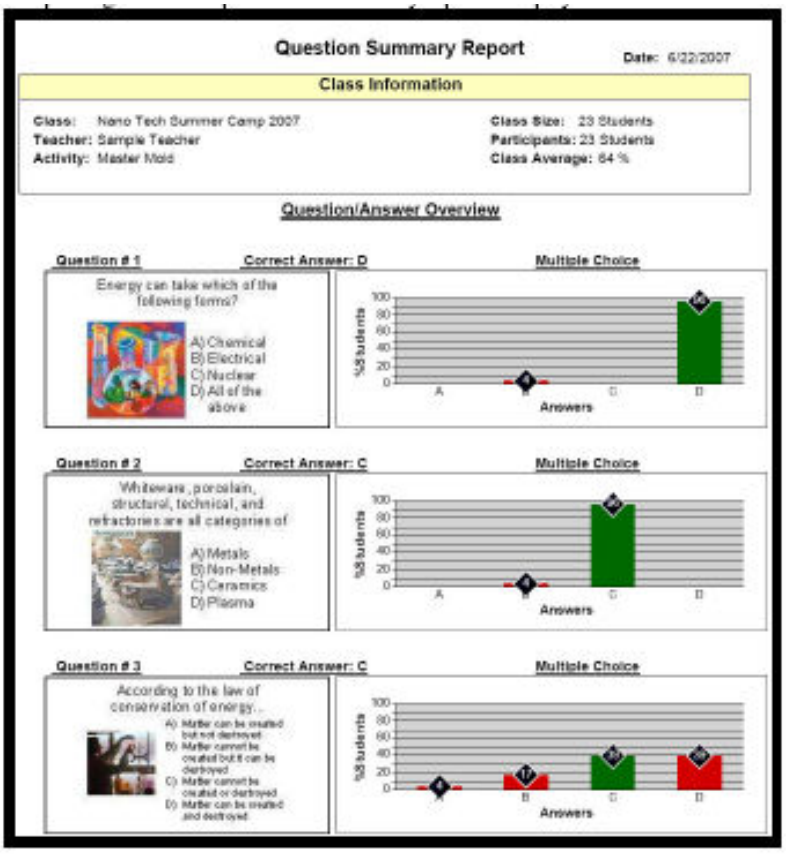

Figure 3: A snapshot of the summary report

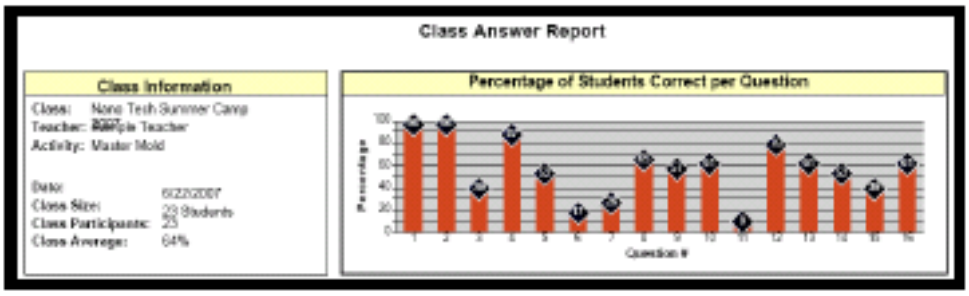

Figure 4: Summary Class Questions answer report.

Conclusion:

Research shows that voting systems such as Quizdom help break down the barrier that holds young people back when trying to express opinions. This seemed to hold true for the students attending the ESP camp. The research questions proved that the boys were more interested in the sports module and but there was no difference in the recall of either gender as displayed by their results in the Quizdom game. Jonas and Sparks found that "Student feedback over an extended period of time demonstrated that the 'novelty factor' did not diminish over time. Student responses highlighted the pleasure they had in using Qwizdom and their comments ranged from Qwizdom ' making lessons fun' through to 'Qwizdom is helping me learn' and Qwizdom makes work exciting'. All students were fully engaged within the classroom environment and the ability of the teacher to maintain maximum cooperation from the group was evident." Based on this research and our own findings we will continue to utilize this gaming system for all subsequent camps.

References:

1. C. Jonas, G.P. Sparks**,** "Interactive Engagement as a Tool for Increasing Student Achievement," 2005, http://mercystreetdallas.org/v1/IE%20Study.pdf

2. Quizdom Education: Interactive Learning System http://www.qwizdom.com

3. Materials World Modules, http://www.materialsworldmodules.org