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Varying Curricula to Meet Physics Students Learning Styles

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Abstract

Through differentiation of physics curriculum, teachers are able to meet various students' learning styles. Educators are able to differentiate the curriculum so that it builds on students' strengths and addresses their weaknesses. An inventory can be issued pre- and post-instruction to assess the students' abilities with certain concepts. Once teachers assess areas of weakness, they are able to make adjustments to curriculum and lesson plans in order to address these issues. Teaching techniques found in *Just-in-time Teaching: Blending Active Learning with Web Technology* were be used in the lesson planning and instruction of the course taught in this research. After the curriculum and lesson plans were implemented and completed by students, the educator then re-administered the concept inventory to their students again, now post instruction, to assess the effectiveness of their teaching techniques.

Research Plan

My research project looks at inventory assessments and makes changes to curriculum and lesson plans according to the strengths and weaknesses of high school students in my physics classroom as a student teacher.

•I gave my students a concepts inventory at the beginning of my student teaching to acquire a baseline of my students' understanding of physics concepts.

•In order to get a better understanding of my students' learning styles, I issued a learning styles survey for the students to complete.

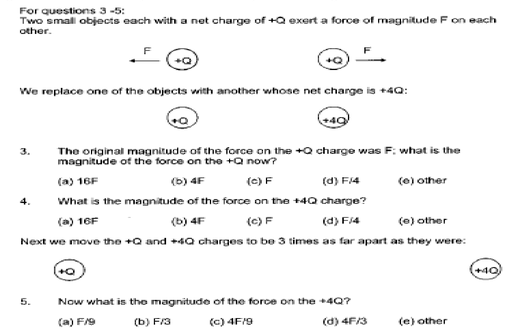
•After of period of instruction the concept inventory was issued again.

•The data collected from the post instruction assessments was then analyzed to determine the effectiveness of using this style of teaching in high school physics classrooms

Background and Theory

Conceptual Survey of Electricity and Magnetism (CSEM)

-Diagnostic Inventory on electricity and magnetism


For questions 3 -5:
Two small objects each with a net charge of +Q exert a force of magnitude F on each other.

F +Q +Q F

We replace one of the objects with another whose net charge is +4Q:

+Q +4Q

3. The original magnitude of the force on the +Q charge was F; what is the magnitude of the force on the +Q now?
(a) 16F (b) 4F (c) F (d) F/4 (e) other

4. What is the magnitude of the force on the +4Q charge?
(a) 16F (b) 4F (c) F (d) F/4 (e) other

Next we move the +Q and +4Q charges to be 3 times as far apart as they were:

+Q +4Q

5. Now what is the magnitude of the force on the +4Q?
(a) F/9 (b) F/3 (c) 4F/9 (d) 4F/3 (e) other

Just-in-Time Teaching

-Present students with physics problems to complete and turn in the night before class via the internet.

-Teachers are able to make changes to the lesson plan for the day based upon the responses to the online assignments.

Gardner's Theory of Multiple Intelligences

•Each student has individual learning needs and certain styles of instruction help accommodate for these needs.

•**Seven Learning Styles:** Linguistic, Logical/Mathematical, Musical, Bodily/Kinesthetic, Spatial/Visual, Interpersonal, and Intrapersonal

Data

Data collection for this research project was carried out in a local high school at which I am student teaching. The charts below show the frequency of scores on the CSEM. *Figure 1* shows the pre and post-instruction CSEM score frequencies for all of the classes in the study. Figure 2 shows the pre and post-instruction CSEM score frequencies for the control group. Figure 3 shows the pre and post-instruction CSEM score frequencies for the experimental group.

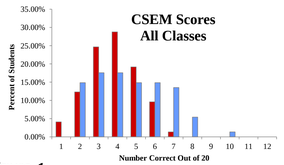


Figure 1.

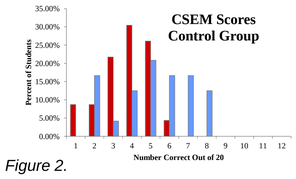


Figure 2.

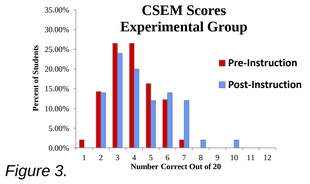


Figure 3.

	Pre-Instruction	Post-Instruction	Gain
All Classes	3.82 ± 1.36	4.67 ± 1.91	0.85 ± 2.57
Control Group	3.79 ± 1.38	5.17 ± 1.97	1.38 ± 2.45
Experimental Group	3.84 ± 1.36	4.43 ± 1.85	0.59 ± 2.59

Figure 4. Shows the pre- and post-instruction mean score out of twenty with the standard deviation for the all classes, control, and experimental groups. The table also shows the gain with the standard deviation for each of the groups.

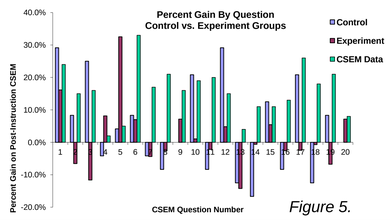


Figure 5.

Figure 5 gives the percent gain for each of the twenty questions from the CSEM which were used in this research. The chart shows the percent gain for the control and experimental groups, as well as the data from Maloney et al. (2001).

Results

After reviewing the results from the CSEM, we decided to focus our analysis on questions 3, 4, and 5.

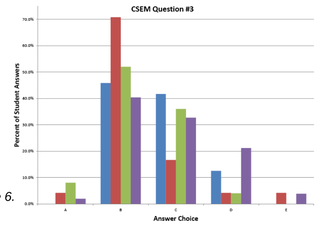


Figure 6.

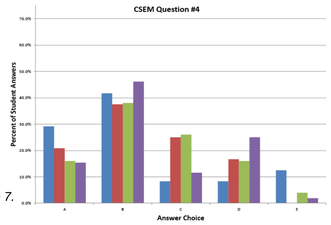


Figure 7.

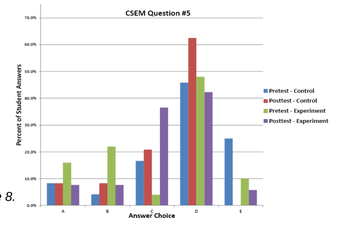


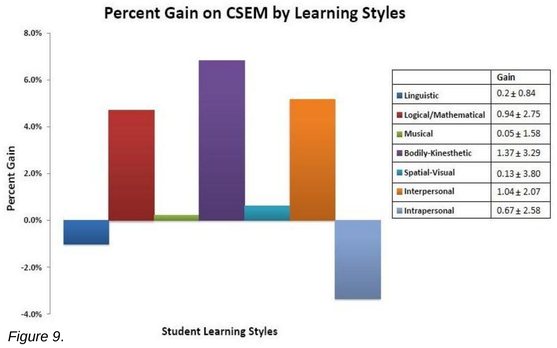
Figure 8.

Figure 6. – Question #3: Correct Answer: B. Force (F) is proportional to *q*. Control group had about a 37% higher gain in correct answer responses.

Figure 7. – Question #4: Correct Answer: B. Force will be equal on both charges. Experimental group had a 12% higher gain in correct answer responses.

Figure 8. – Question #5: Correct Answer: C. Force (F) is proportional to 1 over the distance (R) squared. The experimental group had a 28% higher gain in correct answer responses.

Learning Style Results



	Gain
Linguistic	0.2 ± 0.84
Logical/Mathematical	0.94 ± 2.75
Musical	0.05 ± 1.58
Bodily-Kinesthetic	1.37 ± 3.29
Spatial-Visual	0.13 ± 3.80
Interpersonal	1.04 ± 2.07
Intrapersonal	0.67 ± 2.58

Figure 9.

Figure 9 shows the gain in overall CSEM scores for the students with each particular learning style.

- Logical/mathematical, bodily-kinesthetic, and interpersonal showed the highest percent increase, which were three styles focused on in this research.

The learning styles survey showed that the top learning styles in the experimental group were logical/mathematical, musical, bodily-kinesthetic, and interpersonal.

Strategies Used for Each Learning Style

•**Logical/Mathematical**: Students computed various problems involving concepts being covered. Students also worked problems at the board.

•**Musical**: Classical music played while students completed assignments.

•**Bodily-Kinesthetic:** Demonstrations were performed which involved concepts being taught. Students were incorporated and participated in demonstrations when possible.

•**Interpersonal:** Students were allowed and encouraged to complete assignments with partners or in groups.

Analysis

- Overall score data from the CSEM for pre- and post-instruction shows gains in students' mean scores. The histograms for the CSEM scores show a shift toward higher post-instruction scores.
- The control group showed a 0.78 out of 20 higher gain in total score than the experimental group or a 3.9% overall increase in final score.
- When analyzing the itemized responses for each question on the CSEM, the data showed similar performances for the control and experimental groups on questions 6,7, 8, and 13.
- Questions 4, 5, 9, and 20 show significantly higher gains for the experimental group. A t-test was computed for the responses for question 5, finding a statistically significant difference ($p < 0.01$) in student gains between the experimental group (higher gain) and the control group (lower) gain.

Conclusions

- Overall the CSEM scores show low levels of knowledge pre-test with small gains after instruction.
- The scores show that the instruction for the control group was more effective than the experimental group. However, the t-test shows that there is not a significant statistical difference ($p > 0.16$) in the gains.
- The strategies used by the student teacher did not result in student learning gains to match or exceed that from the students of the experienced teacher (20+ years teaching physics).
- Differentiating instruction to the learning styles present in your classroom can be effective in increasing students' knowledge and understand of the content being taught.
- From the limited data in this research it appears that the strategies used had an effect on students' learning and understanding of the content. However statistical analysis shows that the data is inconclusive.

Further Questions/Research

- What would the gains on the CSEM have been for a new teacher if they had not used these strategies?
- How does the content being taught, such as electricity and magnetism, effect the gains from the strategies used in this research?
- Would other inventories such as the Force Concept Inventory be better suited for these strategies

Reference

- Maloney, D. P., O'Kuma, T. L., Hieggelke, C. J., & van Heuvelen, A. (2001). Surveying student's conceptual knowledge of electricity and magnetism. *American Journal of Physics*, *69*(7), S12.

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