2006-1928: CAN AN ENGINEER TEACH ELEMENTARY EDUCATION MAJORS HOW TO TEACH SCIENCE AND ENGINEERING?

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Can an Engineer Teach Elementary Education Majors How to Teach Science and Engineering?

Abstract

Dr. Karen High, faculty member in Chemical Engineering, was a Laboratory Instructor for the fall 2005 Semester for CIED (Curriculum and Instruction Education) 4353 at Oklahoma State University. The course is "Science in the Elementary School Curriculum." This course covers the purposes, selection and organization of content, teaching and learning procedures and evaluation of outcomes in elementary school science and its participants consist of education students typically without any background in engineering or science.

Approximately 75% of class time is devoted to laboratory activities and field experiences that promote the science content, process, learning theory, philosophy and curricula appropriate for grades 1-8. Class and field activities are hands-on, inquiry-based activities, utilizing whole group discussions, cooperative learning groups, and some individual projects. Laboratory experiences are designed to emphasize the science process skills. The remaining 25% of class time is devoted to lecture, discussion, and demonstration. During the laboratory engineering concepts were discussed and demonstrated.

This paper will focus on the effectiveness of instruction by a chemical engineering faculty member as evaluated by in-course assessment tools. Was there any perceived benefit of having an Engineer involved with a course designed for education majors? Were the students more aware of the engineering field and of engineering concepts due to this involvement? Were the students appropriately taught science methods?

Introduction and Background

The American Society of Engineering Educators (ASEE) has been at the forefront of K-12 Science Education. An Engineering K-12 Center presentation "Why K-12 Engineering?"[1] suggests there are many benefits for teachers to incorporate engineering in their curriculum. They include[1]:

> Engineering is **Academic Glue** – it binds complex math and science concepts for real-world experiences and leads to learning that sticks with students.
>
> Engineering is **Creativity** – the need for problem-solving and innovation brings out the best ideas from every student.
>
> Engineering is **Group Work** – students learn to communicate and work together while they learn math and science by applying engineering principles.

Engineering is **Everywhere** – students learn that engineers have designed, created, or modified nearly everything they touch, wear, eat, see, and hear in their daily lives.

Engineering is **FUN!**

The ASEE Engineering K-12 Center has developed a survey on teacher attitudes about engineering that is being administered on their website[1]. They "are working to develop a greater understanding of K-12 teachers' attitudes, knowledge, and interest about engineering as an academic discipline and profession… they will use the results of the survey to shape communications, products, and services that are designed to serve the K-12 community"[1]. The results of this survey are very interesting. The most positive results were obtained for the statements "Engineers need to be good at math and science (66.7% strongly agree)," "Engineering has a positive impact on my daily life (66.1% strongly agree)," and "Engineering has a large impact on the well-being of the country (66.2% strongly agree)." 91.6% of the teachers surveyed agreed or strongly agreed that engineering can be a way to help teach students science. 97.1% agreed or strongly agreed that engineering can be a way to help teach students math. 90.3% agreed or strongly agreed that understanding more about engineering can help a teacher teach better. The teachers were very positive about the importance of engineering as evidenced by the above questions; only 66% said that they knew enough about engineering to help students decide if they should be engineers.

The authors suggest caution when analyzing the results of this survey. The teachers who participated in this survey had to have enough knowledge about engineering and ASEE to find the website. The demographics of the survey were that 62% were between 40 and 60 years of age. It would be very intriguing to give the same survey to current education students, recent graduates, and young school teachers who are very familiar with the internet. This would remove the bias of the sample population. Alternatively, one could look at the responses of journeymen teachers that would not be likely to take the online survey.

Many studies show the implementation of engineering activities in K-12 curriculum. These are focused at either the students or professional development for experienced teachers. This project was unique in that the engineering concepts were presented within the curriculum of elementary education through a science methods class. This is promising for two reasons. It helps to instill knowledge and confidence in the future teachers in engineering knowledge. It also allows for the concepts to be propagated to many future students.

Course Structure

This course, CIED 4353, Science in the Elementary School Curriculum, is based on the National Science Education Standards for science teaching and science content. These standards are designed to guide the nation toward a scientifically literate society. Based on exemplary practice and research, the Standards describe a vision of the scientifically literate person and present criteria for science education that will allow that vision to become reality. Teachers must have theoretical and practical knowledge and abilities about science, learning, and science teaching. General competencies for licensure and certification in Oklahoma are also addressed. State competencies for licensure and certification for elementary education also inform course content, as well as the Oklahoma Priority Academic Student Skills (PASS) and the Association for Childhood Education International (ACEI).

The course CIED 4353 has two parts. One part is a two hour lecture on Mondays. The other part is a two hour lab on either Tuesday or Thursday. Dr. High was the lab instructor for the Thursday class. There were 23 students in this lab section of the class. The Tuesday section had 25 students. In this paper, we will consider the Thursday group the Experimental Group and the Tuesday group the Control Group.

The Thursday lab was structured in five components. These were labs, Ag in the Classroom, science module training and teaching, engineering concepts, and a final car activity. The Tuesday lab was similar but did not cover engineering. During the first half of the semester, the students did short (30 minutes to two hour) laboratory exercises to expose them to a variety of science content areas. One of the lab periods was used to explore Oklahoma agriculture in the classroom activities[2]. A lab notebook was due at the end of the semester that included self reflection on the science content of the exercises and the appropriate grade level.

The majority of the second half of the semester was devoted to science module training and teaching. The students were trained in science modules for grades 1-5 at the Oklahoma State University Center for Science Literacy[3]. During the module training, the students were taught how to keep laboratory notebooks. The science modules used were developed by the National Science Resources Center (NSRC) that is operated by the Smithsonian Institution and the National Academy of Sciences. The twenty four science modules that have been developed by the NSRC for the Science and Technology for Children® (STC®) program are used in many schools in Oklahoma as well as other states. Stillwater Public Schools extensively uses the modules.

The students were then tasked in groups of 4 to 5 students to teach different modules at the same grade level in which they were trained. The groups then presented the modules to the class using the rest of the students as participants. The modules of teaching experiences occupied one and a half hours of a given two hour lab. The students used the following modules: Solids and Liquids (1st grade), Soils (2nd grade), Sound (3rd grade), Electric Circuits (4th grade), and Food Chemistry (5th grade). Each group used the science modules, which typically consist of 15 to 20 lessons requiring 20 to 45 minutes depending on the grade level, condensing them into a 1 1/2 hour presentation. The rest of the class participants acted as if they were students of the appropriate grade level. These module teaching sessions were presented over a five week period.

For the remainder of the period after the science modules were taught, Dr. High discussed engineering and provided resources for the students, which typically occupied 20 or 30 minutes. Additionally, another class period was devoted to the discussion of engineering concepts The total time that was available to discuss these concepts was between three and four hours. At the end of the semester, the students completed an open ended activity involving the development of a science lesson that used small model cars. The cars were spring-powered, matchbox sized cars that were wound up by being pulled back and moved forward when released. These cars were available in an assortment of styles and colors but were all the same size. The students devised a variety of activities that included classification; relationship between motion and position; and observation, prediction, and measurement.

Science Curriculum

During the two hour Monday lecture, Dr. Beller presented material to support the lab and to provide them with information to teach science. The subjects covered included:

- Inquiry Model[4]
- Observation Model
- Instructional Objectives
- Classification Model
- Inferring Model
- Hypothesizing and Data Collection
- Data Interpretation and Graphing
- Learning Styles
- Warm up activities (to get the students focused on the lesson of the day)
- Filler activities (used when a lesson is completed early)

For the laboratory period, the following eight activities were accomplished:

- Cooperation: The Name of the Game – This activity involves groups of four being given parts of four different puzzles where they must silently and cooperatively create the four complete pictures.
- Don't Crack Up – Working in teams a container must be designed to catch a raw egg using limited resources.
- Building the Thermometer – A one liter and a two liter bottle are used to create a thermometer to observe changes with hot and cold water.
- Metric Olympics - Students become familiar with metric units by estimating and measuring in a "Metric Olympic" setting.
- Lion, Eagle, Turtle, and Chameleon - The students investigate varied problem solving strategies and the strengths of each. The students think about each of the animals in the context of how they solve problems. They then associate with the animal that best represents their problem solving style and group themselves with other like students. The groups then develop and present a list of problem solving characteristics of each.
- Crazy Colloids – This activity provides free exploration with colloids made from cornstarch and water and observes that colloids display properties of both liquids and solids.
- Paper Towel Debate – The student groups are tasked with devising tests for determining the best paper towel from ones provided.

- Surf and Sand I and II – The students determine the surface area of each ocean and continent.

These activities varied in the level of inquiry that they were required to employ (see Table 1). Most of the eight activities that the students did were level zero or one. "Don't Crack Up" was a Level 2 and the Great Paper Towel debate was a Level 3. At the end of the semester the students were required to submit a lab notebook that included a description of the lab activity, the data obtained, and a reflection on the activity. The reflection is a self-completed assessment that considers the activity from a student perspective, a teacher prospective, and classifies the activity based on grade level, inquiry level, and science content. The notebook contained assessments on all of the eight classroom labs.

Table 1. Ascertaining Level of Inquiry[4]

Level of Inquiry	Problem	How To	Answer
0	Given	Given	Given
1	Given	Given	Open
2	Given	Open	Open
3	Open	Open	Open

Engineering Activities

During the module teaching section of the second half of the semester, a variety of engineering discussions were addressed. For five periods, there were 20 or 30 minutes to provide engineering material, resources, and activities. There also was an entire lab period for presenting all of the activities (8 labs that completed in the first part of the semester and 5 activities provided by Dr. High) to discern the engineering content of the activities.

The five engineering activities that Dr. High provided handouts and problem descriptions for were:

- Nylon[5] – This activity shows the reaction of hexamethylenediamine and sebacoyl chloride to form nylon 6-10. This was demonstrated to the students. This is an excellent activity to show the differences between science and engineering and product and process design.
- Lunch Box Design[6] – This activity uses the creative process to design a lunchbox that is attractive to users and functions well as a food container and carrier.
- Invent-A-Jet[7] – This activity involves the use of jet engine for transportation. At the end of the activity, the participants are asked to invent to make better jet engines.
- Cold or Hot[7] – This activity involves the evaluation of different types of insulation. The evaluation looked at keeping liquids warm as well as ice from melting.
- Soapy Separation[7] – This activity involves the use of a chemical to separate solids from liquids. A salt is used to separate a mixture of soap and water.

The education students did not complete the above activities, but Dr. High did demonstrate the Nylon example. They were provided with handouts and were asked to evaluate the activities for engineering content.

For the discussion of the engineering content of the 13 activities, the students in groups were asked to consider the following:

- Is/are there an engineering component(s) in the activity?
- If yes, what is/are they?

They were also asked the following:

- Find an activity on the internet that your group thinks show concepts of engineering.
- What is an engineer?
- Plan to present and hand in your group's thoughts (approximately 1 page)

This discussion was likely the most valuable exercise done with the experimental group. Topics such as what the different engineering disciplines are, what is the difference between science and engineering, and what engineers do were addressed. The students had not thought that there might be engineering components for many of the science activities. After discussion, they realized that many of the science activities did indeed contain engineering concepts. They also realized how closely linked science is with engineering yet were aware of their differences.

The resources that the students were given about engineering included websites from ASEE (e.g., www.engineergirl.org, pbskids.org, www.k12science.org, www.teachengineering.com, www.engineering-goforit.com, and www.ciese.org). Other resources included listings of the types of engineers and what they do. The activities that the students found on the internet included world production of oil, a spider web activity, building a bird cage, why your chewing gum lose its flavor, and building skyscrapers.

Assessment

An assessment was completed during the lab period to determine the effectiveness of having an engineer teach the science methods class. The control group consisted of a Tuesday section of the lab course where a Ph.D. education student was the lab instructor (Adrienne Redmond). The Thursday section was taught by Dr. High as the lab instructor and is the experimental group. All students were in the Monday lecture with Dr. Beller.

Two surveys were administered, one in October and one in December. The students were told to complete the October survey as if it were the beginning of the semester. The three areas of assessment were as follows: were the students effectively taught how to teach science, were the students effectively taught about Engineering, and were the students effectively taught how to teach Engineering? The total number of questions for the survey was 40. The students were asked on a 5 point scale about their agreement with the 40 statements given. The responses could be strongly agree (5), agree (4), neutral (3), disagree (2), and strongly disagree (1). The surveys took the students about 10 minutes to complete. Standard Oklahoma State University procedures for conducting human subject research were followed, and a consent form was signed by the students when surveyed.

The October survey is the “beginning survey” as it was administered before the engineering activities. The December survey is the “ending survey” and was conducted after all activities were completed. Dr. High administered the survey, with Adrienne Redmond maintaining a list of assumed names for the students. The assumed names were kept confidential by Ms. Redmond. The use of assumed names allowed for individual student comparison from the beginning of the semester to the end of the semester.

Were the students effectively taught how to teach science?

SU1. I am comfortable with my science background.
SU2. I am confident in my ability to teach science to Elementary Students.
SU3. I can plan and teach “hands on” and inquiry-based science activities.
SU4. I am confident in my ability to develop appropriate science curriculum.
SU5. I am able to develop multidisciplinary curriculum to include science.
SU6. I am comfortable in teaching modular-based (multi-activity) science.
SU7. I am confident when writing reflections.
SU8. I am confident when writing lesson plans.
SU9. I am aware of resources that are available to me to teach science.
SU10. I am able to develop curriculum that teaches PASS (Oklahoma Priority Academic Student Science Skills) Science Standards.
SU11. I am able to develop curriculum that teaches NSES (National Science Education Standards) concepts.
SU12. I am able to develop curriculum that teaches ACEI (Association for Childhood Educational International) standards.
SU13. I am able to develop curriculum that teaches OGCT (Oklahoma General Competencies for Teachers) concepts
SU14. I can determine appropriate grade levels for science activities.
SU15. I am confident in using the Internet as a classroom resource.
SU16. I am comfortable using computer tools as a classroom resource.
SU17. I am comfortable teaching Lab Book/Journaling skills.
SU18. I can develop appropriate assessment tools for students.
SU19. I am comfortable teaching students how to collect and analyze data and graph experimental results.
SU20. I can develop warm-up and filler science activities for students.

At the beginning of the class, the control group had the highest confidence levels for the SU15, SU16, SU17 and SU20 areas. These dealt with Internet, computers, lab books, and warm up and filler activities. At the end of the class, the control group had the highest confidence for SU3, SU7, SU15, SU16, SU17 and SU20. These dealt with use of inquiry activities, writing reflections, and use of technology and lab books, as well as warm up and filler activities. For the control group, the statistically significant differences (improvement in agreement) were seen for SU4, SU5, SU8, SU12, and SU14.

These dealt with concepts as well as confidence in developing science curriculum and appropriate grade level activities and writing lesson plans.

Table 2. Science Understanding and Teaching Assessment Results

	Control Begin N=25	Control End N=24	Difference (End – Begin)	Experimental Beginning N=22	Experimental End N=23	Difference (End – Begin)
SU1	3.36	3.67	0.31	3.45	3.83	0.37
SU2	3.52	3.83	0.31	3.50	4.17	**0.67***
SU3	4.08	**4.29**	0.21	**4.09**	**4.43**	0.34
SU4	3.44	3.92	**0.48***	3.27	4.04	**0.77***
SU5	3.84	4.21	0.37*	3.64	4.13	0.49*
SU6	3.80	4.00	0.20	3.41	4.22	**0.81***
SU7	4.08	**4.29**	0.21	3.91	4.17	0.26
SU8	3.80	4.17	0.37*	3.82	4.26	0.44*
SU9	3.56	3.83	0.27	3.27	4.09	**0.82***
SU10	4.00	4.29	0.29	4.00	4.22	0.22
SU11	3.08	3.54	0.46	2.95	3.35	0.40
SU12	2.79	3.46	**0.67***	2.55	3.17	0.62
SU13	3.28	3.79	**0.51**	2.86	3.43	0.57
SU14	3.56	4.04	**0.48***	3.55	4.05	0.50
SU15	**4.36**	**4.38**	0.02	**4.27**	**4.52**	0.25
SU16	**4.32**	**4.33**	0.01	**4.18**	**4.43**	0.25
SU17	**4.12**	**4.29**	0.17	4.00	4.39	0.39*
SU18	4.00	4.17	0.17	3.73	4.26	0.53*
SU19	3.96	4.13	0.17	3.82	4.26	0.44*
SU20	**4.36**	**4.38**	0.02	**4.41**	**4.52**	0.11

5=Strongly agree, 4=agree, 3=neutral, 2= disagree, 1=strongly disagree.
Bold numbers indicate the highest numbers in each column.
*A paired t-test shows that the differences are significant at $p<0.05$, a statistically significant difference at the 95% confidence level.

For the experimental group, the highest confidence at the beginning of class was exhibited for SU3, SU15, SU16, and SU20. These are inquiry activities, use of technology, and filler and warm up activities. At the end of the course SU3, SU15, SU16, and SU20 again received the highest confidence levels. The largest improvement in confidence was seen for SU2, SU4, SU6 and SU9 (and the differences are statistically significant as well). These dealt with teaching science to elementary students, developing science curriculum, use of modular based science activities, and awareness of science teaching resources.

The relative similarity between the two groups on these questions answers the question "Were the students appropriately taught science methods?" The students in both groups responded confidently to all of the science understanding and teaching statements at the end of the semester. There are no large differences in the response of the two sections and similar improvements in confidence were seen in both sections.

Were the students effectively taught about engineering?

EC1. I understand the differences and similarities between science and engineering.
EC2. I know the different types of engineering.
EC3. I understand engineering concepts.
EC4. I know the concept of product design.
EC5. I understand the concept of process design.
EC6. I am aware of steps in problem solving.
EC7. I am comfortable working in groups/on teams.
EC8. I am confident in my brainstorming abilities to solve problems.
EC9. An Engineering faculty member can effectively teach me how to teach science.
EC10. It will be/was a benefit to have an Engineer teach this course. (This question was not asked of the control group)

Table 3. Engineering Concept Assessment Results

	Control Begin N=25	Control End N=24	Difference (End – Begin)	Experimental Begin N=22	Experimental End N=23	Difference (End – Begin)
EC1	2.88	2.67	-0.21	2.27	3.91	**1.64***
EC2	**3.52**	**3.46**	-0.06	2.73	3.82	1.09*
EC3	2.40	2.21	-0.19	2.05	3.27	**1.22***
EC4	2.40	2.04	-0.36	2.00	3.30	**1.30***
EC5	2.44	2.00	-0.44	2.09	3.48	**1.39***
EC6	**3.92**	**3.88**	-0.04	3.50	4.13	0.63*
EC7	**4.32**	**4.21**	-0.11	**4.14**	**4.48**	0.34
EC8	**3.96**	**4.17**	0.21	**4.05**	**4.26**	0.21
EC9	3.24	3.39	0.15	**3.50**	**4.39**	0.89*
EC10				**3.55**	**4.48**	0.93*

5=Strongly agree, 4=agree, 3=neutral, 2= disagree, 1=strongly disagree.
Bold numbers indicate the highest numbers in each column.
*A paired t-test shows that the differences are significant at $p<0.05$, a statistically significant difference at the 95% confidence level.

For the control group, the highest agreement at the beginning and end of the semester was for EC2, EC6, EC7, and EC8 that dealt with knowing the types engineering, problem solving, working in teams, and brainstorming. The differences between the beginning and the end were all small or negative and were not statistically significant differences.

For the experimental group, the largest agreement was for EC7, EC8, EC9 and EC10 for the beginning and the end of the semester. These were statements about teams, brainstorming, an engineer effectively teaching science methods, and the benefit of an engineer teaching the class. The largest improvement in agreement was seen for EC1, EC3, EC4, and EC5 (the changes are statistically significant). These statements are about understanding the differences between science and engineering, engineering concepts, product design and process design. Five of the ten items received a greater than one point difference in the beginning and end for the experimental groups. These had been for the questions that had received less than neutral agreement (disagree or strongly disagree with a numerical value less than 3) in the beginning of the semester. The students had not felt confident about engineering concepts, types, comparison to science, process and process design at the beginning. The students did feel confident about these areas at the end of the semester.

Were the students effectively taught how to teach Engineering?

TE1. I feel comfortable teaching the differences and similarities between Science and Engineering.
TE2. I can teach about the different types of engineering.
TE3. I am comfortable teaching engineering concepts to Elementary Students.
TE4. I can teach the concept of product design.
TE5. I can teach the concept of process design.
TE6. I am comfortable teaching the steps in problem solving.
TE7. I am comfortable using groups/teams in a learning environment.
TE8. I am confident having my students brainstorm for problem solving as I teach.
TE9. I am aware of resources that are available to me to teach Engineering.
TE10. I am able to develop curricula and activities that teach Engineering.

Table 4. Engineering Teaching Assessment Results

	Control Begin N=25	Control End N=24	Difference (End – Begin)	Experimental Begin N=22	Experimental End N=23	Difference (End – Begin)
TE1	2.50	2.13	-0.37	1.95	3.63	**1.68***
TE2	2.76	2.29	-0.47	2.27	3.52	**1.25***
TE3	2.50	2.13	-0.37	2.23	3.37	1.14*
TE4	2.63	2.04	-0.59*	2.23	3.39	1.16*
TE5	2.54	2.04	-0.50	2.27	3.39	1.12*
TE6	**3.84**	**3.79**	-0.05	**3.55**	**4.17**	0.62*
TE7	**4.24**	**4.13**	-0.11	**3.95**	**4.24**	0.28
TE8	**4.13**	**4.00**	-0.13	**3.95**	**4.35**	0.40
TE9	2.64	2.63	-0.01	2.32	3.87	**1.55***
TE10	2.24	2.46	0.22	2.23	3.70	**1.47***

5=Strongly agree, 4=agree, 3=neutral, 2= disagree, 1=strongly disagree.
Bold numbers indicate the highest numbers in each column.
*A paired t-test shows that the differences are significant at $p<0.05$, a statistically significant difference at the 95% confidence level.

The control group showed the highest agreement for the beginning and the end of the semester for TE6, TE7, and TE8. These deal with using problem solving, groups, and brainstorming in an educational environment. The differences were either small or negative (showing less agreement at the end of the semester than at the beginning) for all control group responses. All differences were not statistically significant with the exception of TE4, which was regarding teaching process design. The control group felt less confident about teaching process design at the end of the semester.

The experimental group showed the highest agreement at the beginning and the end for the same items, TE6, TE7, and TE8. The largest improvements were seen for TE1, TE2, TE9, and TE10 (statistically significant differences). These are related to comfort in teaching the differences between science and engineering as well as the different types of engineering, and awareness of resources and development of curricula to teach engineering.

Other interesting results from the survey

One intriguing result of the survey was that at the beginning 15 of the 40 statements received less than neutral responses (i.e. some level of disagreement, numerical values less than 3) from the experimental group. These were SU11, SU12, SU13, EC1, EC2, EC3, EC4, EC5, TE1, TE2, TE3, TE4, TE5, TE9, and TE10. At the end of the survey, all questions received positive (greater than neutral) responses. This means that in terms of science content, engineering understanding, and confidence in teaching engineering concepts, the activities that Dr. High did with the experimental group were successful. This fact is also reinforced by the fact that all ending responses for the experimental group were more positive at the end then the beginning.

For the control group 12 of the 40 statements received less than neutral (negative) responses at the beginning. At the end of the semester, 11 statements still received negative responses. An interesting statistic from the control group was that the agreement with the engineering statements was reduced from the beginning of the semester to the end of the semester. This is possibly due to the students realizing that the other students learned more about engineering than they did. While the control group felt in some agreement that they knew the different types of engineering (EC2), they were not comfortable with teaching them to students (TE2). Interestingly, the control class did feel slight agreement (EC9) that an engineer could effectively teach them how to teach science.

Assessment Summary

The results of the assessment show that the two sections of lab were fairly consistent in their science teaching confidence. Moderate increases in agreement and confidence were seen over the semester for the students in the two groups. The major differences between the two groups were in the engineering understanding and the teaching engineering areas. The control group did not feel that they could teach engineering concepts except in areas that they already had exposure from other courses/experiences: working in teams, problem solving and brainstorming. The experimental and control groups also showed the highest agreement with the areas that they had already been exposed. The most significant changes were seen in the confidence of the experimental group to teach engineering concepts, particularly in the differences between science and engineering, engineering concepts, and process and product design.

Concluding Comments

The activities and the presence of an engineer provided an experimental group of students with information and resources to teach engineering to their elementary classes. The activities were successful in improving the ability and the confidence of the elementary education students to understand and teach engineering. The awareness of engineering design and concepts were greatly enhanced. The student's confidence was increased in many areas as evidenced by a survey with 40 statements that the students were asked their agreement about.

Dr. High was also able to effectively teach the students how to teach science. Both the control and experimental groups showed some increase in confidence in teaching science over the course of the semester. The activities used for teaching science included understanding of science standards and concepts, use of lab books, modular and inquiry based science activities, and technology, development of multidisciplinary curricula that includes science and the ability to develop science curricula and to effectively teach science to elementary students. The students in the experimental group felt that Dr. High effectively taught them how to teach science. They showed confidence in teaching engineering concepts. They felt that it was beneficial to have an engineer teach the lab section.

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