The Effect of the Conceptual Change Model on Misconceptions in 9th Grade Physics

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June 2018, Manson, IA
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Background

I remember my high school science teacher holding up two balls and then showing us that one was heavy, and one was light. Then she asked us which would hit the ground first. I remember being sure that the heavier one would hit the ground first. It did not. Although I was not aware of it then, my science teacher was employing parts of the conceptual change model to help me overcome my misconception. The Conceptual Change Model is a strategy that "helps students to become aware of their private views and to confront them" (Stepans 2006, p. 6).

It wasn't until I was an undergraduate student that I realized what had happened and my battle with common science misconceptions began. Over the years, I have worked hard to help my students learn and change their understanding

My experience with misconceptions has lead to this study. In this action research project, I aim to answer the following questions

- *Will using the conceptual change model help 9th-grade students to overcome their physics misconceptions?*
- *Do misconception probes allow students to engage in the first step of the conceptual change method by having "Students become aware of their own preconceptions about a concept by thinking about it and making prediction (committing to an outcome) before an activity begins." (Stepans 2006, p. 7)*
- *Does the conceptual change model improve students attitudes about science?*

Treatment

This study implemented the Conceptual Change Model to help students overcome misconceptions in a unit of Motion and Forces. The Motion and Forces Unit was then compared to a unit on chemical reactions to see if there were fewer misconceptions at the end of a unit that was taught using the Conceptual Change Model.

Students were given pre- and post-tests of conceptions for the Motion and Forces Unit and the Chemical Reactions Unit. The tests used were the Force Concept Inventory and the AAAS Test of Chemical Reactions Concepts. The test scores were then compared using normalized gains and a t-test to see if there was a statistical change in misconceptions.

At the beginning of the Motion and Forces Unit, students were also given a pre-test of attitudes at the beginning of the unit and then a post-test of attitudes at the end of the unit. The survey conducted was the Test of Science Related Attitudes (TOSRA), and the results were scored, and pre- and post-survey scores were compared using a Wilcoxon Signed Rank test to see if there was a change in scores from the beginning to the end of the unit.

Finally, several students were chosen at random to participate in a pre- and post-unit interview using Waller's Interview Questions. The data from these interviews were analyzed for common themes and used as evidence to support other data analysis claims.

Sample

My class was at the Manson Northwest Webster High School in Manson, Iowa. There were 39 students of which 18 were male, and 21 were female, 36 of these students were in ninth grade and three were in eleventh grade. This was a mixed group of students with some high achieving, some average, and some who are repeating the course due to academic or behavioral challenges. There was no ethnic diversity in this class; it was composed entirely of white students.

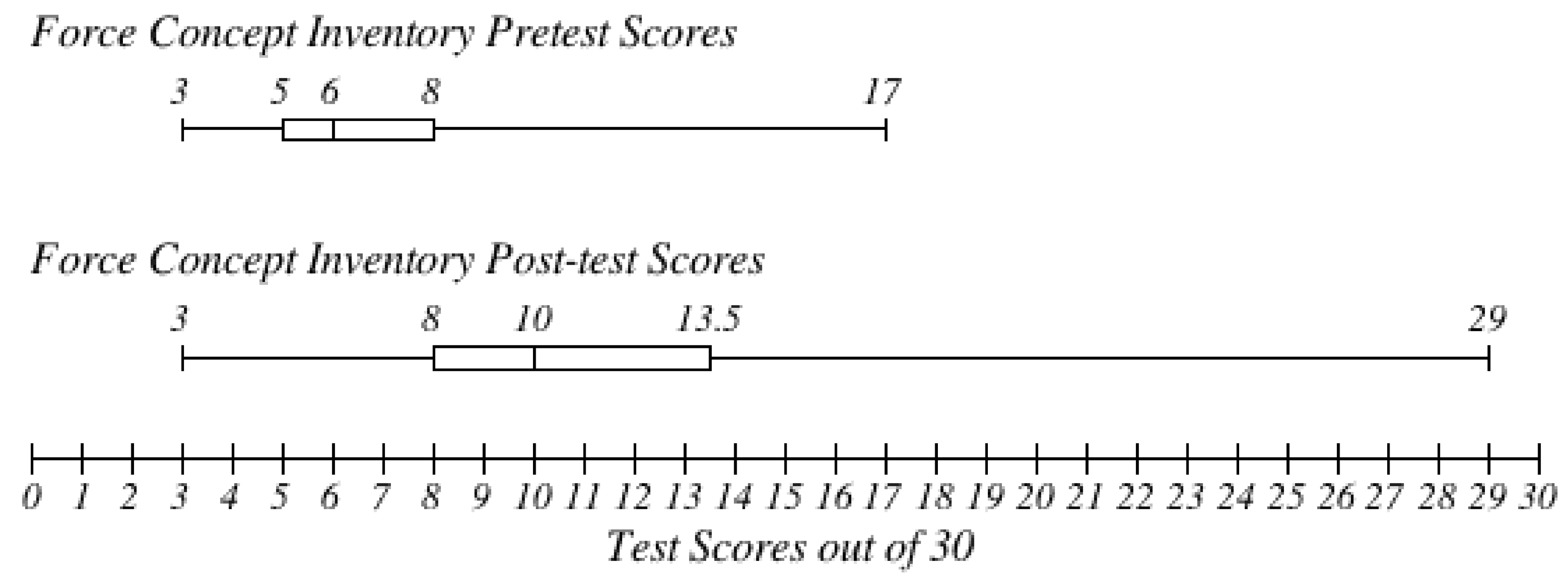

Figure 1. FCI Pre- and Post-test Box and whisker plot, (*N*=39).

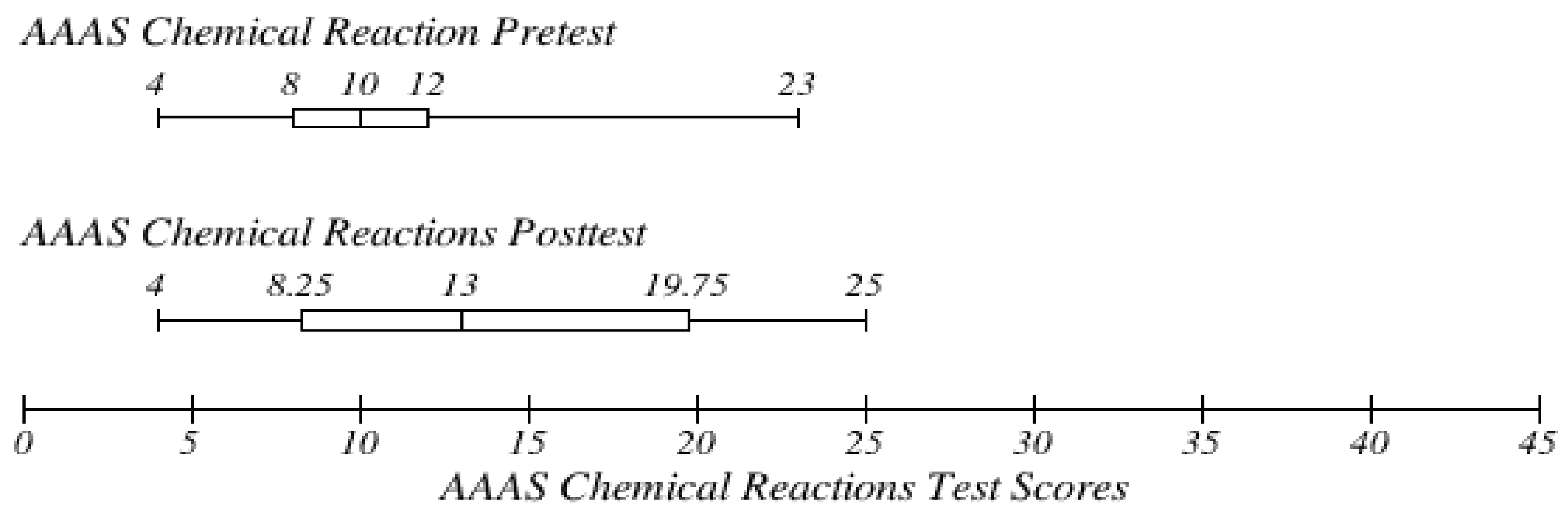

Figure 6. AAAS Chemical Reactions Pre- and Post-test Box and whisker plot, (*N*=39).

Data and Analysis

The results of the Force Concept Inventory (FCI) pre- and post-test showed a range of scores on the pretest of 3 to 17 with a median score of six (*N*= 39). The FCI post-test showed a range of scores from 3 to 29 with a median score of 10 (*N*= 39). When the pre- and post-test scores were compared the lowest scores remained the same but the lowest score of the interquartile range of the post-test scores was higher than the highest score of the interquartile range of the pretest. The normalized gain was calculated for the FCI pre-test and post-tests; this showed to be .22, which according to Hake (1998) is considered low. The normalized gain indicated a small increase in the post-test score as compared to the pre-test score (Figure 1).

Analysis was done using the AAAS Chemical Reactions pre- and post-test data (*N*=39). The AAAS test contained 26 questions on the nature of chemical reactions and conservation of matter. The results showed a range of scores on the pre-test of four to twenty-three with a median score of ten.

Data Continued

The AAAS post-test showed a range of scores from four to twenty-five with a median score of thirteen. The interquartile range increased dramatically between the pre and post-test. The upper quartile of the post-test scores was larger than the whole interquartile range of the pretest. The average normalized gain was calculated for the AAAS pre-tests and post-tests; this showed to be .20. This value is considered low. The normalized gain indicated a small increase in the post-test score as compared to the pre-test score (Figure 6).

Data was analyzed from the Test of Science Related Attitudes (TOSRA) survey.
The results of the pre-survey show a range of scores from 46 to 148 with a median score of 90. The post-test scores show a range from 52 to 200 with a median score of 100. When the scores are compared the interquartile range of the post-test scores was smaller than the interquartile range for the pre-test scores, and the post-test had a higher maximum score.

Literature

The Oxford Dictionary online says that a misconception is, "a view or opinion that is incorrect because based on faulty thinking or understanding" (Misconception, 2017). Misconceptions are not a lack of knowledge, but rather they are incorrect knowledge or understanding. This incorrect knowledge that students develop is based on personal experiences. The incorrect conception that is the source of a misconception is supported through the person's life with many repeated experiences that tell the person that they are correct. When that individual takes high school physics and are faced with conflicting conceptions, the answer based on experience receives more weight, and the students will often fall back to that conception although it is incorrect (Eaton, Anderson, & Smith, 1983).

The Conceptual Change Model (CCM) helps a teacher to meet the conditions necessary for conceptual change. The six parts of the CCM requires that: students become aware of their own preconceptions, students expose their beliefs, students confront their beliefs, and students work toward resolving conflicts, thereby accommodating the new concept. Finally, students extend the concept by trying to make connections between the concept learned in the classroom and other situations, including their daily lives.
Students are encouraged to go beyond, pursuing additional questions and problems of their choice to the concept (Stepans, 2006).

Conclusions

Students misconceptions decreased during both the Motion and Forces Unit and in the Chemical Reactions Unit. The decrease in misconception was greater for the unit on motion and force than for the unit on chemical reactions. This supports the idea that using the Conceptual Change Model helps students overcome their misconceptions. The scores for the pre- and post-survey did not change by a significant amount.

One student interviewed about misconception probes said, "that if I know I'm wrong now maybe I won't get the wrong answer on the test." When asked "How do you feel about using the conceptual change model in class, do you feel that it helps you learn?" one student reflected, "it helps me figure out what I'm doing wrong but, I would like it better if you just told me the answers." Another student was more enthusiastic with a response of, "Yes, I love doing hands-on work, I didn't really think I liked science, but this is fun!"

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