Encouraging Patient Problem Solving: Scaffolding Student Metacognition in Physics

TEACHERSININDUSTRY
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A UA College of Education/Tucson Values Teachers Partnership

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Introduction

I have noticed that students struggle significantly with problem solving when problems are "ill-structured". These types of problems do not present a direct path to a correct answer, may provide less than enough or excessive information, and do not provide "steps" along the way in order to finish. Not only do students have trouble solving these problems, but they are quick to give up and resign themselves to just not "getting it". The purpose of this action research was to help structure student thinking and increase persistence in the face of challenging real-world problems.

Connection to Industry

In my time working at APS I observed employees consistently solving complex problems. These problems were open ended, or "ill-structured", in the sense that there was not a clear pre-determined process to solve them and they required additional information. I developed a problem solving procedure with my students to help structure their thinking during problem solving and to help improve their ability to solve ill-structured tasks representative of those found in industry.

Questions

1.How did my students' problem solving strategies change as a result of the use of a problem solving cycle and structure?

2.How did my students' perceptions of problem solving change as a result of the use of a problem solving cycle and structure?

3.How were my students' perceptions of problem solving related to their success as measured by class grades?

Investigation

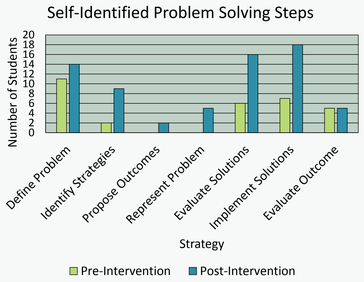
A total of 31 junior and senior general physics students participated in this study. Students participated in a one-week lesson on problem solving strategies after which a formal problem strategy was developed and put into a guide for students. Students were asked to complete the same ill-structured task both before and after the intervention and their work was scored from 0 to 3 in each of the identified strategies based on proficiency. Students also completed problem solving surveys at the beginning and end of the school year as well as before and after the intervention. The surveys used Likert-scale questions to measure students' attitudes toward problem solving and their own abilities.

Problem Solving Steps/Strategies
1) Define the Problem
2) Identify Strategies to Solve the Problem
3) Propose Outcomes to the Problem
4) Represent the Problem in Multiple Ways
5) Evaluate Solutions to Determine Best Approach
6) Implement Solutions
7) Evaluate Outcomes

Finding 1

The sophistication and complexity of students' problem solving strategies increased as a result of explicit problem solving instruction.

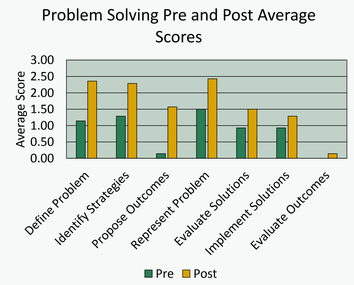
After the intervention, students reported a greater number of steps in their process and the steps they reported had more significance for solving complex problems.

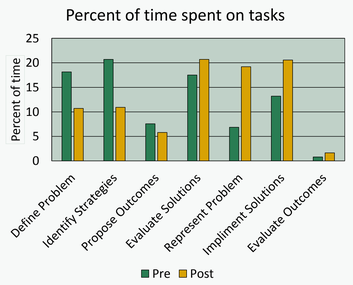


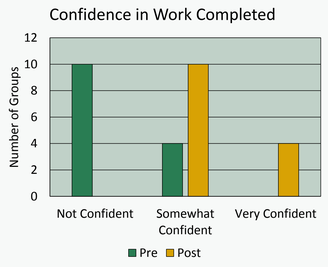
Finding 2

Engaging students in a problem solving procedure increased their understanding of real world tasks.

Students demonstrated greater levels of proficiency and effort in each strategy, spent more time on tasks to solve the problem and less time on tasks to understand the problem, and reported higher levels of confidence in their work.







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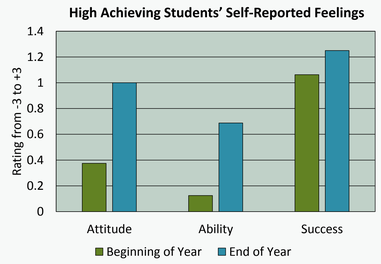
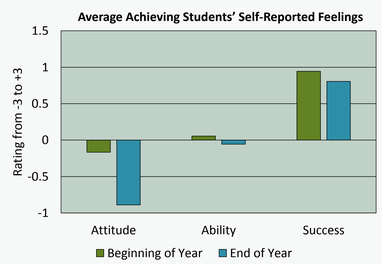
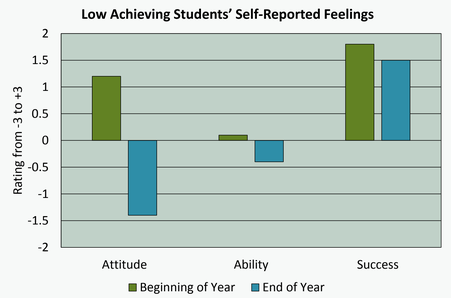
Finding 3

Changes in students' attitude toward problem solving and perceptions of ability were strongly related to their success in class. Overall, students' feelings of success did not change in a statistically significantly way.

- Students showing high levels of traditional academic success developed improved attitudes and feelings of ability and success when problem solving.
- Despite increases in problem solving sophistication and confidence in their work, average and low performing students developed more negative attitudes toward problem solving and their abilities yet maintained feelings of success.







Implications and Plan of Action

- Students benefitted from explicit instruction in problem solving strategies. Thus, I will develop a beginning of the year problem solving unit for my engineering students using industry-based problems.
- Students were able to demonstrate greater levels of ability and knowledge and feel more confident about their work when they used a structured problem solving guide. I will develop an engineering-specific guide and encourage students to use it on all problems.
- Students associated their problem solving ability with their ability to get the "correct answer" and a good grade. This caused low-achieving students to develop negative attitudes toward problem solving and themselves. I will work to develop a grading system that emphasizes the problem solving process over the final product.