Back to the Basics: How Reinforcing Algebraic Foundations Improves Understanding in STEM Classes

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California State University Sacramento | PEER ASSISTED LEARNING PROGRAM

Introduction

As PAL facilitators, we often notice where students succeed and where they sometimes falter. In an effort to assess whether or not a return to the basics of foundational algebra is beneficial to the learning of curriculum in science and math courses, this project was created. This research aimed to assess whether reinforcing foundational mathematical skills improved their understanding in course content. A variety of classes were evaluated in this research project including Chemical Calculations (CHEM 4), General Chemistry II (CHEM 1B), Physics-General for Mechanics, Heat, and Sound (PHYS 5A), and Calculus (MATH 30) courses. A baseline was taken by administering a pre-test to determine students' proficiency before intervention. Two post tests were administered at the end: one consisting of only algebraic problems similar to the pre-test and one consisting of problems that would be applied to the PAL's respective subject. As researchers, we hypothesized the students would score better on the post-test compared to the pre-test and be able to apply the concepts reviewed to the course concepts. Results showed this hypothesis to be somewhat true.

Background

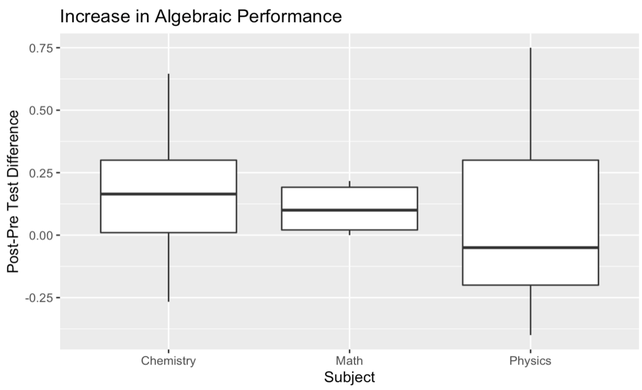
Recently, students in higher education have been having a harder time retaining information they have learned in prerequisite courses, most notably basic mathematical skills and general chemistry foundations, due to the unexpected nature of online schooling and “Zoom University” courtesy of the COVID pandemic (Sharma & Alvi, 2021). For STEM (Science, Technology, Engineering, and Math) students, having these foundations are critical to success in future college courses. In an effort to improve these fundamentals, alternative pedagogical methodologies have been investigated by many academics (Chariker et al., 2013). According to a previous study, the utilization of math and chemistry refreshers has helped students retain foundational concepts better and increase their ability to apply their mathematical knowledge to courses they take in university (Mokry, 2016). Although not everyone feels inclined or passionate about math, studies have shown that math refreshers are a benefit as "of the 33 students who completed the qualitative survey, all students found the assignments at least somewhat helpful. Several students additionally commented that the assignments saved time in class, providing more time for new material” (Morky, 2016).

Methodology and Results

Methodology

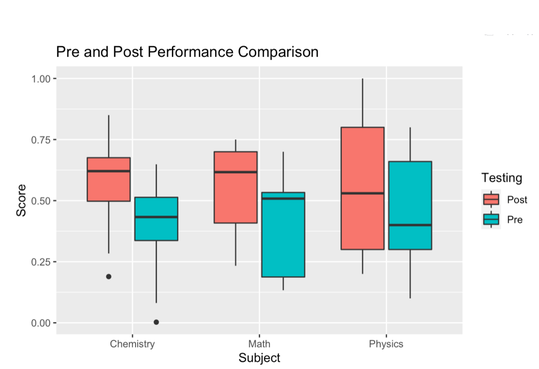
- The students were given a pre-intervention quiz for basic algebra skills that are removed from the context of the courses at hand.
- The intervention consisted of having the students review a question given in the pre-test and teach it to the rest of their peers. Giving students this opportunity allowed them to learn the material themselves well enough to feel confident in sharing their methodology with their peers. This ensured all students got exposure to the algebraic problems.
- The post-intervention quiz contained mathematical, physics-based, or chemistry-based problems that contained the same or very similar algebra skills that required students to recognize and utilize them in order to solve the problem.
  - Evidence includes taking note of the number of correct answers (accuracy) they got on quizzes pre- and post-intervention in a set amount of time; these quizzes contained a number of problems that were not intended to be fully done in the set amount of time given to our students.
  - We compared improvement in concepts pre- and post-intervention.
  - Effectiveness was measured by the student’s ability to recognize the math skill needed without completing problems.

Results

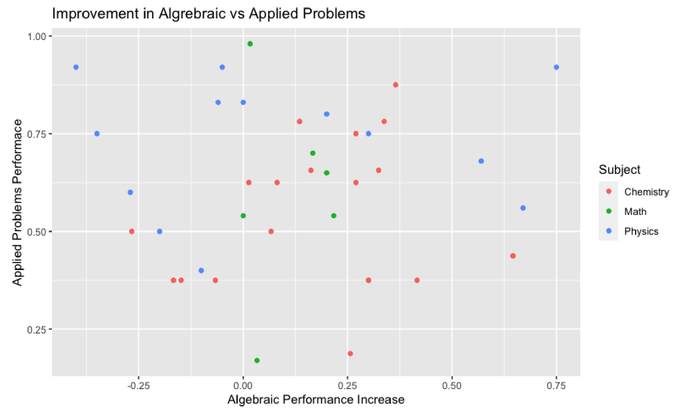


- The data collected consists of unique identification of each students, pre- and post-testing score, as well as score for applied problem assessment
- The boxplot to the left compares the improvement in algebraic knowledge across Chemistry, Math, and Physics.
- The y-axis indicates the difference between pre- and post-testing scores. The x-axis indicates the subjects.
- Since all the boxes overlap, this suggests that there is no significant difference in the mean increase between all subjects

Methodology and Results



- The above boxplot displays the distribution of the score for pre- and post-testing for all subjects.
- The y-axis displays the range of score in percentage and the x-axis indicates the subjects, which are Chemistry, Mathematics, and Physics.
- The boxes for Physics overlap which implies there is no difference in the mean score in pre- and post-testing. This is clarified with a t-test, which returns a p-value of 0.43.
- While the boxes did not completely overlap for Math, t-test indicates that there is no difference between the mean score in pre- and post-testing, with p-value of 0.26
- Since the boxes for chemistry mostly did not overlap, this indicates that there is a significant difference between the mean of pre- and post-testing. This is confirmed with a t-test which returns a value of 0.002 (significance level = 0.05).



- The above plot aims to display the relationship between the score improvement and the ability to apply the algebraic knowledge to problems in Chemistry, Mathematics, and Physics.
- The y-axis represents the difference from pre- to post-testing score. The x-axis represents the grade students score in the applied problems in their respective subjects.
- Since we do not see a linear relationship in the plot, our current data cannot suggest that there is a correlation between the increase in algebraic knowledge and ability to solve problems in Math, Physics, and Chemistry courses.
- Using Kendall's rank correlation test, we get correlation of 0.04. This indicates a weak correlation between the variables.

Conclusion

The project involved evaluating courses such as Chemical Calculations (CHEM 4), General Chemistry II (CHEM 1B), Physics-General for mechanics, Heat, and Sound (PHYS 5A), and Calculus (MATH 30). The hypothesis predicted that students would score better on the post-tests compared to the pre-test and apply the reviewed concepts to practical situations.

The results indicated that reinforcing foundational mathematical skills positively influenced students' comprehension of course content for Chemistry courses. For Physics and Math, there was no statistically significant increase. Students demonstrated improved performance on the post-tests, surpassing their pre-test scores, and exhibited the application of reviewed concepts to real-world problems. These findings suggest that a return to foundational algebra benefits students' understanding of STEM curriculum, equipping them with the necessary skills to succeed in science and math courses.

Future Directions

This project was a new idea that was tested only this semester. There were some holes that we noticed while conducting the intervention. For example, the students struggled to step up the basic of the problem in its respective discipline such as Chemistry and Physics before evening applying the math that were being reviewed. For further research, the refreshers should include math review and review of concept being learned in the discipline, as well.

References

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