Introduction

The Common Core State Standards for Mathematics (NGA Center 2010) states that students should be able to construct mathematical arguments. In particular, the standards indicate that students should be able to justify any conclusions made and clearly communicate their justification. The purpose of this study was to examine the justifications provided by middle school students (Grades 5 to 8) on three mathematical tasks that required students to justify their reasoning. Particularly, we wanted to know,

1. What kind of justifications do middle school students produce?
2. What level of communication do middle school students use in their justifications?

Methods and Materials

Students ranging from fifth to eighth grade were given three different mathematical tasks. The tasks stated,

1. Amy and Stephen are trying out a number trick. Amy picks a starting number between 1 and 10. She adds it to 10 to the number and writes down the answer. Then she adds the two answers from the first two steps. Stephen picks a starting number between 1 and 10. He adds it to 10 to the number and writes down the answer. He subtracts the starting number from 10 and writes down the answer. Then he adds the two answers from the first two steps. What do you notice about the two final answers?
2. What level of communication do middle school students use in their justifications?
3. What level of explanation do middle school students use in their justifications?

Results

Examining Middle School Students’ Methods of Justification

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References


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Furthermore, the justification level is considered a 4 because the student provides ideas based on mathematical reasoning. More specifically, this type of proof is a thought experiment because unlike the other levels, it is no longer a matter of demonstrating the outcome is valid because it works, but rather it establishes the necessary nature of its truth by providing thorough and cohesive mathematical reasoning. Within this response, the explanation level is deemed a 2 because it contains insufficient details. As for the justification level, it is considered a 2 because the reasoning utilizes a stated case as it mentions the example with the 7. This method of reasoning is considered a crucial experiment as it is based on the idea that if a situation applies here then it must always apply. Within mathematics, utilizing this method of reasoning may be flawed because “always” is a large statement and that may not always hold. Therefore, this reasoning classifies as a justification level of 2 since it makes a very large assumption.

Discussion

From our research, we found that for justification, almost half of the student responses had no reasoning or did not provide valid reasoning. Approximately one-fourth of the justifications were based on examples (Levels 1). Additionally, about one-fourth of the justifications were grounded primarily on mathematical reasoning (Levels 3 and 4). As for the explanation, students do not thoroughly communicate their reasoning. Over 90% of responses were missing a justification or insufficient details were provided (Levels 0 to 2).

Conclusions

Overall, our research demonstrated that students are unaccustomed to justifying their solutions. Without the explanations, the reasoning that drives the solution forward remains implicit. This research is of high value to educators, parents, school administrators, and students throughout the world as it provides a sharper and more beneficial method of learning. Educational research is highly important as the future of the world lies within our classrooms today.

Results (cont.)

The researchers scored each response individually and then met to compare scores. Any differences in scores were discussed and the final scores were then negotiated.

Corresponding to question 1, the following is a sample of explanation level 3 and justification level 4.

The student’s work classifies as an explanation level 3 because the justification is mathematically correct, but certain aspects are glossed over. This case is not considered an explanation level of 4 because the student does not state what value x stands for.

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