Relationship between mathematical competencies and achievements in physics of 14 year old students

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Abstract. Students often have difficulty connecting problems in physics with their respective mathematical representation. Numerous studies have been conducted on this topic, but were almost exclusively focused on high school and college physics students. The sample size in this study is focused on 14-year-old elementary school students. A statistically significant positive correlation was obtained for analyzed relationships between mathematical competencies and achievements in physics (overall physics exam scores vs. overall mathematics exam scores, overall physics exam scores vs. math grades of sample students), suggesting that the latter are strongly entangled from the earliest age at which physics is taught.

Introduction

It is well known that students have difficulty relating problems in physics to their respective mathematical representations, and that they are unaware of the possibility of using a mathematical tool that they otherwise use successfully in solving mathematical problems. Numerous studies have been conducted on this or similar topics, but have focused almost exclusively on high school and college physics students. They [1-4] have reported a positive correlation between students' mathematical skills and their grades in physics courses, with addition that mathematical skills alone are not sufficient to guarantee success in physics, but that unless the student has the mathematical skills, the performance in physics could be poor. However, fewer studies have been conducted with elementary school students. Solving traditional problems using previously acquired mathematical skills and an algorithmic approach to problem solving makes up the majority of physics lessons in elementary school. At this stage of students' education, we should look for possible problems in mastering the curriculum content in physics. Our main goal is to determine if there is a connection between the (non)understanding of mathematical procedures and the possibility of their application in solving problems in elementary school physics. The ultimate goal is to determine the most effective methods of teaching mathematics and physics, the application of which would strengthen the connection between the two. This would reduce the misunderstandings of physics concepts that arise from difficulties in applying mathematical tools. To address the above issues, the basic research question "Is there a positive correlation between elementary school students' mathematical skills and their achievements in physics" was formulated.

Methods

The research sample consists of 98 fourteen-year-old students from three elementary schools in Istria County and Primorje-Gorski Kotar County in the Republic of Croatia. Despite the fact that they came from different schools and were taught by different teachers, all students covered the educational content in question only once and within the framework of an equal curriculum. The sample size in this study is not large enough for the generalization of the findings to the whole population, but it is interesting because similar studies are rarely conducted on elementary school populations.

Five seventh grade elementary school mathematical tasks (inverse proportionality, linear dependence, linear function, graphical representation of a linear function, a rectangular coordinate system in the plane and measurement) and the corresponding five eighth grade physics tasks (electric current, electric charge, uniform motion, acceleration) involving the same mathematical procedures were prepared as test instruments. Each student took first a physics exam and then a math exam in the next class. The obtained data were subjected to quantitative correlation analysis, considering Pearson's correlation coefficient r and the corresponding p -value.

Findings

The dependence of the overall score of the physics exam compared to the overall score of the mathematics exam was analyzed. A statistically significant correlation was found with $r = 0{,}75$ and $p < 0{,}0001$, which means that students with better achievements in mathematics generally also have better achievements in physics, i.e., students who perform worse in mathematics generally also perform worse in physics.

The dependence of the overall physics exam scores was also analyzed in comparison to math grades of the sample students in the seventh grade of elementary school (13-year-old students). Since a statistically significant correlation ($r = 0{,}57$, $p < 0{,}0001$) was found, it can be concluded that students with higher math grades in seventh grade generally have higher scores on the physics exam. The analysis also reveals that students with lower math grade do not achieve high scores in physics, but there is also a possibility that a high math grade does not guarantee a good score in physics, which is confirmed by previous findings on physics college students.

Conclusion

A statistically significant positive correlation was obtained for the analyzed relationships between mathematical competencies and achievements in physics among elementary school students (14-year-olds), suggesting that mathematical competencies and achievements in physics are strongly entangled from the earliest age at which physics is taught.

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