Prospective primary teacher and the interplay between mathematics and physics

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Abstract What is the mutual interplay between mathematics and physics when regarded from the perspective of scientific education in primary school? A group of 100 pre-service primary teachers reflected on this topic in a preliminary open overview at the end of the physics education and math education courses. After a seminar on a theoretical model on the interplay math and phys developed by Pospiech etal (2015) and after a discussion on the possible perspectives they answered a questionnaire. Results of the perspectives and contexts assumed by prospective primary teachers evidence their ideas and needs for a transversal perspective in primary education.

Introduction

In primary teaching a transversal perspective in classroom activity is required. In the international guidelines of primary teacher education the operative foundation of the epistemology of the main subjects is considered one of the main goals. But only seldom educative activities are analyzed in terms of their contribution to the operative epistemology of a subject and to the mutual fertilization of different subjects, even if subjects are siblings like math and physics. Sometimes a theoretical overview is offered as premise to the subject-related courses, but the relevant link and the different approaches to problems between subjects is rarely taken as an issue for educational path planning. So it seems appropriate to give prospective primary school teachers an insight into the working of physics including the role of mathematics. These aspects mostly are only considered of importance for high school or university. However, developing formal thought has to start as early as possible in the educational career. In this regard primary education lies the foundations for further development.

The theoretical background

The role of mathematics in physics is manifold. It has the task of representing physics in a comprehensible way and describing physics phenomena appropriately with formal elements, e. g. icons, sketches, diagrams, (line) graphs or formula. In this it offers tools, serves as translator of physical thought and provides structures for recognizing the complexity of physical processes and constructing physics concepts and theories, see also [2].
As a tool, mathematics offers techniques such as the calculation of physical quantities such as areas, volumes, slopes or trends and provides rules for describing how to organize formulas or to change units, … The formal elements have to be interpreted in terms of physics in the interplay of (mathematical) syntax and semantics. This aspect is connected to the communicative role which means the suitability of mathematical elements for representing physical processes or phenomena. This relies on the possibility of ascribing mathematical elements (diagrams, formulas or units) a specific meaning in a physical context. This can be seen in that e. g. laws appear to be relationships between letters, like $F = m\ a$ or $a = (V_f\text{-}V_i) / Dt$ or $Q = c\ m\ DT$, but in physics these letters together with the mathematical syntax take on a precise meaning in specific fields. This is the basis for the structural role of mathematics in physics implying relationships in various perspectives merging physics with the mathematical structure. In this respect mathematics suggests physical structures and may form physical thought [1]. In this role it may help to find new insights, e.g. by analysing derivatives and limits; recognizing similarities and differences by analogies or the combination of algebraic expressions of different laws to find new insights.

The research

For teachers normally textbooks often help in guiding the teaching. In textbooks for children used in primary school math is built using examples of everyday life and those of science are avoided apart from the cases of measure. However, in analyzing the textbooks also misleading descriptions were found e. g. concerning the measurement of volume.
As the interplay of mathematics and physics is only seldom considered in primary teacher education we implemented an exploratory study in order to investigate the scenario of ideas of prospective primary teachers (PPT). The participants were a group of 100 pre-service teachers after three years of university courses including basic courses on pedagogy, psychology, anthropology, sociology, evaluation methods and math education (10cfu), biology education (6cfu), ecology education (6 cfu) and physics education (8cfu).
In a first step the students should identify all the possible links between the two subjects Math and Phys and describe how to highlight them in primary teaching. In this perspective they should give a free report on ideas concerning the role of Math in Physics with respect to teaching in primary school. In the second step we involved the PPT in a seminar, three hours long on a theoretical model of the interplay of math and physics for education (Pospiech et al….) and the possible perspective for an analysis of the role of math in physics/ science education in primary school. PPT took part in a discussion on the content of math and science in the books for the III class of primary school (8 year old pupils). In the third step PPT then should answer to a questionnaire on the following points: 1. Mathematics has a role of representation, a technical and a structural role. What does each of these roles mean and how can it be involved in primary school teaching? 2. Consider the different areas of physics: which examples can be given with respect to the representative, technical and structural role? 3. Can physics support mathematical thinking?
In order to answer in a meaningful way the students got additional hints about the different roles of mathematics in physics, especially examples of the structural role. An example of the hint is: "Through a similar mathematical formalism analogies of scientific behavior are recognized, for example the distribution of one quantity in another as for the laws of density d = m / V and pressure p = F / S or in all the oscillating motions." Then the question was: "What does a structural role of mathematics for physics mean in the light of what has been said? On the other hand, to what extent physics contributes to mathematics in this reciprocal relationship?"
In addition the students should consider two thematic contexts in physics (fluids, thermal phenomena, motion, sound, electricity, magnetism..) and analyze the role of math in these areas, and vice versa, they should exemplify how physics can help math education in primary school
To this end first the roles of mathematics in physics are being described with reduction on aspects suitable for prospective primary school teachers. Then their views are explored and the effect of a short intervention is studied.

Conclusions

The inquiry was done to explore PPT ideas and how they spontaneously identified the role between math and science/ physics, both as basic culture of PPT and concerning their awareness in teaching/learning activity in primary education. The analysis of the results of the questionnaire offers indications concerning the way in which in PPT education the relationship between math and scientific education has to be related, as well as suggestions for teaching and book analysis which are relevant for the professional formation of primary teachers.

References

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