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**Modelling mathematical reasoning in physics education.**

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Summary: Many findings from research as well as reports from teachers describe students' problem solving strategies as manipulation of formulas by rote. The resulting dissatisfaction with quantitative physical textbook problems seems to influence the attitude towards the role of mathematics in physics education in general. Mathematics is often seen as a tool for calculation which hinders a conceptual understanding of physical principles. However, the role of mathematics cannot be reduced to this technical aspect. Hence, instead of putting mathematics away we delve into the nature of physical science to reveal the strong conceptual relationship between mathematics and physics. Moreover, we suggest that, for both prospective teaching and further research, a focus on deeply exploring such interdependency can significantly improve the understanding of physics. To provide a suitable basis, we develop a new model which can be used for analysing different levels of mathematical reasoning within physics. It is also a guideline for shifting the attention from technical to structural mathematical skills while teaching physics. We demonstrate its applicability for analysing physical-mathematical reasoning processes with an example. The authors Olaf Uhden, Ricardo Karam contributed equally to this work.

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