



## Commentary on Paul Ernest's Theory about Teachers' Beliefs and Practice

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### Abstract

In this short communication, the author analyzed Paul Ernest's theory on relationships between teachers' beliefs, and their impact on teachers' practice of mathematics. The author considered the teachers' espoused and enacted models of mathematics assessment in addition to the teachers' views of the nature of mathematics, teaching, and learning models. The author also considered three purposes of mathematics assessment.

**Keywords:** assessment, beliefs, mathematics

### INTRODUCTION

#### Teachers' beliefs about mathematics, teaching, and learning

Much research on teachers' beliefs focuses on beliefs about mathematics, mathematics teaching, and mathematics learning (Beswick, 2007; Cross, 2009; Ernest, 1989; Handel, 2003; Liljedahl, 2009; Maasz & Schlöglmann, 2009; Philipp, 2007; Raymond, 1997; Stipek, Givvin, Salmon, & MacGyvers, 2001; Thompson, 1992; Žalská, 2012). However, there has been almost no research on students' and teachers' beliefs about assessment in mathematics (Suurtaam et al., 2016).

Teachers' views of mathematics, like their belief systems on the nature of mathematics as a whole, form the basis of the philosophy of mathematics, although some teachers' views may not have been elaborated into fully articulated philosophies. According to Ernest (1989), "teachers' conceptions of the nature of mathematics by no means have to be consciously held views; rather they may be implicitly held philosophies" (p. 249). Based on their observed occurrence in the teaching of mathematics, Ernest describes three philosophies of mathematics: *instrumentalist*, *Platonist*, and *problem-solving*.

- In the *instrumentalist* view of mathematics, mathematics is an accumulation of facts, rules, and skills to be used in the pursuance of some external end. Thus, mathematics is a set of unrelated but utilitarian rules and facts.
- In the *Platonist* view of mathematics, mathematics is a static but unified body of certain knowledge. Mathematics is discovered, not created.
- In the *problem-solving* view of mathematics, mathematics is dynamic, continually expanding field of human creation and invention, a cultural product. Mathematics is a process of inquiry and coming to know, not a finished product, for its results remain open to revision.

These three philosophies of mathematics, as systems of beliefs, can be assumed to form a hierarchy. In this hierarchy, instrumentalism is at the lowest level, involving knowledge of mathematical facts, rules, and methods as separate entities. The Platonist view would be at the next level, involving a global understanding of mathematics as a consistent, connected, and objective structure. At last, at the highest level, the problem-solving view perceives mathematics

as a dynamically organized structure located in a social and cultural context.

On the other hand, when it comes to the model or view of teaching mathematics, this model represents the teacher's conception of the type and range of teaching roles, actions, and classroom activities associated with the teaching of mathematics. Ernest points out three different models that can be specified through the teacher's role and intended outcome of instruction as follows.

Teacher's Role	Intended Outcome
Instructor	Skills mastery with correct performance
Explainer	Conceptual understanding with unified knowledge
Facilitator	Confident problem posing and solving

In addition, he suggests that the use of curricular materials in mathematics is also very important in a model of teaching and points out three patterns of use:

- The strict following of a text or scheme;
- Modification of the textbook approach, enriched with additional problems and activities;
- Teacher or school construction of the mathematics curriculum.

Similarly, when it comes to the teacher's mental model of the learning of mathematics, this model represents the teacher's view of the process of learning mathematics, what behaviors and mental activities are involved on the part of the learner, and what constitutes appropriate and prototypical learning activities. Ernest points out two key constructs for these models:

- learning as active construction, as opposed to the passive reception of knowledge;
- the development of autonomy and child interests in mathematics, versus a view of the learner as submissive and compliant.

Ernest suggests that the teaching practice of mathematics depends fundamentally on the teacher's system of beliefs, and in particular, on the teacher's views of the nature of mathematics and teaching and learning mathematics. Besides, according to Ernest, the practice of teaching mathematics also depends on the social context of the teaching situation, particularly the constraints and opportunities that provide, and the teacher's level of thought processes and reflection. These factors determine the autonomy of the mathematics teachers within their teaching.

Ernest provides a diagram that describes the relationships between teachers' views of the nature of mathematics and their models of teaching and learning (see Figure 1).

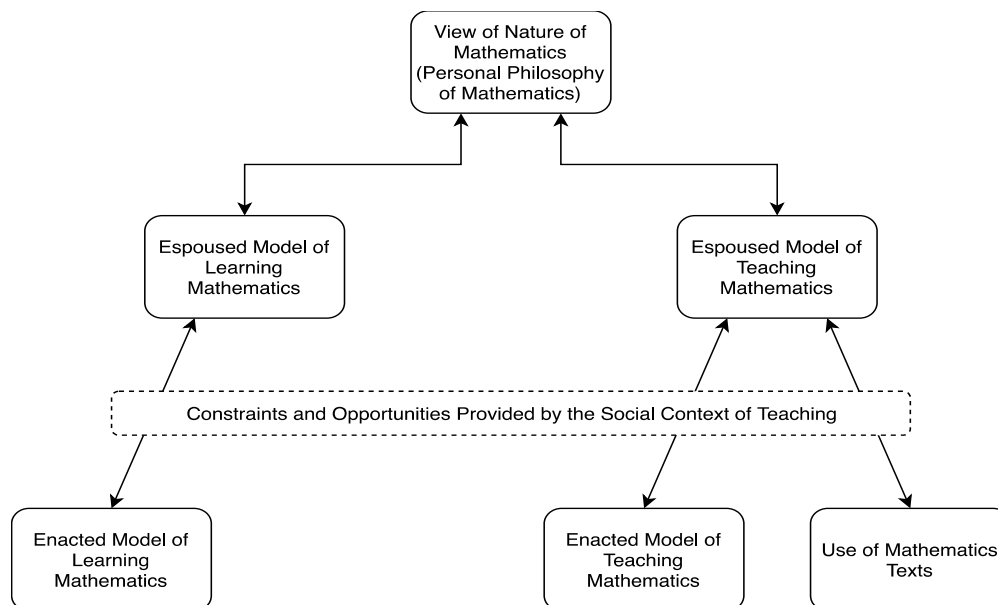


Figure 1. Relationships Between Beliefs and Their Impact on Practice (Ernest, 1989)

This illustrative diagram shows how teachers' views of the nature of mathematics provide a basis for the teachers' mental models of the teaching and learning of mathematics, as indicated by the downward arrows. Hence, for example, the instrumental view of mathematics is likely to be associated with the instructor model of teaching, and with the strict following of a text or scheme. Also, it is likely to be associated with the child's compliant behavior and mastery of the skills model of learning. On the other hand, mathematics as a Platonist unified body of knowledge is likely to be associated with the teacher as an explainer and learning as the reception of the knowledge model. And lastly, mathematics as problem-solving is likely to be associated with the teacher as facilitator and learning as the active construction of the understanding model, possibly even as autonomous problem posing and solving.

According to Ernest, these teacher's mental or espoused models of teaching and learning mathematics are subject to the constraints and contingencies of the school

context and they are transformed into classroom practices. These are the enacted model of teaching mathematics, the use of mathematics texts or materials, and the enacted model of learning mathematics. He believes that the espoused-enacted distinction is necessary because case studies have shown that there can be a great disparity between a teacher's espoused and enacted models of teaching and learning mathematics.

Ernest points out two main causes for the mismatch between beliefs and practices. Firstly, there is the powerful influence of the social context, as the results from the expectations of others including students, parents, peers (fellow teachers) and superiors, and the institutionalized curriculum (the adopted text or curricular scheme), the system of assessment, and the overall national system of schooling. Secondly, there is the teacher's level of consciousness of his or her own beliefs, and the extent to which the teacher reflects on his or her practice of teaching mathematics.

## RESULT AND DISCUSSION

### Espoused and enacted models of mathematics assessment

Based on Ernest's theory, the system of assessment is to be viewed as one of many sets of constraints that can affect the enactment of the models of teaching and learning mathematics, but he does not specifically state if the model of mathematics assessment falls under learning or teaching model particularly. So, it is not quite clear why is mathematics assessment part of the broader set of constraints and not viewed as a separate model like models of learning and teaching mathematics. Also, if mathematics assessment is to be viewed as a separate model, the author wonders, what would be Ernest's

personal philosophy about mathematics assessment? In the remainder of this paper, the author briefly presents some of her personal views on the matter.

Firstly, the author considers the extension of Ernest's model of relationships between beliefs and their impact on practice. The modified model, presented in Figure 2 (see right-hand side), shows the relationships between the teachers' views on mathematics assessment and mathematics assessment practice. The extension includes the addition of espoused and enacted models of mathematics assessment. The model of mathematics assessment is to be viewed as a separate entity.

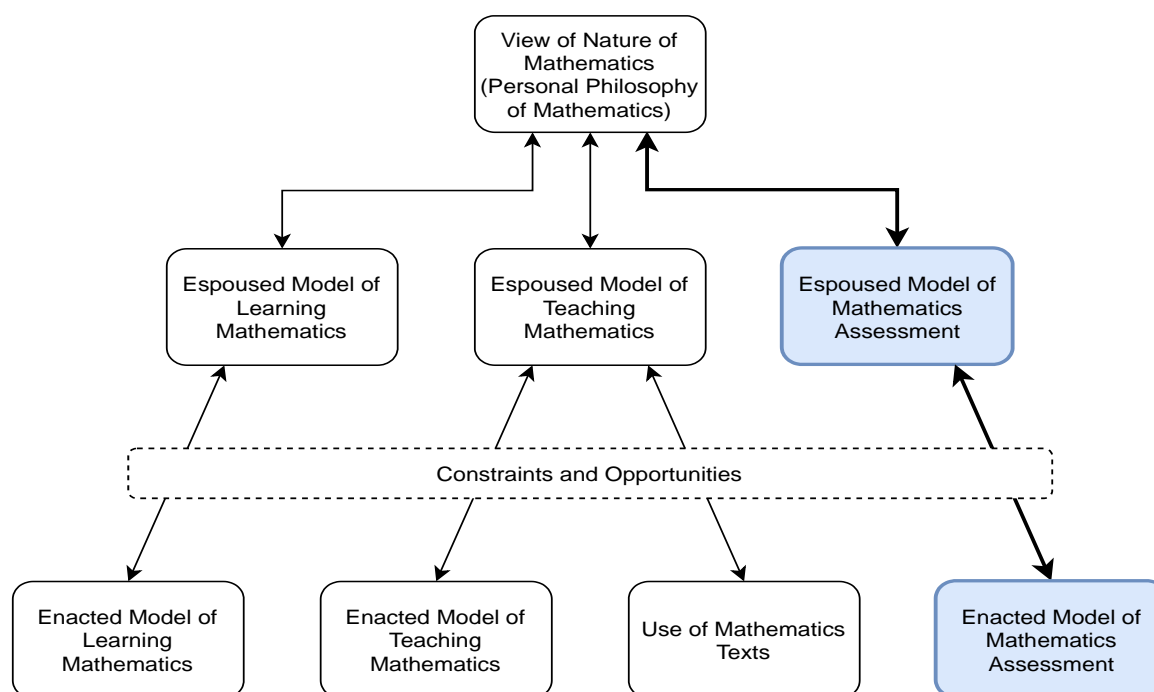


Figure 2. A Modified Version of Figure 1: Relationships Between Beliefs and Their Impact on Practice

This modified diagram shows how the mathematics teachers' views of the nature of mathematics provide a basis for the teachers' mental model of mathematics assessment. This teachers' mental or espoused model of

mathematics assessment is subject to the constraints and opportunities provided by the social context of teaching, and it is transformed into classroom practices. This is the enacted model of mathematics assessment.

Secondly, based on each of Ernest's three philosophies of mathematics, *instrumentalist*, *Platonist*, and *problem-solving*, the following three purposes of mathematics assessment might be considered:

- In the *instrumentalist* view of mathematics, the purpose of mathematics assessment is to assess a set of skills, which involves assessing mathematical calculations and using rules, procedures, and formulas.
- In the *Platonist* view of mathematics, the purpose of mathematics assessment is to assess logic and rigor by writing rigorous proofs and exact definitions.
- In the *problem-solving* view of mathematics, the purpose of mathematics assessment is to assess a constructive process, which involves assessing mathematics through the process of problem-solving, building rules, and formulas, so that students are able to experience the actual doing of mathematics and finding relations between different notions.

Similarly, it would be assumed that these three purposes of mathematics assessment, as systems of beliefs, form a hierarchy. Based on this hierarchy of purposes of mathematics assessment, in the instrumentalist view of mathematics, the purpose of mathematics assessment would be considered to be at the lowest level. At this level, the purpose of mathematics assessment would be to assess *instrumental understanding* – as the ability to

execute mathematical rules and procedures (Skemp,1976), and *procedural knowledge* – a knowledge that consists of rules or procedures for solving mathematical problems (Hiebert & Lefevre, 1986).

Then, the purpose of mathematics assessment in the Platonist view of mathematics would be at the next level. At this level, the purpose of mathematics assessment would be to assess *relational understanding* – as knowing both what to do and why (Skemp,1976), and *conceptual knowledge* – a knowledge rich in relationships, which can be thought of as a connected web of knowledge, a network in which the linking relationships are as prominent as the discrete pieces of information (Hiebert & Lefevre, 1986).

Lastly, at the highest level, the purpose of mathematics assessment would be in the problem-solving view of mathematics. At this level, the purpose of mathematics assessment would be to assess both procedural and conceptual knowledge and instrumental and relational understanding.

## CONCLUSION

These three purposes of mathematics assessment might provide the basis for important insights into mathematics teachers' views of mathematics, mathematics assessment, and mathematics assessment practices. Now, how these purposes of mathematics assessment can be adapted to different teaching and learning situations have not been studied yet, but they might be considered for future research studies.

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