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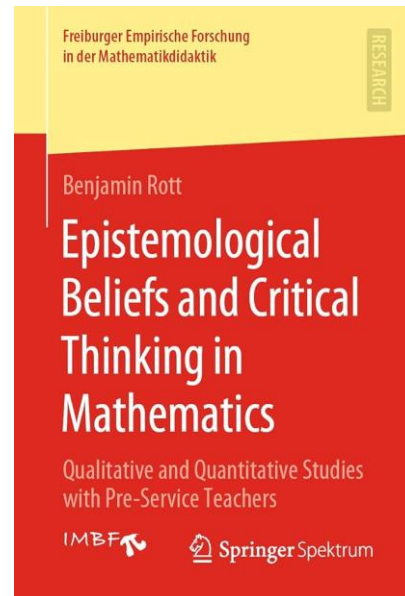
Rott, B. (2021). *Epistemological beliefs and critical thinking in mathematics: Qualitative and quantitative studies with pre-service teachers.* Springer.

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Epistemological Beliefs and Critical Thinking in Mathematics by Benjamin Rott offers valuable insights into mathematics education. Rott's work is based on a study involving 463 pre-service teachers from two German universities (University of Education, Freiburg, and University of Duisburg-Essen), representing those preparing to teach at primary, lower secondary, and upper secondary levels. The study used questionnaires and tests to assess participants' epistemological beliefs, specifically their positions and justifications regarding the certainty of mathematical knowledge and their mathematical critical thinking skills, with the goal of examining the relationship between these constructs and their development over time.



A key challenge in math education is that learners often prioritize obtaining the correct answer over understanding the reasoning process. Rott addresses this by exploring how students' epistemological beliefs influence their reasoning and learning approaches. He argues that viewing mathematics as a fixed body of knowledge with only one correct answer severely limits the development of critical thinking. Rott aims to explain, evaluate, and analyze the connection between epistemology and critical thinking, particularly among students and pre-service teachers. In the process, he recognizes that this link is essential for advancing mathematics learning.

In Chapter 1, we learn that the term “epistemological belief” is a reference to the beliefs that an individual holds regarding knowledge, such as “Where do facts come from?” and “How do scientists arrive at research results?” (p. 1). It becomes

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apparent in Rott's discussion that epistemological beliefs play an important role in how people study, think, and comprehend mathematics. The reasons for holding particular beliefs are critical in determining critical thinking skills of learners. According to the author, "epistemological beliefs can have subtle but comprehensive effects on learning processes" (p. 12). At the same time, epistemological beliefs also have something to do with critical thinking, and more specifically, the correlation of the extent of epistemological justification with critical thinking abilities in mathematics. Moreover, the significance of using appropriate instruments capable of uncovering the cognitive processes of students must be stressed. Knowledge of students' perceptions and thought processes must be gained for better math education outcomes.

Chapter 2 expands on how mathematics is perceived in the field, emphasizing people's epistemological views toward math education. The concept of the "mathematical world" (p. 28), which refers to people's attitudes and beliefs about mathematics, such as whether it is viewed as definite or indefinite, or as correct or incorrect, frequently takes the place of the term "epistemological beliefs" in this field, despite the fact that it is not used directly. As they "filter his/her perceptions and direct his/her actions" (p. 28), these beliefs underpin how individuals process information, guide their behavior, approach problem-solving, and acquire mathematical knowledge. The study employed qualitative methods, specifically in-depth interviews, to capture the nuanced nature of these beliefs, recognizing that questionnaires alone are insufficient for this purpose. However, the research is limited by a small sample size and an unclear articulation of the practical implications for educational settings. These constraints highlight the necessity for further investigation to better connect epistemic beliefs with instructional practice and caution against overgeneralizing the findings.

A test to gauge pupils' mathematical critical thinking (CT) abilities is introduced by Rott in Chapter 3. This test assesses students' ability to reflect on, validate, and update their problem-solving methods rather than just their mathematical skills. In this situation, critical thinking entails challenging preliminary responses rather than taking them at face value and analyzing them to ascertain their accuracy. One of the main examples utilized in Rott's study (Chapter 3) is the well-known "bat and ball" problem from *Thinking, Fast and Slow* (2011), which emphasizes the interaction of three modes of thinking: automatic (intuitive), procedural (algorithmic), and reflective (evaluative). The exam operationalizes CT as the capacity to use reflective judgment to overcome procedural or spontaneous answers, especially in mathematical situations that can be resolved with simple arithmetic. Its strengths lie in emphasizing deeper cognitive engagement and being grounded in a robust theoretical framework of human thought processes.

In Chapter 4, the author examines the relationship between pre-service math instructors' critical thinking abilities and their epistemological beliefs. According to *Beliefs about Knowledge and Knowing: Domain Specificity and Generality* (2006), critical thinking abilities pertain to reflective judgments within a specific context, whereas epistemological beliefs concern impulsive judgments without any context. Rott concludes that students can change their attitudes towards math and acquire

critical thinking skills particularly by formulating arguments, during the course of their education. However, there is no consistent correlation between students' critical thinking abilities and their ideas about the certainty of mathematical knowledge, that is, whether they consider mathematical truths to be provisional and subject to modification or permanent and absolute. To put it another way, a student's attitude toward mathematical certainty is not a reliable indicator of their capacity to use reflective and critical thinking when working through mathematical difficulties.

The topic of “judgment about knowledge claims” (p. 80) is central to Rott's analysis in Chapter 4, which looks at the epistemological views and critical thinking skills of pre-service mathematics teachers. This perspective emphasizes that knowledge is context dependent and potentially uncertain, rather than absolutely true or false. Adopting this view promotes a more nuanced and critical understanding of knowledge, which supports the development of critical thinking skills. However, the findings presented are based on a relatively small and specific sample of teacher education students from the University of Education Freiburg, underscoring the need for further research with larger and more diverse populations to improve the generalizability of the results.

Rott's study, which is discussed in Chapter 5, shows that pre-service teachers' critical thinking skills are directly linked to how they defend or justify their attitudes toward mathematics. “Belief position and belief justification are independent of each other” (p. 101) highlights the significance of differentiating between belief position and belief justification. This contrast supports Rott's study's consistent conclusion that the complexity of belief justification is linked to critical thinking. According to the findings of Rott study, critical thinking is more closely linked to the quality of argumentation or the reasoning behind a belief position than it is to the attitude toward knowledge in general, whether it relates to certainty or doubt.

According to Rott, mathematical understanding encompasses not only deductive and inductive reasoning, but also the capacity to explain and defend one's own beliefs. He asserts that mathematical knowledge can be validated through both inductive and deductive means, a perspective that resonates with Polya's (1954) ideas in *Mathematics and Plausible Reasoning*. Rott also contends that the quality of an argument is more strongly connected to critical thinking than to the nature of the belief itself. He further states that writing a deductive proof constitutes merely the concluding stage of an argumentation process, whereas the processes of discovery and justification are essentially inductive in nature. Drawing on interview data from his study, explanations of mathematical truth tend to be dynamic and flexible in character, suggesting that deductive proof is not the sole valid approach in mathematics.

Learning mathematics involves more than just strategy; it also involves articulating concepts and viewpoints. The justification for the beliefs should take precedence over the ideas themselves. Differences in beliefs do not exclude someone from exhibiting high levels of critical thinking abilities provided they are backed by convincing arguments. This is because critical thinking relies more on the quality of arguments than the content of beliefs. As Rott reports, “Contrary

to assumptions from psychological research, persons who argue for the certainty of mathematical knowledge did not necessarily hold naïve or unreflected beliefs” (p. 148). In other words, contrary to previous psychological research findings, individuals who perceive mathematics as certain are not characterized by naïve, unreflective, or superficial thinking but can possess sophisticated and well-justified epistemological positions.

Rott’s arguments are consistent. Specifically, from the first page until the last one, the main concern is that it is more important to recognize that the beliefs about mathematics itself are explanations that back up these beliefs. Moreover, throughout the entire book, the author consistently treats critical thinking as reflection rather than calculations or problem-solving. And finally, the author criticizes throughout the use of oversimplified ways of measuring students’ abilities, e.g., using closed questionnaires. There is no inconsistency among the ideas presented in different chapters, rather, the arguments seem to be mutually supportive and complementary. Nevertheless, consistency of arguments should not imply their completeness. Methodologically, several flaws can be identified in the study on which this book is based. For example, in Chapter 2, only 16 participants are studied. Problems occur at the level of measurement as well. Epistemological beliefs are quite complicated, and consistent assessment requires continuous efforts to achieve reliability and validity of measurement. Moreover, research findings demonstrate that critical thinking development varies among learners, and sometimes even declines in certain cases, such as for some prospective elementary teachers. One is left with the impression that current teacher training programs are inadequate in fostering critical thinking among their trainees.

References

- Hofer, B. K. (1997). *The development of personal epistemology: Dimensions, disciplinary differences, and instructional practices*. (Order No. 9811094). Available from ProQuest Dissertations & Theses Global. (304356421).
<https://www.proquest.com/openview/54496356a83acc479dd364d8fcbb74a7/1?pq-origsite=gscholar&cbl=18750&diss=y>
- Muis, K. R., Bendixen, L. D., & Haerle, F. C. (2006). Domain-generality and domain-specificity in personal epistemology research: Philosophical and empirical reflections in the development of a theoretical framework. *Educational Psychology Review*, 18(1), 3–54. <https://doi.org/10.1007/s10648-006-9003-6>
- Kahneman, D. (2011). *Thinking, fast and slow*. Farrar, Straus and Giroux.
- Polya, G. (1954). *Mathematics and plausible reasoning. I. Induction and analogy in mathematics. II. Patterns of plausible inference*. Princeton University Press.
<https://doi.org/10.1515/9780691218304>
- Xinyu, Y., & Xiaoqing, J. (2025). Review of *How do we learn? A scientific approach to learning and teaching (evidence-based education)*, by H. Ruiz Martín. *Education Review*, 32. <https://doi.org/10.14507/er.v32.3981>

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Benjamin Rott is Professor of Mathematics Education at the University of Cologne, Germany. His research focuses on mathematical problem solving, beliefs, and giftedness. The present work was written as a postdoctoral thesis (Habilitation) at the University of Education Freiburg.


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