Transformasi : Jurnal Pendidikan Matematika dan Matematika
Volume 6, No.1, Bulan Juni Tahun 2022, pp. 87-94
ISSN 2549-1164 (online)
DOI: 10.36526/tr.v%vi%i.1958
Available online at https://ejournal.unibabwi.ac.id/index.php/transformasi

EXPLORING TEACHER'S AND STUDENTS' BELIEFS CONCERNING HIGHER ORDER THINKING IN MATHEMATICS

Elizar Elizar and Cut Khairunnisak
Fakultas Keguruan dan Ilmu Pendidikan, Universitas Syiah Kuala
Corresponding email: elizar@unsyiah.ac.id

Accepted: (29-05-2022), **Revised**: (01-07-2022), **Published** : (15-07-2022)

ABSTRACT

Teacher beliefs play a fundamental role in mathematics teaching and learning, as they will ultimately influence the teacher's classroom practices. Student beliefs on a subject matter also hold equal importance as they will be reflected in how the students approach the learning and related issues to the subject. The importance of research on teachers' beliefs stems from the possible relationship between teacher beliefs and student beliefs. This descriptive quantitative study aimed to measure the degree of conformity between teacher and student beliefs concerning mathematics related to Higher Order Thinking (HOT) and Lower Order Thinking (LOT). The population was all Year 9 students in Aceh, Indonesia, and the samples were 1135 Year 9 students and 46 Year 9 mathematics teachers from 25 schools selected through stratified random sampling. Data collection was obtained through teacher and student questionnaires, and data were analyzed descriptively by SPSS 20. The finding of this study revealed that teacher beliefs concerning mathematics related to HOT were highly positive (83%). While the percentage of students who hold highly positive beliefs concerning mathematics related to HOT was just over 50%, indicating the discrepancy between teacher and student beliefs. However, regarding the beliefs concerning mathematics related to LOT, teacher and student beliefs conformed; they had somewhat positive beliefs (68% and 71.30%, respectively). This study implies that teachers need to promote HOTS in mathematics teaching at schools to foster students' positive beliefs toward HOT.

Keywords: *teacher belief, student belief, higher order thinking, lower order thinking, mathematics*

Introduction

Beliefs hold an essential position in the education landscape, including mathematics education. Many previous researchers have long explored teacher beliefs (Carter & Norwood, 1997; Levin, 2014) for their importance in mathematics teaching and

Contact: Elizar Elizar, elizar@unsyiah.ac.id, Universitas Syiah Kuala

learning. Teachers beliefs are believed to influence their classroom practices ultimately (Collins, 2014), how they approach the subject matter and how they perceive their students' abilities (Zohar et al., 2001). Teacher beliefs are defined as teacher beliefs and ideas of teachers (Nishino, 2012). "Teachers, including those at pre-service level, hold a set of complex beliefs about a wide range of professional practices and the people, structures, systems, and theoretical paradigms that underpin them" (Devine et al., 2013. p. 84). Rubie-Davies et al. (2012) stated that teacher beliefs influence their action and decision related to instructional teaching. In addition, teacher beliefs about mathematics may significantly impact the quality of teaching and learning (Belbase, 2019). Thus, teacher beliefs ultimately affect students learning experiences.

On the other hand, student beliefs also hold equal if not more important than the teacher. Student beliefs may contribute to how students perceive learning (Kloosterman, 2002) and their motivation toward certain subjects (Hannula, 2018). Markovits and Forgasz (2017, p. 3) stated that "students' beliefs about mathematics might influence the way they see the mathematics and the way they learn the subject. "Furthermore, it is paramount to examine the beliefs of students as they will influence how they learn and interact with mathematics in the classroom (McDonough & Sullivan, 2014).

Thus, both students' and teacher's beliefs are paramount in mathematics learning, and these topics should be explored further. However, the concept of beliefs is rather complicated. Its complexity has advantages and disadvantages for the study related to this issue. The broad range of definitions and descriptions of what beliefs have enabled numerous explorations from multiple points of view. Among the teacher beliefs include beliefs related to knowledge, subject matter, pedagogy ability, student attribution, intelligence, and self-efficacy, while student beliefs may cover beliefs concerning the subject matter, motivation, anxiety, self-efficacy, and self-esteem (Levin, 2014). On the other hand, the complexity and breadth of the belief hindered the formation of a standard agreements between researchers. However, one should not view the disagreement as a negative aspect; instead of an opportunity for sustainable development of the related issue.

Higher Order Thinking (HOT) and Lower Order Thinking (LOT) has been discussed in the literature for decades since Bloom (1956) formally established his taxonomy. Bloom (1956) defined HOT as the three upper categories in the taxon-

omy, namely: analysis, synthesis, and evaluation, while the first lower categories are classified as LOT, namely: knowledge, comprehension, and application. Schools are required to equip students with HOT skills to prepare them for the challenges they may encounter in their life. HOT is also related to 21st-century skills, where students are demanded to be able to solve a new problem using the new solution they invented (Brookhart, 2010). Teaching 21st-century skills to students also means teaching HOT. In brief, HOT is necessary and inevitably skills to develop in the classroom, including mathematics.

In Indonesia, the government started incorporating HOT in mathematics learning in 2013 through the revised curriculum called the curriculum 2013. It was an urgent call considering the poor mathematics performance of Indonesian students, as indicated by international studies such as the Programme for International Student Assessment/PISA (Gurria, 2016) and the Trends in International Mathematics and Science Study/TIMSS (Mullis et al., 2016). One of PISA's focuses is reasoning skills, which is also one of the traits of HOT (Engel et al., 2019). The lack of Indonesian students' performance in PISA indirectly reflects their lack of HOT skills. Teaching approaches that promote such skills should be incorporated into mathematics teaching and learning. However, the beliefs of teachers and students concerning mathematics related to HOT and LOT are necessary first to investigate. This is because the beliefs may have an impact on the teachers' classroom practices, how they teach mathematics and the students on how they perceive mathematics learning.

Many studies related to teacher beliefs have been conducted by previous researchers, such as Bobis et al. (2016), who investigated teachers' beliefs concerning how students engage in mathematics. Likewise, previous studies have also investigated student beliefs concerning mathematics. However, studies simultaneously investigating both teacher and student beliefs concerning mathematics related to HOT and LOT have been limited, especially in a developing country such as Indonesia. Therefore, this study aimed to investigate the degree of conformity between teacher and student beliefs concerning mathematics related to Higher Order Thinking (HOT) and Lower Order Thinking (LOT).

Method

This study employed a quantitative descriptive survey to describe teacher and student beliefs concerning mathematics related to HOT and LOT and present to what extent their beliefs were conformed. The 1135 Year 9 students and 46 Year 9 mathematics teachers from 25 schools in *Aceh*, Indonesia, were involved in this study. The sample was selected using stratified random sampling from two districts in *Aceh*, *Banda Aceh*, and *Aceh Besar*, representing the urban and rural areas. Data were analyzed descriptively by SPSS 20. Student beliefs survey items were adapted from Kloosterman (2002), Op'tEynde et al. (2003), Presmeg (2002), Schoenfeld (1992), and Thompson (1992). Meanwhile, the teacher beliefs survey were items adapted from Battista (1994), Hart (2002), Perry et al. (1999), Peterson et al. (1989), Zakaria and Musiran (2010), followed by several items developed by researchers for this study.

In addition, it should be noted that the dataset used in this research was excerpted from a broader study investigating factors affecting student mathematics achievement related to HOT and LOT. Self-administered teacher and student questionnaires were used in this study. The original dataset comprises more comprehensive data, including demographics, attitudes, beliefs, and classroom practices. However, for this article, only data concerning the beliefs related to HOT and LOT were used.

Results and Discussion

One of the measures in the teacher questionnaire was about teacher beliefs concerning mathematics related to HOT and LOT. An index of teacher beliefs concerning mathematics related to LOT was created from 13 items, while the index of beliefs related to HOT was created from 16 items. An index of student beliefs concerning mathematics related to LOT and HOT was also computed from 11 and three items, respectively, of the related measures from the student questionnaire. The index for each measure of beliefs was calculated based on a four-point Likert scale: 'disagree a lot' = 1, 'disagree a little' = 2, 'agree a little' = 3, and 'agree a lot' = 4. A highly positive level was indicated by an average score of more than or equal to 3, corresponding to teachers/students agreeing with the statements 'a little' or 'a lot'. A negative level was indicated by an average score of equal to or less than 2, corresponding to

teachers/students disagreeing with the statements 'a little' or 'a lot'. A somewhat positive level is indicated by an average score of greater than 2 but less than 3. The summary of the index of teacher beliefs concerning mathematics related to LOT and HOT presented in Tables 1 and 2 shows the summary of the student beliefs concerning mathematics related to LOT and HOT.

Table 1. The Index of Teacher Beliefs concerning Mathematics related to LOT and HOT (N = 46)

	LOT		HOT	
	Frequency	Percent	Frequency	Percent
Negative	14	30	0	0
Somewhat positive	31	68	8	17
Highly Positive	1	2	38	83

Table 2. The Index of Student Beliefs concerning Mathematics related to LOT and HOT (N = 1134)

	LOT		HOT	
	Frequency	Percent	Frequency	Percent
Negative	89	7.90	56	4.9
Somewhat positive	830	73.30	721	42.8
Highly Positive	213	18.80	911	52.2

Most teachers (n = 31, 68%) indicated that they held somewhat positive beliefs concerning mathematics related to LOT. Only two percent of teachers held highly positive beliefs (n = 1, 2%), and nearly a third (n = 14, 30%) held negative beliefs concerning mathematics related to LOT. Regarding the students, almost three-quarters of the students had somewhat positive beliefs (n = 830, 73%). Some students had high positive beliefs (n=213, 18%), and only eight percent of students had negative beliefs. The percentage of teacher and student beliefs indicated that their beliefs concerning mathematics related to LOT were conformed. This is in line with (Collins, 2014), mentioning that student beliefs agree with the teacher's beliefs as they are manifested in their practices and transferred to students.

As for the beliefs concerning mathematics related to HOT, most teachers (n = 38, 83%) had highly positive, and a small number of teachers (n = 8, 17%) had somewhat positive beliefs concerning mathematics related to HOT. None of the teachers had negative beliefs concerning mathematics related to HOT. Half students

(n = 592, 52%) had highly positive beliefs about mathematics related to HOT and a further large number (n = 486, 43%) had somewhat positive beliefs. A small number of students (n = 56, 5%) had negative beliefs related to this matter. In brief, student beliefs concerning mathematics related to HOT were not conformed with the teachers. Teachers tended to have more positive beliefs toward mathematics related to HOT. It may be due to the lack of HOT-related activities and problems provided by teachers during a mathematics lesson in Indonesia (Usnul et al., 2019).

Conclusion

In summary, this study revealed that the teacher and student beliefs towards mathematics related to LOT were aligned. However, their beliefs concerning mathematics related to HOT were not, with teachers having more positive beliefs. This study implies that students' beliefs tend to be more positive concerning LOT; thus, educators should engage students more with mathematics, requiring HOT to foster their positive beliefs towards HOT. Further investigation is required to explore the potential cause of the differences. Correlation between the beliefs is necessary should this article expand later on. Further research should also explore how to improve students' beliefs about HOT.

References

Battista, M. T. (1994). Teacher beliefs and the reform movement in mathematics education. *The Phi Delta Kappan, 75*(6), 462-470.

Belbase, S. (2019). Meanings, dimensions, and categories of mathematics teacher beliefs: A navigation through the literature. *International Journal on Emerging Mathematics Education*, *3*(1), 1-26.

Bloom, B. S. (1956). Taxonomy of educational objectives. Vol. 1: Cognitive domain. *New York: McKay*, 20–24.

Bobis, J., Way, J., Anderson, J., & Martin, A. J. (2016). Challenging teacher beliefs about student engagement in mathematics. *Journal of Mathematics Teacher Education*, *19*(1), 33–55.

Brookhart, S. M. (2010). *How to assess higher-order thinking skills in your classroom*. ASCD.

Carter, G., & Norwood, K. S. (1997). The relationship between teacher and student beliefs about mathematics. *School Science and Mathematics*, *97*(2), 62–67.

Collins, R. (2014). Skills for the 21st century: Teaching higher-order thinking. *Curriculum & Leadership Journal*, *12*(14).

Devine, D., Fahie, D., &McGillicuddy, D. (2013). What is 'good teaching? Teacher beliefs and practices about their teaching. *Irish Educational Studies*, *32*(1), 83-108.

Engel, L. C., Rutkowski, D., & Thompson, G. (2019). Toward an international measure of global competence? A critical look at the PISA 2018 framework. *Globalization, Societies and Education*, *17*(2), 117–131.

Gurria, A. (2016). PISA 2015 results in focus. *PISA in Focus*, (67), 1.

Hannula, M. S. (2018). Young learners' mathematics-related affect: A commentary on concepts, methods, and developmental trends. *Educational Studies in Mathematics*, 309–316. https://doi.org/10.1007/s10649-018-9865-9

Hart, L. C. (2002). Pre-service teachers' beliefs and practice after participating in an integrated content/methods course. *School Science and Mathematics, 102*(1), 4-14.

Kloosterman, P. (2002). Beliefs about mathematics and mathematics learning in the secondary school: Measurement and implications for motivation. In *Beliefs: A hidden variable in mathematics education?* (pp. 247–269). Springer.

Levin, B. B. (2014). The development of teachers' beliefs. In *International handbook of research on teachers' beliefs* (pp. 60–77). Routledge.

Markovits, Z., &Forgasz, H. (2017). "Mathematics is like a lion": Elementary students' beliefs about mathematics. *Educational studies in mathematics*, *96*(1), 49-64.

McDonough, A., & Sullivan, P. (2014). Seeking insights into young children's beliefs about mathematics and learning. Educational Studies in Mathematics, doi:10.1007/s16049-014-9565-z.

Mullis, I. V. S., Martin, M. O., Foy, P., & Hooper, M. (2016). TIMSS advanced 2015 international results in advanced mathematics and physics. *Boston: Boston College, TIMSS & PIRLS International Study Center*.

Nishino, T. (2012). Modeling teacher beliefs and practices in context: A multimethods approach. *The Modern Language Journal*, *96*(3), 380-399.

Op'tEynde, P., De Corte, E., & Verschaffel, L. (2003). Framing students' mathematics-related beliefs. In G. C. Leder, E. Pehkonen, & G. Törner (Eds.), *Beliefs: A hid-*

den variable in mathematics education? (pp. 13-37). Dordrecht: Kluwer Academic Publishers.

Perry, B., Tracey, D., & Howard, P. (1999). Head mathematics teachers' beliefs about the learning and teaching of mathematics. *Mathematics Education Research Journal, 11*(1), 39-53.

Presmeg, N. (2002). Beliefs about the nature of mathematics in bridging everyday and school mathematical practices. In G. C. Leder, E. Pehkonen, & G. Torner (Eds.), *Beliefs: A hidden variable in mathematics education?* (pp. 293-312). The Netherlands: Kluwer Academic Publishers.

Rubie-Davies, C. M., Flint, A., & McDonald, L. G. (2012). Teacher beliefs, teacher characteristics, and school contextual factors: What are the relationships?. *British journal of educational psychology*, *82*(2), 270-288.

Schoenfeld, A. H. (1992). Learning to think mathematically: Problem-solving, metacognition, and sense-making in mathematics. In D. A. Grouws (Ed.), *Handbook of research on mathematics teaching and learning* (pp. 334-370). New York: Macmillan.

Thompson, A. (1992). Teachers' beliefs and conceptions: A synthesis of the research. In D. Grouws (Ed.), Handbook of research on mathematics teaching and learning (pp. 127-146). New York: Macmillan.

Usnul, U., Johar, R., & Sofyan, H. (2019). Potential effect of PISA equivalent mathematical reasoning abilities questions using the context of Aceh's traditional houses for junior high school students. *JRAMathEdu (Journal of Research and Advances in Mathematics Education)*, *4*(2).

Zakaria, E., & Musiran, N. (2010). Beliefs about the nature of mathematics, mathematics teaching and learning among trainee teachers. *The social sciences, 5*(4), 346-351.

Zohar, A., Degani, A., & Vaaknin, E. (2001). Teachers' beliefs about low-achieving students and higher order thinking. *Teaching and teacher education*, *17*(4), 469–485.