

Beliefs about the Nature of Mathematics, Mathematics Teaching and Learning Among Trainee Teachers

¹Effandi Zakaria and ²Norulpaziana Musiran

¹Department of Methodology and Educational Practice, Faculty of Education,
University of Kebangsaan Malaysia, 43600 Bangi, Selangor, Malaysia

²Faculty of Education, University of Kebangsaan Malaysia, 43650 Bangi, Selangor, Malaysia

Abstract: This study aims to investigate the beliefs about the nature of Mathematics, Mathematics teaching and learning among teacher trainees. The sample is consisted of 100 teacher trainees from two higher institution of learning in Selangor, Malaysia. Research tool used is a Mathematical belief questionnaire which consists of three dimensions: beliefs about the nature of Mathematics, beliefs about teaching and beliefs about learning of Mathematics. Descriptive statistic was used to describe and summarize the data. In addition, t-test was used to test the hypothesis. The results indicate that the beliefs of Mathematics trainee teachers are positive towards the constructivism approach. Teacher trainees believe that mathematical problems can be solved in many ways. Teacher trainees also believe that teaching Mathematics should involve the opportunity to use Mathematics in daily situations and in learning Mathematics students need to understand the concepts, principles and strategies of Mathematics. Lastly, the findings also found that there were significant differences regarding the beliefs about the nature of Mathematics and beliefs about learning of Mathematics based on gender.

Key words: Beliefs, Mathematics, teachers, teaching and learning, trainee teachers, Malaysia

INTRODUCTION

Teachers play an important role in the process of teaching and learning (Wiseman *et al.*, 1999). Effectiveness in delivering a lesson depends on the beliefs and pedagogical content knowledge of the teacher (Tickle, 2000). This includes mastery of content knowledge about student learning styles and teaching and learning strategies (Even and Tirosh, 1995; Shulman, 1986). Knowledge about how to make teaching simple and the use of appropriate teaching method in order to understand concept is related to the belief and commitment of teachers towards pedagogical practices in the classroom (Fennema and Frankle, 1992; Swafford *et al.*, 1997).

According to Raymond (1997), Mathematical beliefs refers to the beliefs of Mathematics as a discipline, how Mathematics is learn and teach. Early formation of beliefs is based on the experience of the teachers as a student and the influence of their teachers while in school. Similarly, Pehkonen (1997) categorized belief into several parts: beliefs in Mathematics as a discipline, belief about teaching and beliefs about Mathematics learning. Ernest (1994) state three philosophies about the views of Mathematics. First, there is a view that says Mathematics is a collection of facts, rules and skills also known as instrumentalist view. Second, Platonist views

Mathematics as static and a unification of some other knowledge. Mathematics is discovered not created. Third, there are views that state Mathematics is dynamic i.e., a continuous process of development result from human creation. Mathematics is a continuous process of knowing and there is no end to it. Further, McLeod (1992) proposes four categories of Mathematical beliefs of students. First, beliefs about Mathematics including the beliefs that Mathematics is difficult or bound to the rules. Second, belief in self including self-confidence in learning Mathematics and the ability to be successful or failure in Mathematics. Third, beliefs about teaching include beliefs about what teachers should do to help students learn Mathematics. Fourth, belief in social context.

This category includes the beliefs that Mathematics learning is competitive and parents or outsiders influence the learning of Mathematics. The relationship between beliefs in teaching and practices among teachers are often studied by researchers (Raymond, 1997). A group of researchers suggests that teacher beliefs and values of teaching and learning affect teaching practices of teachers (Barkatsas and Malone, 2005; Barlow and Cates, 2006; Ernest, 1994; Richardson, 1996; Thompson, 1992). Beliefs of teachers about Mathematics, Mathematics teaching and learning also play an important role in determining how teachers make students learn Mathematics (Ma, 1999; Pajares, 1992; Van Zoest *et al.*, 1994).

Researchers in Mathematics education have been giving a lot of contributions in an effort to understand the beliefs and knowledge of teachers. Schuck and Groontenboer (2004) in their study of student beliefs found that prospective teachers generally have a belief that prevents them from teaching Mathematics, effectively. Perry *et al.* (2002) found that there are clear differences between various groups of teachers about their beliefs of Mathematics and Mathematics learning and the effects on student achievement.

Hart (2002) argued that most beliefs are formed through experience and observation from time to time. According to Hart (2002), pedagogical practices that support constructivist theory can be nurtured by engaging preservice teachers in constructivist experiences. Beliefs of teacher trainees about Mathematics are actually affected by factors such as attitude, educational background, experience and biological factors of gender itself.

Differences based on gender are actually as a result of many factors. The belief of teachers about Mathematics, Mathematics teaching and learning can affect their teaching in schools (Beswick, 2007). Teachers bring with them different experiences based on their beliefs. These beliefs exist through cultural context, community, teacher education and further during their careers in the field. Individually, they interpret their experience alone and brought to class with various Mathematical assumptions and prejudices that exist.

Schuck and Groontenboer (2004) reported that prospective primary school teachers generally hold beliefs about Mathematics that prevent them from teaching Mathematics that empower children. Pajares (1992) noted that the study of beliefs is very important in educational research. According to Pajares (1992), beliefs cannot be observed or measured directly but it must be inferred from what is said or spoken, the intention and actions of a person. The present study attempted to seek the beliefs of Mathematics trainee teachers about the nature of Mathematics, teaching and learning Mathematics in school and also to determine the differences in trainee teacher beliefs according to gender.

MATERIALS AND METHODS

This study uses a quantitative method. Data were collected by distributing the questionnaires to 100 trainee teachers consisting of 47 male students and 53 female from two public institutions of higher learning in Selangor, Malaysia. Target population for this study is the teacher trainees who are currently pursuing Bachelor of Education degree who took Mathematics as a subject of specialization (major) and teacher trainees who took

Mathematics as a minor subject. The selection of the two institutions is to facilitate researchers to obtain data and information studies.

Instrumentation: This study employs questionnaires as a measurement tools. The questionnaire contains 23 items. Likert scale is used because it requires subjects to indicate the direction and degree of feeling of items based on the four rating. Participants' responses to the Likert-type questions range from 1 (indicating strong disagreement) to 4 (indicating strong agreement). However, for items 21-23, the responses are 1 (not important) to 3 (very important). A higher score indicated a belief consistent with the constructivist approach. Some of the responses were recoded so that a higher score would represent a belief more in line with the constructivist approach. The beliefs instrument has three dimensions, beliefs about the nature of Mathematics, beliefs about teaching Mathematics and beliefs about learning Mathematics.

Items were adapted from Evans (2003) and Hart (2002). Cronbach alpha reliability index for beliefs about the nature of Mathematics is 0.74, beliefs about the of teaching Mathematics is 0.85 and beliefs about the learning of Mathematics is 0.71. This value exceeded the suggested value of 0.70 (Nunnally, 1978).

RESULTS AND DISCUSSION

Table 1 shows the respondents' profile. Number of male teacher trainees is 47 and the number of female teacher trainees is 53. Teacher trainees' age distribution showed that the majority of respondents involved are between the ages of 21-25 years. Most prospective graduate teachers are from matriculation compared to diploma graduates and STPM (higher school certificate) graduate. A total of 36% of prospective teachers were Mathematics major while 64% took Mathematics as a minor. Table 2 shows the beliefs about the nature of

Table 1: Respondent's profile

Respondents profits	(N = 100)
Gender	
Male	47
Female	53
Age	
2-25 years	97
26 years and above	3
Academic qualification	
Diploma	9
Matriculation	73
STPM (higher School certificate)	18
Specialised area	
Mathematics (major)	36
Mathematics (minor)	64

Table 2: Beliefs about the nature of Mathematics

No.	Items	SD%	D%	A%	SA%
3	Mathematics problems can be done correctly in only one way	52.00	43.0	3.0	2.00
7	Males are better at math than females	27.00	41.0	28.0	4.00
10	Some students have a natural talent for math and others do not	7.00	37.0	48.0	8.00
12	Mathematics is primarily a formal way of representing the real world	0.00	17.0	67.0	16.00
14	Some ethnic groups are better at math than others	21.00	52.0	23.0	4.00
19	In Mathematics something is either right or it is wrong	11.00	40.0	43.0	6.00
20	Some people are good at Mathematics and some are not	9.00	34.0	52.0	5.00

Table 3: Beliefs about Mathematics teaching

No.	Items	SD%	D%	A%	SA%
2	Mathematics should be taught as a collection of skills and algorithms	1.0	3.0	80.0	16.00
4	In Mathematics, increased emphasis should be given to use of key words to determine which operation to use in problem solving	0.0	8.0	77.0	15.00
5	A major goal of Mathematics instruction is to help student develop the belief that they have the power to control their own success in Mathematics	6.0	26.0	62.0	6.00
8	More than one representation (picture, concrete material and symbol set etc.) should be used in teaching a math concept	0.0	8.0	64.0	28.00
11	Good math teachers show you the exact way to answer the question you will be tested on	2.0	17.0	61.0	20.00
13	In Mathematics, skill in computation should precede word problems	11.0	32.0	45.0	12.00
15	Students should be encouraged to justify their solution, thinking and conjectures	1.0	14.0	64.0	21.00
17	Basic computational skills on the part of the teacher are sufficient for teaching Mathematics	27.0	51.0	19.0	3.00

Table 4: Beliefs about Mathematics learning

No.	Items	SD%	D%	A%	SA%
1	Mathematics should be learned as sets of algorithms or rules that cover all possibilities	0.0	11.0	74.0	15.0
6	A demonstration of good reasoning should be regarded even more than student's ability to find correct answers	5.0	25.0	54.0	16.0
9	In Mathematics, you can be creative and discover things by yourself	0.0	3.0	60.0	37.0
16	Learning Mathematics must be an active process	0.0	3.0	56.0	41.0
18	To solve most math problems you have to be taught the correct procedure	0.0	6.0	71.0	23.0
No.	Items		NI	I	VI
To be good at Mathematics at school, how important do you think it is for students to:					
21	Remember formulas and procedures?		1.0	80.0	19.0
22	Think in a sequential manner		1.0	75.0	24.0
23	Be able to provide reasons to support their solutions		0.0	54.0	46.0

SD; Strongly Disagree, D; Disagree, A; Agree and SA; Strong Agree; NI; Not Important, VI; Very Important; I = Important

Mathematics among teacher trainees. As shown in Table 2, the overall mean value is 2.74 which indicates that trainee teachers' beliefs about nature of Mathematics in schools is at a moderate level of 3.45. The highest mean value is item 3 "Mathematics problems can be done correctly with only one way only".

A total of 95% did not agree with that statement. Also, 83% agreed with the statement Mathematics is primarily a formal way of representing the real world. As shown in Table 3, the overall mean value is 2.29 which indicates that trainee teachers' beliefs about teaching Mathematics in school is at a moderate level. The highest mean value is item 8 (3.20). About 92% of respondents agreed with the statement, >1 representation (diagrams,

concrete materials and the set of symbols etc.) should be used in teaching a math concept. Also, 96% of respondents agreed with the statement, Mathematics should be taught as a collection of skills and algorithms. As shown in Table 4, the overall mean is 2.74. The highest mean is for item 23 with a mean of 3:41. Be able to give reasons to support their solution where 100% of the respondents agreed with the statement. Also, 94% of pre-service teachers agreed with the statement to solve most math problems you have to be taught the correct procedure. Table 5 shows the comparison of mean score of beliefs between male and female trainee Mathematics teaches. The obtained t-value is $t = -1.997$ ($p < 0.05$). Therefore, H_0 is rejected. This means that there are

Table 5: t-test of beliefs according to gender

Beliefs dimension	Gender	Frequency	Mean±SD	t-value	Significant level
Nature of Mathematics	Male	47	2.74±0.299	-1.997	0.049*
	Female	53	2.88±0.262		
Teaching Mathematics	Male	47	2.59±0.195	1.026	0.307
	Female	53	2.55±0.243		
Learning Mathematics	Male	15	2.34±0.220	-2.097	0.039*
	Female	27	2.43±0.234		

*At the significant level of 0.05

significant differences between mean scores of beliefs about the nature of Mathematics in terms of gender. Female trainee teachers (mean = 2.88) is higher than male trainee teachers (mean = 2.74).

For the belief about teaching Mathematics, the obtained t-value is $t = 1.026$ ($p > 0.05$). Therefore, H_0 is accepted. This means, there is no significant difference in mean score of trainee teacher beliefs about Mathematics teaching in terms of gender.

For the belief of learning Mathematics, the obtained t-value is $t = -2.097$ ($p < 0.05$). Thus, H_0 was rejected. This means that there are significant differences in mean score of beliefs about Mathematics learning in terms of gender. Female trainee teacher (mean = 2.43) is higher than male trainee teacher (mean = 2.34).

In the aspect of the nature of Mathematics, trainee teacher believe that Mathematical problems can be solved in many ways and not focused on only one way. Also, a majority of the trainee teacher believe that Mathematics can be represented in the real world. For teaching Mathematics, trainee teachers believe that more than one representation (diagrams, concrete materials and the set of symbols etc.) should be used in teaching Mathematical concepts. This means that teachers must use teaching materials that help teach the appropriate lessons, effectively.

However, a majority of the respondents also agreed that Mathematics is a collection of skills and algorithms. For the learning of Mathematics, trainee teachers believe that learning Mathematics must involve an active process and students should give reason to support problem solving in Mathematics. However, a majority of respondents also agreed that to solve Mathematics problems the students have to be taught the correct procedure. This finding did not exclusively believe in the traditional or constructivist perspective of teaching and learning.

However, it is more towards the constructivist perspective. This might be due to the impact of their past experience and exposure during their teacher education program. Findings of this study correspond with Perry *et al.* (2002) who found a positive response to the approach of teaching and learning of Mathematics which are inline with constructivist principle. According to

Barlow and Cates (2006), teachers whose beliefs that are inline with the NCTM standards will use students-centred teaching as a daily routine.

Also, it was found that trainee teacher beliefs about the nature of Mathematics and Mathematics learning are influenced by the gender factor. However, no difference was found regarding beliefs about Mathematics teaching. Chan (2004) found no differences in gender on the conception about teaching and learning held by Hong Kong teacher education students.

However, a study by OECD (2009) found that female teachers are less likely than male teachers to hold direct transmission beliefs about teaching. Hobden (2001) reported that preservice teacher personal beliefs about the nature of Mathematics were found to be incompatible with the theoretical underpinning of the school curriculum.

CONCLUSION

Overall, this study indicates that the beliefs of trainee teachers about the nature of Mathematics, Mathematics teaching and learning are positive i.e., towards constructivism approach. This scenario shows a positive development for teachers, especially teachers who will teach Mathematics in school. Findings of this study have implications for Mathematics teacher trainees. According to Barkatsas and Malone (2005), initial teacher education has the power to influence teaching practices. Intervention programs that focus on the problems faced by teachers can further enhance the beliefs of prospective Mathematics teacher.

Trainee teachers should be exposed to student-centered teaching methods. Students must be exposed directly to the method of teaching based on research. This will create confidence among teacher's trainees to teach Mathematics in school and thus can avoid the negative belief. Trainee teachers also need to be exposed to teaching techniques more specific to the field of specialization. Cheng *et al.* (2009) suggest that universities and schools should work in partnership to facilitate classroom contexts and to practice contemporary pedagogical approaches such as constructivism in teaching and learning.

The effectiveness of teaching is not only depends on skills but also attitudes, beliefs and feelings of teachers of their duties. We need teachers who are innovative, make changes according to the needs of students and strive to overcome difficulties that might arise. In summary, there remains much to be uncovered regarding the beliefs of preservice teachers. More study is needed to develop a deeper understanding of the beliefs of preservice Mathematics teachers.

REFERENCES

- Barkatsas, A. and J. Malone, 2005. A typology of mathematics teachers beliefs about teaching and learning mathematics and instructional practices. *Math. Educ. Res. J.*, 17: 69-90.
- Barlow, A.T. and J.M. Cates, 2006. The impact of problem posing on elementary teachers beliefs about mathematics and mathematics teaching. *School Sci. Math.*, 106: 64-73.
- Beswick, K., 2007. Teachers beliefs that matter in secondary mathematics classrooms. *Educ. Stud. Math.*, 65: 95-120.
- Chan, K.W., 2004. Preservice teachers epistemological beliefs and conceptions about teaching and learning: Cultural implications for research in teacher education. *Aust. J. Teacher Educ.*, 29: 1-13.
- Cheng, M.M.H., K.W. Chan, S.Y.F. Tang and A.Y.N. Cheng, 2009. Pre-service education students epistemological beliefs and their conceptions of teaching. *Teaching Teacher Educ.*, 25: 319-327.
- Ernest, P., 1994. The Impact of Belief on the Teaching of Mathematics. In: *Teaching and Learning in Mathematics*, Bloomfield, A. and T. Harries (Ed.), Association of Teachers of Mathematics, Derby.
- Evans, B.D., 2003. Early Childhood Preservice Teachers Beliefs about Mathematics, Teaching Mathematics and Learning Mathematics. Georgia Southern University, Statesboro, Georgia, USA.
- Even, R. and D. Tirosh, 1995. Subject matter knowledge and knowledge about students as sources of teacher presentations of the subject matter. *Educ. Stud. Math.*, 29: 1-2.
- Fennema, E. and L.M. Frankle, 1992. Teachers Knowledge and its Impact. In: *Handbook of Research on Mathematics Learning and Teaching*, Grouws, D.A. (Ed.) MacMillan, New York, ISBN-13: 9780029223819 pp: 47-164.
- Hart, L.C., 2002. Preservice teachers beliefs and practices after participating in an integrated content method course. *School Sci. Math.*, 102: 4-14.
- Hobden, S., 2001. Preparing square pegs to fit into round holes: A discussion of preservice teachers' personal beliefs about teaching and learning mathematics. Proceedings of the 24th Annual Conference of Mathematics Education Research Group of Australasia, Paper Presented at the Numeracy and Beyond.
- Ma, L., 1999. *Knowing and Teaching Elementary Mathematics*. Lawrence Erlbaum, Mahwah, New Jersey, ISBN: 0-8058-2909-1.
- McLeod, D.B., 1992. Research on Affect in Mathematics Education: A Reconceptualization. In: *Handbook of Research on Mathematics Teaching and Learning*, Grouws, D.A. (Ed.). MacMillan, New York, pp: 575-596.
- Nunnally, J.C., 1978. *Psychometric Theory*. 2nd Edn., McGraw-Hill, New York, ISBN-10: 007047849X.
- OECD, 2009. Teaching practices, teachers beliefs and attitudes. Retrieved 23 April 2010. <http://www.oecd/dataoecd/32/9/43541655.pdf>
- Pajares, M.F., 1992. Teachers beliefs and educational research: Cleaning up a messy construct. *Rev. Educ. Res.*, 62: 307-322.
- Pehkonen, E., 1997. Teachers conceptions on mathematics teaching. Proceedings of the MAVI-5 Workshop on the Current State of the Research on Mathematical Beliefs 5, Aug. 22-25, University of Helsinki, Finland, pp: 83-91.
- Perry, B., C. Vistro-Yu, P. Howard, N.Y. Wong and H.K. Fong, 2002. Beliefs of primary teachers about mathematics and its teaching and learning: Views of Singapore, Philippines, China, Hong Kong, Taiwan and Australia. Proceedings of the 25th Annual Conference of the Mathematics Education Research Group of Australia. Paper Presented at the Mathematics Education in the South Pacific.
- Raymond, A.M., 1997. Inconsistency between a beginning elementary school teacher's mathematics beliefs and teaching practice. *J. Res. Math. Educ.*, 28: 550-576.
- Richardson, V., 1996. The Role of Attitudes and Beliefs in Learning to Teach. In: *Handbook of Research on Teacher Education*, Sikula, J. (Ed.). 2nd Edn., Simon and Scuster Macmillan, New York, pp: 102-119.
- Schuck, S. and P. Groontenboer, 2004. Affective Issues in Mathematics Education. In: *Research in Mathematics Education in Australasia*, Perry, G.A.B. and C. Diezmam (Eds.). MERGA, Sydney, pp: 53-74.
- Shulman, L.S., 1986. Those who understand: Knowledge growth in teaching. *Educ. Res.*, 14: 4-14.

- Swafford, J.O., G.A. Jones and C.A. Thornton, 1997. Increased knowledge in geometry and instructional practice. *J. Res. Math. Educ.*, 28: 467-483.
- Thompson, A., 1992. Teachers Beliefs and Conceptions: A Synthesis of the Research. In: *Handbook of Research on Mathematics Learning and Teaching*, Grouws, A.D. (Ed.). Macmillan, New York, pp: 127-146.
- Tickle, L., 2000. *Teacher Induction: The Way Ahead*. 1st Edn., Open University Press, Buckingham.
- Van Zoest, L.R., G.A. Jones and C.A. Thornton, 1994. Beliefs about mathematics teaching held by preservices teachers involved in a first grade mentorship program. *Math. Educ. Res. J.*, 6: 37-55.
- Wiseman, D.L., D.D. Cooner and S.L. Knight, 1999. *Becoming a Teacher in a Field Based Setting: An Introduction to Education and Classroom*. 1st Edn., Wadsworth Publishing Company, USA., ISBN-13: 9780534508715.