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Relationship between Parents' Beliefs in Early Mathematics and Learning Environment Provision at Home

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Abstract. Mastering early mathematics is crucial for young children's development and future, and parents' beliefs in early mathematics development and learning environment provision at home have been identified as factors that affect children's mathematical mastery. This cross-sectional survey study was conducted to examine the relationship between the level of parents' beliefs in early mathematics and learning environment provision at home. Two adapted structured questionnaires were used for data collection, namely, parents' beliefs in early mathematics, and learning environment provision at home. The questionnaire was distributed online using the Google form platform and a total of 478 respondents completed it. Later, data were analyzed using the Statistical Program Package for Social Science through inferential statistics (Pearson's correlation coefficient test). Findings indicated that there was a weak, significant, positive relationship between the level of parents' beliefs in early mathematics and learning environment provision at home. These findings proved that parents' belief in early mathematics was positively associated with provision of a learning environment at home. The increase in the level of parents' belief in early mathematics is associated with increases in the learning environment provision at home. Therefore, support programs or workshops can be provided to parents to increase their knowledge of how to provide an appropriate, comprehensive and effective learning environment at home. These efforts, in turn, may help children to do well in mathematics.

Keywords: early mathematics; parents' beliefs; learning environment; young children

1. Introduction

Early mathematics is one of the knowledge or skills that children need to master before entering primary school. Knowledge in early mathematics is the basic knowledge required for mathematical concepts that will be learned in the future. Without solid basic knowledge, children will face problems in mastering mathematics during elementary school (Bakar et al., 2020b), and various studies

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have shown that early mathematics and numeracy skills have an impact on children's academic achievement in school in the future (LeFevre et al., 2010;). Children who are weak in literacy and numeracy skills face problems in learning in primary school (Buyong et al., 2020), and poor early mathematics and numeracy skills at the commencement of Standard 1 schooling will result in children achieving lower levels than their peers (Jordan et al., 2007). Some studies have found that individuals with higher mathematical knowledge obtain better jobs and earn higher wages (Ritchie & Bates, 2013). If children's knowledge in early mathematics is not mastered at the pre-school level, their mathematics learning in primary school will be affected and will directly compromise their achievements in the future.

Children spend most of their time at home in childhood, and parents are their first educators. Therefore, the learning environment at home is crucial to stimulate children's development and improve their skills in early mathematics (Niklas & Schneider, 2017). Nevertheless, scholars claim that parents are more likely to conduct literacy activities at home several days a week, whereas numeracy activities, such as counting and calculating, are performed only once a week or once a month (Skwarchuk et al., 2022). This is in line with the study by Ramani et al. (2015) which found that most pre-school children tend to spend time on non-numerical activities at home. Parents pay less attention to mathematics activities at home than to literacy activities in the belief that literacy skills are more important than mathematics. This view is supported by Blevins-Knabe et al. (2016 who record that parents' attitudes are more positive towards reading activities than towards mathematics activities.

Lack of disclosure about the importance of mathematics activities and how to provide a learning environment at home for early mathematics causes parents to rarely perform mathematics activities at home. According to Ginsburg et al. (2012), most parents seldom emphasize mathematics learning as they have no knowledge of how to apply mathematics skills at home. They do not know how to provide a learning environment for mathematics and appropriate activities for mathematical skills. Moreover, actions are seldom implemented by certain parties to assist parents in providing a mathematics learning environment at home (Starkey & Klein, 2000). A study by Niklas et al. (2015) revealed that interventions to create a numeracy learning environment can be carried out. The intervention group in the study showed a significant increase in the level of providing a numeracy learning environment at home and in the children's achievement in mathematics.

Hart et al. (2016) conducted a study into the mathematics learning environment at home and its effect on mathematics skills. The study involved 339 parents with children aged between 3 and 8 years. The researchers found that parents who strongly believed in the importance of mathematics provided more numeracy activities at home. On the other hand, parents with low levels of belief rarely provided mathematics and numeracy activities at home (Zippert & Rittle-Johnson, 2018). Because of the scarcity of related studies, Johnson (2018) stated that further studies are needed to understand the relationship between parents'

beliefs about children's academics and the mathematics learning environment at home. Thus, the study of parents' beliefs about early mathematics development is vital as it is one of the main factors that affects mathematics achievement and the level of learning environment provision at home.

Not many previous studies have examined the mathematics learning environment at home; most studies have focused on the literacy learning environment at home (Burgess et al., 2002; Kirby & Hogan, 2008). As a result, the evidence or research related to numeracy learning and the learning environment at home is still new and is not comprehensive (Niklas et al., 2015; Skwarchuk et al., 2022).

Furthermore, most of the previous studies on mathematics learning environments at home have focused on numeracy, a component in mathematics. For example, Susperreguy et al. (2020) conducted a study of the numeracy learning environment at home for 390 Chilean pre-school children; Skwarchuk et al. (2022) built a model of a learning environment at home that involved numeracy activities only. There are few studies that have comprehensively examined the mathematics learning environment at home (Zippert & Rittle-Johnson, 2018). The study by Hart et al. (2016) on mathematics learning environments at home has included spatial skills in early mathematics. This is in line with the opinion of Mix and Cheng (2012) who stated that spatial thinking, that is, visual imagination and manipulation of spatial information, is needed to solve mathematical problems. In addition, Anders et al. (2012) and Niklas et al. (2015) also maintain that studies on numeracy or mathematics learning environments at home focusing on the early stages of children are rare. Most studies have focused on primary school students.

In Malaysia, studies on the mathematics learning environment at home are also very scarce. Most related studies have examined classroom learning environments (Salina et al., 2007; Lo, 2019) or virtual learning environments (Sumarni & Zamri, 2018; Mahizer & Mohd Azli, 2016). Although there are some studies that have examined the learning environment at home, most studies in Malaysia only emphasized parental involvement in learning activities at home in general and did not specifically focus on early mathematics. For example, Irma Yanti et al. (2018) studied the relationship between parental involvement in learning activities at home and student academic achievement. The involvement of parents in the previous study was general without focusing on the mathematics learning environment.

Based on the issues and problems discussed above, the relationship between parents' belief in early mathematics and learning environment provision at home remains limited and has not gained thorough attention in Malaysia. Therefore, this study was conducted to investigate the relationship between parents' belief in early mathematics and learning environment provision at home. As a result, the following hypothesis was proposed in this study:

H_0: There is no significant relationship between parents' beliefs in early mathematics and learning environment provision at home.

2. Literature Review

Mathematics is crucial and necessary knowledge and is a skill for life. Most life skills require mathematical knowledge, such as counting money, cooking, executing business and buying things. As a result, mathematics is taught at all levels of education, from pre-school to university. At the pre-school level, young children are introduced to mathematics through early mathematics subjects which aim to help children in developing a general understanding of numbers and basic mathematical concepts (Harris & Petersen, 2017). This understanding includes counting and calculation, comparing and contrasting, explaining patterns, shapes and positions, solving problems (Aubrey & Godfrey, 2003; Aunio et al., 2015; Harris & Petersen, 2017; Ramani & Eason, 2015), and non-symbolic and symbolic knowledge (Rittle-Johnson et al., 2017). This early mathematics knowledge is crucial for mastering higher-level and more difficult mathematical concepts like operations and geometry (Bakar et al., 2020a; Buyong et al., 2020; Ramani & Eason, 2015).

Various studies have proved the importance of knowledge in early mathematics (Aubrey & Godfrey 2003; Aunio et al. 2015; Clerkin & Gilligan 2018; Harris & Petersen, 2017; Jordan et al., 2009; Jordan & Levine, 2009). Children who have a low level of mathematics proficiency when entering pre-school tend to achieve less than their peers in the future (Harris & Petersen, 2017), showing a relationship between early mathematics and children's future achievement in mathematics (Skwarchuk et al., 2022; Bakar et al., 2020b).

Researchers have reported that there are multiple factors that influence the mastery of early mathematics during childhood. The factors are: family income and parents' education level (Hart et al., 2016; Jordan & Levine, 2009; Sheridan & McLaughlin, 2016), parents' beliefs about mathematics (Burns, 2020; Elliott & Bachman, 2018; Fredricks & Eccles, 2002), parents' attitudes towards mathematics (Skwarchuk et al., 2022), and early mathematics learning environments at home (DeFlorio & Beliakoff, 2015; Ramani & Eason, 2015; Zippert & Rittle-Johnson, 2018). Previous studies have reported that parents' belief in early mathematics plays a significant role in children's mathematics mastery (Musu-Gillette et al., 2015; Trautwein et al., 2012), which is in line with the Expectancy-Value Theory introduced by Eccles (1993). This theory emphasizes that parents' beliefs and attitudes towards something will influence children's motivation and achievement. Parents who have high confidence in their children's abilities in mathematics usually encourage the children to aim for high achievements in mathematics (Fredricks & Eccles, 2002).

In addition to parents' beliefs, the learning environment at home is one of the factors that influences children's mathematics mastery (Cheung et al., 2021). Home is the first learning environment for children. Scholars emphasize that the level of children's knowledge in early mathematics differs significantly before they enter school (Lehrl et al., 2020, indicating that children have mastered

knowledge in early mathematics before their schooling commences in pre-school. This knowledge is mastered informally when children interact with parents and through learning experiences at home (Niklas & Schneider, 2014). Findings from a study by Niklas and Schneider (2017) found that the learning environment at home not only has an impact on early knowledge and skills, but also on children's achievement at the end of primary school. Therefore, the learning environment at home plays a vital role in the development and learning of children.

Studies on the learning environment at home have been long conducted, mostly abroad. Three streams of research have inspired the implementation of research on mathematics learning environments at home (Blevins-Knabe, 2016). The first stream examines the parents' influence on children's cognitive development and academic achievement (Alexander & Entwisle, 1988; Eccles, 1993; Goodnow & Collins, 1990). The second stream investigates the effect of the learning environment at home on the cognitive development of children tested through Home Observation for Measurement in the Environment (HOME) as an instrument (Bradley, 2010; Caldwell & Bradley, 1984). The third stream studies how the literacy learning environment at home affects children's literacy development. These three streams have encouraged the implementation of studies on the learning environment of mathematics or numeracy at home. Most previous studies have focused more on the numeracy learning environment at home (Durkin et al., 1986; Young-Loveridge, 1988; Saxe et al., 1987) and have proved that the numeracy learning environment at home does have a significant effect on children's achievement in mathematics.

Other studies report that parents' beliefs about children's academic achievement are related to the learning environment at home (Skwarchuk et al., 2022; Zippert & Rittle-Johnson, 2018). Manolitsis et al. (2013) reported that both literacy and numeracy learning environments at home play an important role in children's pre-reading and mathematics mastery. Different learning environments will stimulate different development. Therefore, parents play a role in providing a diverse learning environment at home to stimulate the child's overall development. To improve children's skills in early mathematics, parents need to provide a suitable learning environment at home.

In Malaysia, mathematics achievement is still not satisfactory, as is indicated by the results of the Program for International Student Assessment (PISA). The average mathematics score in PISA from 2009 to 2018 has not yet reached the average score set by the Organization for Economic Co-operation and Development (Organization for Economic Co-operation and Development, 2019). Mastery of skills in early mathematics during the early stages of childhood is one of the causal factors. This outcome is consistent with the longitudinal study that shows a strong and significant relationship between ability and future academic achievement in early mathematics (Jordan et al., 2009). Children who had problems in mathematics during pre-school still faced the same problems in Standard 3. Thus, early mathematics is significant for children and their future achievement in mathematics.

Skills in early mathematics are also emphasized in early childhood education programs in Malaysia, particularly in the Early Childhood Care and Education Curriculum and the Standard National Pre-school Curriculum (KSPK). The Early Childhood Care and Education Curriculum was introduced in 2008 as a guide for early education providers to plan a program for children aged from 0 to 4 years in Malaysia. One of the learning areas emphasized in this curriculum is the Early Development of Mathematics and Logical Thinking. This subject aims to build children's basic mathematical concepts through the processes of recognizing, estimating, arranging, comparing differences, composing, and counting, as well as using numbers and solving problems. Malaysia embarked on the KSPK in 2010 and reformed it in 2017. This curriculum is a national curriculum that must be used in all pre-schools and early childhood centers in Malaysia (Education Act 1996). One of the pillars of KSPK is Science and Technology. The knowledge disciplines in this pillar are early science and early mathematics. Early mathematics in KSPK provides early mathematical experience, including pre-numbers, number concepts, number operations, concept of time, value of money as well as shapes and spaces for children aged from 5 to 6 years (Ministry of Education Malaysia, 2016).

The government and certain parties have implemented various actions to solve the problem of low achievement in early mathematics in Malaysia; the Primary Literacy and Numeracy (PlaN) program was introduced in 2020 to replace the Literacy and Numeracy Screening (LINUS 2.0) program. The PlaN program aims to ensure that all Standard 2 and Standard 3 students can have achieved at least a minimum proficiency level in Malay, English, and Mathematics, and PlaN can help children who have a low level of achievement in early mathematics (Ministry of Education, 2020).

3. Methodology

3.1 Research Design and Sample

This study used a cross-sectional survey research design with a quantitative approach to examine the relationship between the independent variable (parents' beliefs) and the dependent variable (learning environment provision). This type of research design and approach is suitable for collecting information about beliefs, opinions, attitudes or characteristics that involve a large sample (Creswell, 2012; Ary, 2010).

The population in this study consisted of parents in Malaysia who have children aged from 4 to 6 years. Based on Krejcie and Morgan's (1970) sample size determination table, at least 384 people need to be selected as a sample if the population number exceeds 1,000,000 to determine the confidence level at 95% and the sampling error at 5% to represent the population. A total of 478 parents were randomly selected from the population as a study sample. A simple random sampling technique was used in this study to ensure that all individuals in the population had an equal chance to be selected as a sample (Creswell, 2012). Table 1 shows the demographic information of the study respondents.

Table 1: Demographic Information

Item		Frequency	Percentage (%)
Childrens' age	4 years	119	24.9
	5 years	182	38.1
	6 years	177	37.0
Children's gender	Male	219	45.8
	Female	259	54.2
Parents' age	20 years and less	0	0
	21 – 30 years	64	13.4
	31 – 40 years	358	74.9
	41 – 50 years	51	10.7
	More than 50 years	5	1.0
Relationship with children	Father	42	8.8
	Mother	436	91.2
Father's highest education level	Primary and secondary schools	241	50.4
	Diploma	95	19.9
	Bachelor's, Master's and Doctoral Degrees	142	29.7
Mother's highest education level	Primary and secondary schools	163	34.1
	Diploma	112	23.4
	Bachelor's, Master's and Doctoral Degrees	203	42.5
Family Income	B40	223	46.7
	M40	189	39.5
	T20	66	13.8

3.2 Research Instrument

This study used a structured questionnaire for data collection consisting of three sections: Section A: Demographic Information; Section B: Parents' Beliefs in Early Mathematics, and Section C: Learning Environment Provision. Parents' beliefs in early mathematics was adapted from previous research by DeFlorio (2011). Learning environment provision was adapted from previous research by Hart et al. (2016). Both research instruments were translated into the Malay language and modified for the Malaysian context. The demographic information of the respondents consisted of seven items on the respondent background such as, the children's age and gender, age of parents, relationship status, educational level of parents, and household income.

Section B contained 25 items about parents' beliefs in children's early mathematics learning. This section aimed to collect parents' opinions about the importance of skills in early mathematics that needed to be mastered by their child before entering Standard 1. The answer choices for this section were measured based on

a 4-point Likert scale, namely "1 - not important at all", "2 - not important", "3 - important", or “4 - very important” for each item.

Section C contained 23 items on the early mathematics learning environment at home adapted from Hart, et al. (2016). This section aimed to collect information on how often a mathematical activity is carried out at home. The section consisted of 10 formal numeracy activity items, eight informal numeracy activity items and five space activity items. The answer choices for this section were measured based on a 3-point Likert scale. Respondents were asked to respond by marking either "1 - never", "2 - sometimes" or "3 - always". Table 2 summarizes the questionnaire information.

Table 2: Questionnaire Information

Section		**No. of Items**
A	Respondent Demographic Information	7
B	Parents' Beliefs in Early Mathematics	25
C	Early Mathematics Learning Environment Provision at Home	
	Formal numeracy activities	10
	Informal numeration activities	8
	Space activities	5
	Total	**55**

3.3 Validity and Reliability

Two experts were appointed to evaluate the content validity of the adapted instrument. Both experts were early childhood education lecturers with Doctorate degrees in Early Childhood Education from the Teacher Education Institution. In addition, both experts have more than 15 years of experience in the field of early childhood education. Overall, the experts agreed that the adpated instrument was suitable for use in the Malaysian context to elicit answers to the research questions. However, the expert required items 16 and item 17 be modified so that the levels of addition and subtraction operations were set in the range of 10 or 20. They also stated that the mathematical skills asked in the questionnaire needed to be in line with the KSPK content. Therefore, these two items were added "within 10". In addition, experts also required the first item to exclude "one of the people".

Cronbach's alpha value was calculated to measure the reliability of the adapted instrument. The Cronbach's alpha value obtained for parents' belief in early mathematics development was 0.93 and 0.88 for early mathematics learning environment provision at home, and the Cronbach's alpha value for all items in this instrument was 0.91. These results confirmed the high internal consistency of the instrument used in this study (Creswell, 2012).

3.4 Data Collection and Analysis

Before commencing the study, the researchers listed pre-schools, private kindergartens and parents' Facebook groups found on the internet. A permission

letter or message was sent via social media or email to all schools and pre-school teachers requesting their help in distributing a questionnaire in the Google form to parents who met the characteristics of the sample, that is, who had children aged from 4 to 6 years. Parents were informed that the purpose of this questionnaire and the information obtained would be used for this study only. The questionnaire had to be answered by one of the parents, either mother or father. Parents were also informed that the questionnaire contained three parts, namely the demographic of the respondent, the parents' beliefs about early mathematics development, and the early mathematics learning environment at home. Parents were given the choice of answering or not answering the questionnaire. Upon receiving consent from the parents to participate in this study, the Google Form was provided. After completion, the researcher collected data from the Google Form and analyzed the data.

Inferential statistics were used to examine the relationships between parents' beliefs and the early mathematics learning environment. A Pearson correlation test was performed to determine the relationship between these two variables. The strength of the relationship was described based on the interpretation suggested by as illustrated in Table 3.

Table 3: Correlation Strength Interpretation

r Values	Interpretation
0 .10– 0.29	Weak
0.30 – 0.49	Moderate
0.50 – 1.00	Strong

4. Findings

The relationship between parents' beliefs in early mathematics and learning environment provision at home was computed using the Pearson product-moment correlation coefficient. Preliminary analyses were performed to ensure no violation of the assumptions of normality, linearity, and homoscedasticity. There was a weak, significant, positive linear relationship between the two variables, $r(476) = 0.285$, $p < 0.001$, with high levels of parents' beliefs associated with higher levels of early mathematics learning environment provision at home. Table 4 illustrates the relationship between these two variables.

Table 4: Relationship between Early Mathematics Beliefs and Environmental Provision

Variables	Environment Preparation (*r*)	*p*
Early Mathematics Beliefs (*r*)	0.285**	0.000

5. Discussion

The findings of this study showed that there was a significant and positive relationship between the level of parents' belief in early mathematics development and learning environment provision at home. The higher the level of parents' belief in early mathematics development, the higher the level of

learning environment provision at home, signifying that parents with a high level of belief in early mathematics development usually provided more relevant activities at home. The findings also revealed that parents' level of belief in early mathematics development had a relationship with all types of environments, namely formal numeracy, informal numeracy and space.

These findings are in line with the study by Wu and Honig (2010) and Dhima (2014) that parents' belief is the main factor that affects all parental involvement in their children's activities. In addition, Puccioni (2015) examined parents' beliefs on children's readiness for pre-school with parenting practices at home. The study found that parents with higher levels of belief provided more learning activities at home and directly had a positive effect on children's academic achievement while in pre-school. The findings of this study are supported by Expectancy-Value Theory (Eccles 1993) which demonstrates that parents' beliefs in terms of expectations, values and gender will influence their practices and the learning environment at home. The higher or more positive the parents' belief, the more activities and encouragement provided by the parents to improve their knowledge of the domain.

These findings are also in line with various previous studies that parents' belief in early mathematics is significantly related to the provision of an early mathematics learning environment at home. Parents' belief in positive mathematics development can increase the level of provision by parents of the mathematics learning environment at home, so benefiting children's early mathematics development (Hart et al., 2016; De Keyser et al., 2020; LeFevre et al., 2010; Missall et al., 2015; Musun-Miller & Blevins-Knabe, 1996; Susperreguy et al., 2020). This is in line with Martini & Senechal's (2012) findings that parents' belief in the development of literacy is related to the provision of a literacy learning environment at home. LeFevre et al. (2002) also demonstrated that parents' beliefs are related to the means parents use to teach and directly affect children's achievement.

Parents who consider skills in early mathematics as important for children to master before Standard 1 tend to provide more early mathematics activities at home (Cheung et al., 2021). Saban et al. (2018) also found that parents with a high level of belief are more sensitive in providing a learning environment at home compared to parents with medium and low levels of belief. They are better prepared in providing a rich and meaningful learning environment because a high level of trust can motivate parents to improve their children's skills at home so that their children achieve skills that are considered very important before Standard 1. This belief also guides parents in planning early mathematics activities at home (Martini & Senechal 2012) and in providing more relevant activities that can help their children master the skills that are crucial and need to be mastered before Standard 1. Thus, parents with a high level of belief tend to provide more early mathematics activities at home.

A study by Zippert and Rittle-Johnson (2018) found that parents' belief in a construct in early mathematics has a relationship with a certain type of

environment. For example, parents with high levels of belief in space skills will provide more space activities at home. This aspect is evidenced in this study, where parents provide a skill more often if they have a high level of belief in that skill. For example, many parents perceived that the skill of counting objects is vital for children and should be mastered before Standard 1; this skill was the activity most frequently carried out at home. Thus, the division of constructs for skills in parental beliefs can be performed extensively to study the relationship between parents' beliefs and early mathematics development and learning environment provision at home.

Nevertheless, the findings showed a weak relationship between the level of parents' belief in early mathematics development and learning environment provision at home due to the effect of external factors on the variables studied. The level of early mathematics learning environment provision at home was not only influenced by the level of parents' belief in the importance of skill but was also influenced by other factors. Parents' belief in early mathematics development and learning environment provision at home could be influenced by parents' education level (De Keyser et al., 2020; Dearing et al., 2012; Susperreguy et al., 2020b) as well as family income (Bassok et al., 2016, Dayang & Zamri, 2019; Kluczniok et al., 2013; Lombardi & Dearing, 2021). In fact, parents' anxiety about mathematics mastery (Hart et al., 2016; Silver et al., 2021) may also affect the early mathematics learning environment at home. For example, parents with high levels of anxiety tend to provide more spatial activities (Hart et al., 2016). Parents' attitudes towards mathematics (Susperreguy et al., 2020a) also influence the mathematics learning environment at home. This evidence proved that there are many factors that can have an impact on the level of parents' belief and on the level of early mathematics learning environment provision at home. Parent's interest in a certain skill or field also affects the practice and provision of the learning environment at home (Trickett et al., 2022; Junge et al., 2021). It can thus be inferred that the relationship between the level of parents' belief in early mathematics development and learning environment provision at home is weak as it was influenced by other factors.

6. Conclusion

This study provides views on the relationship between parents' beliefs in early mathematics development and learning environment provision at home. The findings indicated that Malaysian parents strongly believe in early mathematics development. However, they do not create a conducive setting for young children to learn mathematics at home. Further investigation reveals there is a weak, significant, positive relationship between these two variables. The findings demonstrate that, despite parents' strong belief in the development of young children's mathematic skills, they fail to create an atmosphere that is conducive to learning early mathematics at home. Therefore, assistance should be provided to parents so they can create an appropriate, effective, and positive learning environment at home. It is undeniable that a positive learning environment will help the children to have a positive attitude toward early mathematics and help them to do better in this subject. Consequently, it is recommended that future research considers how social and cultural values affect parents' beliefs, the

learning environment at home, and how they promote young children's early mathematical development.

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