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MATHS IN EARLY CHILDHOOD EDUCATION: AN ANALYSIS OF TEACHERS' BELIEFS

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ABSTRACT

Maths starts with children's first experiences of their world with understanding spatial relations, and then continues with their experiences to extend their learning. The learning process starts before formal education and moves along with school learning. As the first stage of formal learning, early years and early years teachers play an important role in learning outcomes. Such learning outcomes are shaped by teachers' beliefs during mathematical activities. Therefore, a mathematical beliefs survey was used to collect data from early years educators, and data was collected from 148 early years teachers and practitioners. The research indicated that although early childhood educators generally appreciate the importance of mathematics in early childhood education, their attitudes and practices differ, in particular about the timing and methods of introducing maths and the educator's role in facilitating learning. The responses were considered in terms of policy and practices with detailed analysis where appropriate to explore the trends. As a result, the experiences of teachers played a role in practicing experience-based learning opportunities for children as it is expected by the curriculum.

Keywords: Maths; Early years; Learning; Teaching; Curriculum

INTRODUCTION

Maths is part of the daily life of children through play (Özdoğan, 2011), especially in terms of understanding their environment (Vanluydt et al., 2021) because the process of understanding contexts and finding the right reaction involve maths skills. A child's life is abundant in spatial relations through various places like home, work, school and so on (Liben, 2006) because maths is key to understanding and to interpreting the world (Cross et al., 2009). Children's maths-related play underpins their reactions to their current situation as well as preparing them for experiences in the future (Özdoğan, 2011), which is parallel to the findings of Ompok et al.'s (2021) research on the impact of games. However, the actual learning outcomes of maths are influenced by the input from teachers, maths teaching content, teachers' knowledge and methods, the inclusion of the child in the learning process, their participation, and so on (Wilson et al., 2013).

> A quote from 'Birth to 5 Matters: non-statutory guidance for the Early Years Foundation Stage':
> …it is important that the curriculum includes rich opportunities for children to develop their spatial reasoning skills across all areas of mathematics including shape, space and measures. It is important that children develop positive attitudes and interests in mathematics, look for patterns and relationships, spot connections, 'have a go', talk to adults and peers about what they notice and not be afraid to make mistakes (Early Years Coalition, 2021, p. 104).

As this quote indicates, teaching maths in early years is about providing wide opportunities for children to let them explore, with adult support when needed, and help them extend their learning. However, Gifford (2014) mentions that learning to count to 10 for school readiness is a prior aim in addition to supporting and fulfilling the natural curiosity of children about numbers. In order to achieve school readiness and holistic mathematical development, teachers need to understand situations from the children's perspectives (Baroody et al., 2022) as children have a different understanding of situations and different ideas than adults (Sarama et al., 2022). Although Cross et al. (2009) mention the increasing importance of maths teaching throughout the early years to policy makers at the time of their research, Gripton (2022) states that some areas of maths have fallen behind in the curriculum in England in terms of providing children with holistic learning opportunities. This might be because, in the past, teaching maths in the years before the start of formal schooling was not valued (Cross et al., 2009). Teachers should be aware of what to expect from children depending on their age (Sarama et al., 2022); sometimes teachers are required to support language development for maths because of having a positive outcome of verbal environment in spatial thinking (Liben, 2006). Thus, designing the learning environment for children can be difficult for teachers, but this can be helped through developing children's experiences in relation to their knowledge as well as encouraging them to use such knowledge when solving real problems (Özdoğan, 2011). Children can learn from maths-related experiences in outdoor activities that they can engage in physically such as jumping, running, using big numbers, etc. as part of their play activities (Gifford, 2004a). However, the maths learning opportunities related to children's experiences and natural learning involvements have been insufficiently emphasised in practices (McCluskey et al., 2023) although there is a wide range of natural and artificial materials, which provides mathematical learning opportunities for children (Speldewinde & Campbell, 2022). This might be the result of lack of knowledge (Kesicioğlu & Mart, 2022).

"Mathematizing happens when children can create a model of the situation by using mathematical objects (such as numbers or shapes), mathematical actions (such as counting or transforming shapes), and their structural relationships to solve problems about the situation" (Cross et al., 2009, p. 44). The successful outcome of maths learning has a basis in children's first-hand experiences (Otte et al., 2019); maths learning occurs throughout a person's natural life; adults have responsibilities to create opportunities to complement life and maths experiences for children (McGrath, 2010). This is in parallel with their everyday maths opportunities through daily experiences such as counting, cooking (Gifford, 2004b) and dealing with money (Vanluydt et al., 2021); children can combine maths-related experiences with life skills. As Wai Leng et al. (2021) mention in their research, using concrete materials in classroom to solve real-life maths questions is part of curriculum designs in classrooms. Their experiences of maths and real-life events influence children's behaviours, notions, feeling and enthusiasm for learning maths (Batchelor et al., 2019). Supporting this, Gripton's (2022) findings indicate that teachers' knowledge, engagement of children and provision of a rich learning environment underpin maths development in early years.

Clements et al. (2023) mention about how to find the right ways of teaching maths in early years although there is an increase in concerning teaching maths recently. This is because the learning and teaching experiences in early ages play a key role in children's mathematical success (Cerezci, 2020). Also, the findings of Karakuş et al. (2022) show that the prominent method to teach maths in early years is about demonstrating, question and answer and learning through play. Although, early years teachers are expected to provide extensive opportunities for children, there is some differences in the practices. Therefore, this research aims to investigate early years' teachers' beliefs about teaching maths and determine any areas of disagreement in approaches to teach mathematics in early years.

METHODS

This research was designed using quantitative research methods to obtain a wide range of responses from early years teachers and practitioners. Quantitative methods allow for extensive explanations for actions and perspectives, which can be illustrated with factors and hypotheses (Creswell & Creswell, 2018). Through this, the research aim is to identify the impact of different variables on maths attainment in early years.

Research Tool

A questionnaire was developed by the researchers on the basis of Platas' (2015) Mathematical Development Beliefs Survey conducted in the US to measure early childhood teachers' beliefs about mathematics teaching and learning. As the contexts of the countries are different, Plata's survey was used as a guide to focus on similar questions adapted to the English context, and the number of questions was reduced. Once the questions were finalised, five different practitioners with early years' experience were asked to review the questions in terms of articulacy and pertinence.

Ethics

Ethical approval was collected from the University of Plymouth Ethics committee prior to starting data collection. On the first page of the online questionnaire, detailed information about the research, process and data security was given, and participants were asked to indicate 'consent given' before moving to the next sections.

Sample and Participation

The target group for the research was national and focused on teachers and practitioners working in early years settings. Our aim was to achieve a random sample where "each individual has an equal probability of being selected from the population, ensuring that the sample will be representative of the population" (Creswell & Creswell, 2018, p. 334). To review its representation of the workforce in early years education we considered the age distribution for this sample (see Figure 1) and this is in line with the Department for Education's (DfE) report on Survey of Childcare and Early Year Providers (see DfE, 2021).

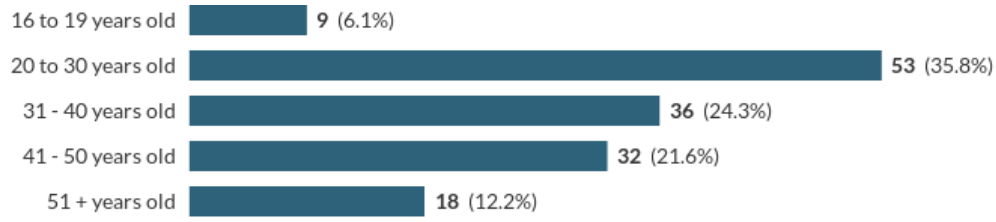

Figure 1. Age Range of the Participants.

Data Analysis

In our questionnaire, we aimed to find out about the participants and their views on teaching mathematics to early years learners, in activities both inside and outside the classroom. This online questionnaire was open to all potential teachers, teaching assistants and care professionals teaching or looking after early years learners.

Although this is an 'ramdom' sample, the responses given in Questions 7 and 8 (see below Table 1) indicate that this sample is very much in line with national data in England provided by the DfE and hence could be regarded as a reasonable representative sample (see DfE, 2021).

We first highlight some of the key questions and responses in the table below and then consider their implications for policy and practise in teaching and learning early years mathematics.

KEY QUESTIONS AND RESPONSES

Table 1
Key Questions and Responses.

No	Summary of Responses	Explanations
6	*Gender Type?* Male: 3.4%, Female: 95.9%, No response: 0.7%	This highlights the very low percentage of males in our sample but this is representative.
7	*What age group do you belong to?* 16-19: 6.1%, 20-30: 35.8%, 31-40: 24.3%, 41-50: 21.6%, 51+: 12.2%	This is in line with national data for England.
8	*How many years' experience do you have working with young children?* Up to 1year: 6.8%, 1-2years: 3.4%, 2-5years: 18.9%, 5-10years: 16.2%, 10+years: 54.7%	This is also in line with national data but it is of interest to note the 55% of participants who have worked more than 10 years in this sector.
10	*Maths is an important part of the early years curriculum.*	This is no surprise but worth highlighting.

continued

	Strongly Agree: 52.7%, Agree: 39.2%, Somewhat Agree: 6.8% Somewhat Disagree: 0.7%, Disagree: 0%, Strongly Disagree: 0.7%	
11	*It is better to wait until Reception for maths activities.* Strongly Agree: 0.7%, Agree: 2.7%, Somewhat Agree: 11.5% Somewhat Disagree: 14.2%, Disagree: 40.5%, Strongly Disagree: 30.4%	We have here a significant number who would wait till the reception year for maths activities.
13	*Early Years children are capable of learning maths.* Strongly Agree: 49.3%, Agree: 37.8%, Somewhat Agree: 10.8% Somewhat Disagree: 1.4%, Disagree: 0%, Strongly Disagree: 0.7%	Note the strong support that think early years children are capable of learning maths.
14	*I am knowledgeable enough to teach maths in early years.* Strongly Agree: 39.9%, Agree: 44.6%, Somewhat Agree: 11.5% Somewhat Disagree: 2.0%, Disagree: 2.0%, Strongly Disagree: 0%	Strong support but how can teachers be assured that their mathematical knowledge is sufficient at this stage?
16	*Early years children learn mathematics without support from teachers.* Strongly Agree: 21.6%, Agree: 39.9%, Somewhat Agree: 30.4% Somewhat Disagree: 5.4%, Disagree: 2.7%, Strongly Disagree: 0%	There is high support for the concept that children can learn mathematics without support from teachers.
17	*Maths activities are a very important part of the early years experience.* Strongly Agree: 41.2%, Agree: 43.2%, Somewhat Agree: 14.2% Somewhat Disagree: 0%, Disagree: 0.7%, Strongly Disagree: 0%	It is interesting that maths activities are given high support in early years.
18	*The teacher should play a central role in early years mathematics activities.* Strongly Agree: 20.3%, Agree: 43.9%, Somewhat Agree: 31.1% Somewhat Disagree: 2.7%, Disagree: 2.0%, Strongly Disagree: 0%	Interesting result here but somewhat in contradiction to the responses for Question 16.

continued

20	*Supporting development in academic subjects such as maths is the primary goal of early years.* Strongly Agree: 12.8%, Agree: 18.9%, Somewhat Agree: 27.0% Somewhat Disagree: 14.9%, Disagree: 20.3%, Strongly Disagree: 6.1%	Here there is a range of views from strong support to strong disagreement.
22	*In early years education, children should learn specific procedures for solving maths problems (i.e., 2 + 4).* Strongly Agree: 4.1%, Agree: 14.2%, Somewhat Agree: 27.0% Somewhat Disagree: 16.9%, Disagree: 31.1%, Strongly Disagree: 6.8%	This is another question with diverse and contradictory responses.
24	*In early years, children construct their mathematical knowledge without the help of a teacher.* Strongly Agree: 3.4%, Agree: 12.8%, Somewhat Agree: 45.9% Somewhat Disagree: 20.3%, Disagree: 16.9%, Strongly Disagree: 0.7%	Again, there are diverse and opposing views and this will be discussed in more detail below.
25	*Teachers should help early years children memorize number facts (for instance, 2 + 3).* Strongly Agree: 2.7%, Agree: 6.8%, Somewhat Agree: 25.0% Somewhat Disagree: 20.9%, Disagree: 27.0%, Strongly Disagree: 17.6%	Here is another question that had diverse and opposing views (see below).
28	*Teachers should show early years children the correct way of doing mathematics.* Strongly Agree: 12.8%, Agree: 31.8%, Somewhat Agree: 29.1% Somewhat Disagree: 12.8%, Disagree: 10.8%, Strongly Disagree: 2.7%	This is another question that has very different responses and again this will be considered below.
29	*Outdoor activities are helpful for developing new mathematical concepts and topics.* Strongly Agree: 45.3%, Agree: 45.9%, Somewhat Agree: 7.4% Somewhat Disagree: 0%, Disagree: 0.7%, Strongly Disagree: 0.7%	Interesting that there is strong support for outdoor maths activities.
30	*Outdoor activities are useful for reinforcing or revising mathematical topics.* Strongly Agree: 43.9%, Agree: 41.2%, Somewhat Agree: 13.5%	As expected, this is strongly supported.

continued

	Somewhat Disagree: 0%, Disagree: 1.4%, Strongly Disagree: 0%

Table 1 represents the prominent question with comments for those questions. There was no significant difference through the rest of the questions, so they are not included in the table.

Interpretation of the Data

Q14: It is interesting to note that almost all the respondents were confident in their mathematical knowledge and understanding to help their learners but, for some, this confidence may be misplaced. Mathematics is a very linear subject, with each new topic dependent on previous knowledge and concepts. It is important that learners at this early age do not have misconceptions or misunderstanding of mathematics symbols and so the competence of those instructing them is vital to their learning, etc.

Q16: Again, there are issues here as children can learn mathematics without help from a teacher but there are concerns that children might have or develop key misconceptions at this early age, and it is problematic to correct misconceptions later on.

Q20: This is one of a number of questions where significant diverging opinions are held; clearly mathematics is an important aspect of education but at these early ages there are other equally important or more important aspects of life skills to emphasise.

Q22: There are varied but correct ways of adding 2 + 4, and different ways of achieving the answers and the concept of having several correct ways of achieving the answer is an important aspect of mathematics to help in understanding; for example: 2 + 4 = 1 + 1 + 4 = 1 + 5 = 6. or 2 + 4 = 2 + 1 + 3 = 3 + 3 = 6 etc.

Q24: This is similar to Q16 and can lead to issues if the mathematics the learners develop is not entirely correct as appropriate notation is crucial for developments at a later age. So it is important that teachers are aware of work that learners construct and correct and modify where needed as it is very problematic to revise at a later stage.

Q25: This is a question that divides opinions; just memorising facts provides procedural understanding but not necessarily conceptual understanding; so learners can memorise that 2 + 3 = 5 but they also need to count two objects and three objects together to recognise there are in total 5 objects. At this early age conceptual understanding rather that just learning facts is important for learners to progress in mathematics.

Q28: Here is another issue: teachers should ensure that their learners have a correct way of doing mathematics but there are often many correct ways, and this is an important aspect of mathematics.

We also looked at the Questions with diverse responses (that is Questions 20, 22, 24, 25, and 28) to see whether the differences might be related to either teachers' age or experience. There is only one of these that shows such a relationship, namely Question 28, 'Teachers should show early years children the correct way of doing mathematics', where the responses correspond with the age groups.

To show the relationship between the responses and age group, we summarise data into two groups, "agree" and "disagree" and the age groups into 16-30 years, 31-40 years and 41+ years. This provides sufficient numbers in each of the cells below to produce a contingency table:

Table 2
Distribution of Age and Responses for Question 28.

Age Groups	Agree	Disagree	Totals
16-30 years	51	11	62
31-40 years	25	11	36
41+ years	33	17	50
Totals	109	39	148

Here we use a χ^2test with hypothesis defined by:

H_0 = there is no association between response and age group

H_1 = there is association between response and age group

Table 3
X^2 Test and Values.

Age Groups	Agree	Disagree	Totals
16-30 years	51 (41.5)	11 (20.5)	62
31-40 years	25 (24.1)	11 (11.9)	36
41+ years	33 (33.4)	17 (16.6)	50
Totals	109	39	148

We calculate the individual χ^2 values, using the formula

$$\chi^2 = \frac{(E-O)^2}{E} \quad (E \text{ is the expected value}, O \text{ the observed value})$$

and these values are given in the table below:

Table 4
χ^2 Results with Formula.

Age Groups	Agree	Disagree
16-30 years	2.175	4.402
31-40 years	0.033	0.069
41+ years	0.005	0.010

Finally, the X^2 value is found by adding the 6 individual values to give X^2=6.693 and at 5% significance level the critical value is 5.99 (from tables).

As 6.693 > 5.99, we can reject H_0 and accept there is evidence to accept H_1, that is, there is evidence that shows there is association between responses and age group. This can be seen from the table above where the X^2 values are high showing that the younger age group is very much out of line with much higher level of agreement that 'teachers should show early years children the correct way of doing mathematics'.

This is the only set of paired data that shows association between age and the question responses, but it is a significant difference.

DISCUSSION AND CONCLUSION

The role of teachers is important in delivering correct content of mathematics to young children (Sarama et al., 2022), which is parallel to findings and interpretation on teaching knowledge to progress in maths. However, this might lead teachers to false judgement on considering another question about children's maths learning without adult support because the mathematical learning process needs opportunities designed with some specific aims (McGrath, 2010) as well as using correct language (Liben, 2006). In terms of emphasising the promotion of academic subjects, there is a range of views from strongly agreeing to strongly disagreeing. This is because of focusing on life skills in early years, but maths-related experiences can occur through real-life experiences (Batchelor et al., 2019), so the responses might vary because of considering such experiences. Throughout the teaching, teachers are expected to organise the activities considering the children's knowledge and possible ways of children's interpretation of the subject (Clements et al., 2023), so the reflection of teachers is likely to differ as considering of their own cases.

Another interesting distribution is the question 'children should learn specific procedures for solving maths problems', which was about using foundational maths problems. Although this question focused on daily skills and the use of traditional maths opportunities such as counting the number of sweets or number of children in real life situations (Gifford, 2004b; Vanluydt et al., 2021), half of the responses failed to consider this. This might be related to findings by Lüken (2023), the observed findings of children's maths abilities can give some information for teachers, but it may not reflect their potential. Thus, this might be the result of inadequate consideration of learning in activities.

In addition, responses on children's mathematical knowledge construction were shown in the questionnaire, but this might depend on individual cases; Sarama et al. (2022) underline the necessity of teachers' awareness of children's needs in respect of their age. It is necessary to design the appropriate learning environment for children to experience such knowledge-constructing opportunities (Özdoğan, 2011). Constructing correct concepts of maths is crucial for developments at later ages.

However, there are diverse and opposing responses to memorizing number facts. This is because of the focus of the curriculum, which is about providing rich opportunities for children to develop positive attitudes and interest in maths (Early Years Coalition, 2021). While teachers are considering the regulations around early years such as Birth to 5 Matters, EYFS (Early Years Foundation Stage), the traditional view leads to greater emphasis on memorising. For example, having daily routines like cooking (Gifford, 2004b) require memorising the steps and counting as memorised.

In other respects, there are diverse responses to the statement about teachers 'showing early years children the correct way of doing mathematics'. As Cross et al. (2009) remark, mathematical knowledge development occurs when children use and create mathematical objects. Thus, there is more than one way of solving problems, or following the steps. Having first-hand experiences (Otte et al., 2019) and real-life experiences (Batchelor et al., 2019) can lead to various options for solving a problem. Therefore, focusing on the 'correct' way of doing mathematics can mislead children, because children's perspectives and understanding of situations can be different than teachers' (Sarama et al., 2022). Thus, teachers need to understand situations from children's perspectives (Baroody et al., 2022) and the teacher's correct way of doing maths from the teacher's perspective may limit children's problem-solving skills and creativity. Interestingly, further analysis with responses and variables shows that there is a relationship between the age of the teacher and their response to 'showing the correct way of doing maths'. Overall, the younger age group of teachers agreed with 'showing the correct way'. This might be because they have not understood that children have different ideas than adults (Sarama et al., 2022). Mathematical development in early years is directly related to teachers' knowledge and to facilitating children's engagement in maths-related content as well as providing a rich environment (Gripton, 2022), so younger, probably less experienced teachers may not be aware of such conceptual differences.

IMPLICATIONS

Although early years education includes real life experiences providing empirical opportunities, the opportunities and the approaches to teaching maths can become based on memorisation of facts. However, the aim of the curriculum is about substantial opportunities for children to construct their knowledge, and this depends on the teachers' awareness and beliefs. The perspectives of children and teachers vary, so the traditional belief of teachers to teach maths may limit children's learning opportunities. In order for teachers to support a wide range of learning in maths, a rich learning environment needs to be provided, and this can be related with the experiences of teachers. In this case, the focus of curriculum to teach maths should be explicitly delivered to early years teachers, so that teachers can consider the children's needs.

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REFERENCES

Baroody, A. J., Clements, D. H., & Sarama, J. (2022). Challenging but Achievable Math for Young Children. *Mathematics Teachers: Learning and Teaching PK-12*, *115*(7), 468–475. https://doi.org/10.5951/MTLT.2021.0252

Batchelor, S., Torbeyns, J., & Verschaffel, L. (2019). Affect and mathematics in young children: an introduction. *Educational Studies in Mathematics*, *100*(3), 201–209. https://doi.org/10.1007/s10649-018-9864-x

Cerezci, B. (2020). The impact of the quality of early mathematics instruction on mathematics achievement outcomes. *Journal of Childhood, Education and Society*, *1*(2), 216–228. https://doi.org/10.37291/2717638X.20201248

Clements, D. H., Lizcano, R., & Sarama, J. (2023). Research and Pedagogies for Early Math. *Education Sciences*, *13*(839), 1–27. https://doi.org/10.3390/educsci13080839

Creswell, J. W., & Creswell, J. D. (2018). *Research Design: Qualitative, Quantitative and Mixed Methods Approaches* (5th ed.). SAGE.

Cross, C. T., Woods, T. A., & Schweingruber, H. (2009). *Mathematics Learning in Early Childhood: Paths Toward Excellence and Equity*. The National Academies Press.

DfE. (2021). *Survey of Childcare and Early Year Providers: Main Summary, England, 2021*. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1039675/Main_summary_survey_of_childcare_and_early_years_providers_2021.pdf

Early Years Coalition. (2021). *Birth To 5 Matters: Non-statutory guidance for the Early Years Foundation Stage*. Early Education. https://birthto5matters.org.uk/wp-content/uploads/2021/04/Birthto5Matters-download.pdf

Gifford, S. (2004a). A new mathematics pedagogy for the early years: In search of principles for practice. *International Journal of Early Years Education*, *12*(2), 99–115. https://doi.org/10.1080/0966976042000225507

Gifford, S. (2004b). Between the secret garden and the hothouse:Children's responses to number focused activities in the nursery. *European Early Childhood Education Research Journal*, *12*(2), 87–102. https://doi.org/10.1080/13502930485209451

Gifford, S. (2014). A good foundation for number learning for five-year-olds? An evaluation of the English Early Learning 'Numbers' Goal in the light of research. *Research in Mathematics Education*, *16*(3), 219–233. https://doi.org/10.1080/14794802.2014.895677

Gripton, C. (2022). Developing mathematical patterning in ECE classrooms: participatory research with teachers of 3–5-year-olds. *European Early Childhood Education Research Journal*. https://doi.org/10.1080/1350293X.2022.2108097

Karakuş, H., Akman, B., & Durmuşoğlu, M. C. (2022). Okul Öncesi Öğretmenlerinin Matematik Eğitimine ve Sınıf İçi Uygulamalarına İlişkin Görüşleri [Preschool Teachers' Views on Mathematics Education and Classroom Implementations]. *E- Kafkas Eğitim Araştırmaları Dergisi*, *9*(1), 171–193. https://doi.org/10.30900/kafkasegt.959036

Kesicioğlu, O. S., & Mart, M. (2022). The preschool teachers' opinion on teaching geometry. *Southeast Asia Early Childhood Journal*, *11*(2), 21–36. https://doi.org/https://doi.org/10.37134/saecj.vol11.2.2.2022

Liben, L. S. (2006). Education for Spatial Thinking. In W. Damon & R. M. Lerner (Eds.), *Handbook of Child Psychology* (6th ed.). John Wiley and Sons.

Lüken, M. M. (2023). Young children's self-initiated pattern-making during free play. *Mathematical Thinking and Learning*, 1–21. https://doi.org/10.1080/10986065.2023.2276798

McCluskey, C., Kilderry, A., Mulligan, J., & Kinnear, V. (2023). The role of movement in young children's spatial experiences: a review of early childhood mathematics education research. *Mathematics Education Research Journal*. https://doi.org/10.1007/s13394-023-00446-0

McGrath, C. (2010). Supporting Early Mathematical Development. In *Supporting Early Mathematical Development: Practical Approaches to Play-Based Learning*. Routledge. https://doi.org/10.4324/9780203855560

Ompok, C. C., Mei Teng, L., & Sapirai, J. (2021). Effect of Games towards Children's Mathematics Performance. *Southeast Asia Early Childhood*, *10*(1), 1–17. http://eric.ed.gov/?id=EJ1296276

Otte, C. R., Bølling, M., Elsborg, P., Nielsen, G., & Bentsen, P. (2019). Teaching maths outside the classroom: does it make a difference? *Educational Research*, *61*(1), 38–52. https://doi.org/10.1080/00131881.2019.1567270

Özdoğan, E. (2011). Play, mathematic and mathematical play in early childhood education. *Procedia - Social and Behavioral Sciences*, *15*, 3118–3120. https://doi.org/10.1016/j.sbspro.2011.04.256

Platas, L. M. (2015). The Mathematical Development Beliefs Survey: Validity and reliability of a measure of preschool teachers' beliefs about the learning and teaching of early mathematics. *Journal of Early Childhood Research*, *13*(3), 295–310. https://doi.org/10.1177/1476718X14523746

Sarama, J., Clements, D. H., & Guss, S. S. (2022). Longitudinal evaluation of a scale-up model for professional development in early mathematics. In S. Dunekacke, A. Jegodtka, T. Koinzer, K. Eilerts, & L. Jenßen (Eds.), *Early Childhood Teachers' Professional Competence in Mathematics* (pp. 163–186). Routledge. https://doi.org/10.4324/9781003172529-11

Speldewinde, C., & Campbell, C. (2022). Mathematics learning in the early years through nature play. *International Journal of Early Years Education*, *30*(4), 813–830. https://doi.org/10.1080/09669760.2022.2122026

Vanluydt, E., Wijns, N., Torbeyns, J., & van Dooren, W. (2021). Early childhood mathematical development: the association between patterning and proportional reasoning. *Educational Studies in Mathematics*, *107*(1), 93–110. https://doi.org/10.1007/s10649-020-10017-w

Wai Leng, A. P., Hui-Shen, C. L., Dhamotharan, M., & Che Mustafa, M. (2021). Preschool teachers' beliefs and classroom practices of child-centred learning at private preschools in central region. *Southeast Asia Early Childhood Journal*, *10*(2), 69–83. http://ejournal.upsi.edu.my/index.php/SAECJ

Wilson, P. H., Mojica, G. F., & Confrey, J. (2013). Learning trajectories in teacher education: Supporting teachers' understandings of students' mathematical thinking. *The Journal of Mathematical Behavior*, *32*(2), 103–121. https://doi.org/10.1016/J.JMATHB.2012.12.003