



HAL
open science

The status of early childhood mathematics education research in the last decade

Zişan Güner Alpaslan, Feyza Tantekin Erden

► To cite this version:

Zişan Güner Alpaslan, Feyza Tantekin Erden. The status of early childhood mathematics education research in the last decade. CERME 9 - Ninth Congress of the European Society for Research in Mathematics Education, Charles University in Prague, Faculty of Education; ERME, Feb 2015, Prague, Czech Republic. pp.1933-1939. <hal-01288478>

HAL Id: hal-01288478

<https://hal.science/hal-01288478v1>

Submitted on 15 Mar 2016

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



HAL Authorization

The status of early childhood mathematics education research in the last decade

Ziřan Güner Alpaslan¹ and Feyza Tantekin Erden²

1 Bülent Ecevit University, Faculty of Education, Zonguldak, Turkey, zguner@metu.edu.tr

2 Middle East Technical University, Faculty of Education, Ankara, Turkey

This study explores early childhood mathematics education research from 2000 to 2013 in major journals of mathematics education and prior CERME-Early Years Mathematics papers. The comparison between the studies published in the journals and in CERME uncovers some interesting results: i) the majority of studies are from English-speaking countries in the journals whereas the majority of CERME papers are from non-English speaking countries, and ii) the focus of research topics in the journals seems to be significantly different than that in the CERME papers. Moreover, there are more empirical studies than any other types of research and studies mainly focusing on children appear to be more popular. Accordingly, there should be more diversified papers (e.g. regarding research topic) to deepen and enrich this field.

Keywords: Early childhood mathematics education, research trend, systematic review.

INTRODUCTION

Early childhood mathematics education (ECME) which refers to the education of the ages of 3- to 6-year-old children (NAEYC, 2010) is significant for young children (Clements, Baroody, & Sarama, 2013). The study of Clements and colleagues (2013) briefly positions its reasons in two main frames by stressing the benefits of early childhood mathematics (ECM) for minimizing the achievement gap among students from different backgrounds, and for being a precursor for children's further achievement. The studies also indicate that ECME enables children's acquisition of mathematical understanding and skills (Perry & Dockett, 2002) as well as their gaining positive attitudes towards learning mathematics (Stevenson & Newman, 1986). The contributions of early years to children's cognitive and affective domains play an important role for their

further mathematics success (Campbell et al., 2001). Furthermore, its significance is stressed through perceiving early years as an opportunity to support and improve children's readiness for the learning of mathematics (Clements & Sarama, 2010). Hence, ECME has major interrelated goals concerning children. The first is related to content related goals, namely children's gaining a mathematical understanding and thinking. The second goal of ECME is about process goals, which include mathematical skills such as reasoning and predicting. The last one is about affective goals like enjoying learning mathematics (Clements et al., 2013). The above-mentioned outcomes and goals of ECME can undoubtedly be achieved through the high quality educational practices which rely on the research based policies, guidelines, and practices (Fox, 2007). In this sense, Sarocho and Spodek (2009) argue the significance of increasing number of research studies in early childhood education on the growing interest in ECME. Thus, the contribution of published articles in ECME research cannot be undermined because getting to know about the research trend becomes a priority for ECME researchers especially for the novice ones in terms of their guidance for the future of the field. However, the majority of these review papers reflect the status of this research field from a national perspective such as Australasian (Fox, 2007; Highfield & Goodwin, 2008), and American (Hachey, 2013). Besides, the remaining review papers seem controversial since they do not investigate the research papers on a certain database/journal and for a certain time period (Sarocho & Spodek, 2009). Rather, they examine the development of this field from a historical view. Therefore, this study aims to reveal the status of international ECME research from 2000 to 2013 in highly refereed mathematics education journals [i.e. Educational Studies in Mathematics (ESM), Journal for Research in Mathematics Education (JRME), For the Learning of Mathematics (FLM),

Mathematical Thinking and Learning (MTL), The Journal of Mathematical Behavior (JMB), Journal of Mathematics Teacher Education (JMTE), and ZDM: The International Journal on Mathematics Education (ZDM)] and Early Years Mathematics WG papers in CERME6, CERME7 and CERME8. The review is guided by the following questions: (a) What were the nationalities of authors contributing to ECME research during these fourteen years? (b) What were the types of research design in ECME research during these fourteen years? (c) What were the research topics in ECME research during these fourteen years? (d) What were the research samples in ECME research during these fourteen years? In this way, the findings of this study will guide ECME researchers to better plan and improve the research field relying on the information about under-researched areas and also will call the need for the collaboration between policy makers and teacher educators to sustain the quality in this field.

METHOD

This review study was carried out in Turkey. The journals were selected considering the ranking of European Mathematical Society (EMS) in terms of some criteria such as recognition and citation of the journals (Törner & Arzarello, 2012). Therefore, this study only focused on the journals ranked as A plus and A category which are ESM and JRME in A plus journals; and FLM, MTL, JMB, JMTE, and ZDM in A journals. Among these journals, FLM was not included into analysis due to the limitation of online access. Besides, CERME papers were examined since the first meeting of Early Years Mathematics Working Group (WG) in CERME6. For the purpose of this study, the age interval for ECME (3 to-6-year-old) in NAEYC (2010) report was considered. Therefore, the papers that studied first and/or second grade children were not included. As a result, 49 published articles in the journals and 35 papers in CERME were analysed.

The nationality of contributing authors was quantitatively analysed in order to reveal the contributing countries to this research field. In this sense, the formula of Howard, Cole and Maxwell (1987) was utilised. According to this formula, each paper was given one point. In the case of multiple authors from different countries, the order of author (*i*) and the total number of countries (*n*) in the study were taken into consideration.

$$\text{Score} = \frac{(1,5^{n-i})}{\sum_{i=1}^n 1,5^{n-i}}$$

Research type of the published articles were determined based on the previous review study of Tsai and Wen (2005) which categorized the papers as empirical (e.g., quantitative and qualitative), position (i.e., advocating a certain issue related to the topic under investigation), theoretical (i.e., proposing or generating a theory the related field), review (i.e., summary of the previous research studies), and other papers (e.g., clarification of a specific curriculum or programme for the related research field). The interrater reliability was calculated by the authors of the study and it was found as .95.

Research topic was determined considering the working group names of the Eighth Congress of the European Society for Research in Mathematics Education (CERME, 2013). Whereas some of the WG names such as university mathematics education and history in mathematics education were not included, the determined sub-titles in Early Years Mathematics WG were additionally used. The adapted version of research topics were as follows: Teaching and Learning of Number Systems and Arithmetics (Topic1), Algebraic Thinking (Topic2), Geometrical Thinking (Topic3), Mathematical Potential, Creativity and Talent (Topic4), Affect and Mathematical Thinking (Topic5), Mathematics and Language (Topic6), Comparative Studies in Mathematics Education (Topic7), The Role of Natural Language in Early Years Mathematics (Topic8a), The Role of Play in Early Years Mathematics (Topic8b), The Role of Manipulatives and ICT Tools in Early Years Mathematics (Topic8c), The Transition between Manipulation and Different Kinds of Representation (Topic8d), Designing and Implementing Tasks for Early Years Mathematics (Topic8e), The Transition between Pre-primary and Primary School in Early Years Mathematics (Topic8f), Ways to Learn to Become a Learner at School (Topic8g), Early Years Mathematics and Learning Disorders; Early Identification and Intervention (Topic8j), Teacher Education and Development in Early Years Mathematics (Topic8k), Theoretical Approaches in Early Years Mathematics (Topic8l), Technology in Early Years Mathematics (Topic9), Social, Cultural and Political Challenges for Mathematics Education (Topic10), Stochastic Thinking (Topic11), and Argumentation and Proof (Topic12). The interrater agreement for research topic of the published articles was calculated as .90.

RESULTS

The results indicated that there were 49 published articles about ECME in the investigated journals during the last fourteen years. The distribution of published articles was respectively provided by year and journal. Besides, there were 35 papers in Early Years Mathematics working group in prior CERME conferences.

(For further details about results: <https://www.academia.edu/7957956/CERME-9-Appendix>).

Contributing Countries

The formula of Howard and colleagues (1987) revealed the countries' contribution to ECME research in the selected journals from 2000 to 2013. The scores of the countries were analysed in terms of year and journal. There were totally 18 contributing countries to this research field during these fourteen years. The analysis by year indicated the high ranking contributing countries as the USA, Germany, and the UK. There was not any study about ECME in the years of 2000 and 2006 in the investigated journals. Although the total scores of the US, the UK and Germany were striking when compared to other countries, only the research articles from the USA were published during almost each year. As for Germany, the year of 2013 was efficient in terms of the increased number of published articles when compared to previous years. The analysis of contributing countries by journal indicated that the variation of the countries was higher in ESM (44.4%) and MTL (38.8%) than other journals. Authors from five countries contributed to ZDM, JRME and JMB, while JMTE had publications from four countries. Although the dominance of English-speaking countries appeared in each journal, the top ranking countries were from non-English speaking countries such as Israel, Germany, and Turkey in ESM and JMTE. Furthermore, the number of articles from Germany (40%) and Israel (26.6%) was striking in ESM. As for the contributing countries in previous CERME conferences, there have been eleven countries since the first emergence of Early Years Mathematics WG. As opposed to the majority of English-speaking countries in mathematics education journals, the top countries were Germany (37.1%), Israel (20%), and Norway (14.2%). The major contributing countries consistently continued to participate in CERME which is biennially organized. Although the number of coun-

tries in CERME6 and CERME7 was five, it increased to eight different countries in the recent CERME.

Research type

During the last fourteen years, almost all of the published articles were in the empirical category (87.75%). In particular, all of the published articles were empirical between 2001 and 2009. Among these empirical papers, qualitative research paradigm was the most popular (46.51%), and this was followed by quantitative (30.23%) and mixed type research designs (23.25%). Yet, other research types such as review (2.04%), theoretical (2.04%) and position (2.04%) were rarely presented in 2001, 2011 and 2013. As for the other research types, there were totally three papers published in 2010 and 2013 in order to provide an introduction into a mathematics education programme and/or a curriculum. The research type by mathematics education journals showed similar consistency in terms of the majority of empirical papers per journal. All of the papers were specifically empirical in JRME, MTL and ZDM. Each investigated journals published studies with different research paradigms including qualitative, quantitative and mixed research design. Among these papers, the dominance of qualitative research paradigm continued in ESM (54.5%), JRME (44.4%), JMB (66.6%), JMTE (66.6%), and ZDM (75%). However, the number of quantitative (50%) and mixed design research papers (40%) was interestingly higher than qualitative research papers in MTL. Other research types such as review, theoretical, position and other were published in ESM, JMB and JMTE. The dominance of empirical research papers (91.4%) was still seen in previous CERME Early Years Mathematics WG papers. Most of the papers were qualitative (80%) and it was followed by quantitative (17.14%), and mixed design (2.85%) studies. Besides, there were three research papers in the category of other to describe a certain curriculum or a programme. But, there were not any review, theoretical and position papers.

Research topic

From 2000 to 2013, the mostly investigated research topics were about number systems and arithmetics (22.44%), algebraic thinking (16.32%), teacher education in early years mathematics education (12.24%), designing and implementing tasks for early years mathematics (10.2%), and comparative studies in mathematics education (8.16%). The studies about number systems and arithmetics insistently became frequently explored topic almost each year except for 2000,

2002, 2005 and 2006. Even though the frequencies of popularly investigated topics varied, the studies about teacher education reached its highest proportion in 2011 (40%). Other research topics about geometrical thinking (6.12%), language and mathematics (6.12%), the role of play (4.08%), manipulatives and ICT tools (4.08%) in mathematics, theoretical approaches to early years mathematics (4.08%), affect in early years mathematics (2.04%), stochastic thinking, social and cultural challenges in mathematics education (2.04%) were not drawn attention by the researchers as much as popular topics. Furthermore, there were not any published articles about the role of natural language in mathematics, representations in early years mathematics, transition between preschool and primary school mathematics, technology in early years mathematics, ways to become a learner at school, and disadvantaged students in early years mathematics and intervention. As for the research topic by journal, the dominance of the research topics about numbers and arithmetics and algebraic thinking permanently continued as top research topics in JRME, JMB, and MTL. However, the top research topics per journal showed variance. For instance, designing and implementing tasks for early years mathematics got the highest proportion in ESM (20%) and JRME (22.2%), whereas all of the published articles in JMTE were about teacher education and half of the articles in ZDM were about geometrical thinking. There were CERME papers about various research topics. Although some of the popular topics in CERME papers were consistent with the publications in mathematics education journals, some of them were strikingly different. Among these papers, the most prominent ones were about the role of play in early years mathematics (14.2%), teacher education (14.2%) and designing and implementing tasks for early years mathematics (11.4%). It was followed by some of these research topics including geometrical thinking (8.57%), mathematics and language (8.58%), and the role of manipulatives and ICT tools in early years mathematics. On the other hand, the top research topics showed variance per each CERME conference. To be more specific, the top topic was designing and implementing tasks in early years mathematics (33.3%) in CERME6, teacher education (20%), the role of play (20%) and the role of natural language (20%) in early years mathematics became popular in CERME7. As well as the popularity of the role of play (18.7%) continued in CERME8, the use of manipulatives and ICT tools in early years mathematics (18.7%) were drawn attention.

Research sample

Research sample refers to the participants (e.g. children and teachers) of the studies in the investigated journals and proceedings. Considering the research sample in published articles, only empirical papers were further examined and analysed by year and journal respectively. The results illustrated that studying with children (74.4%) was the most popular method in early years mathematics education research during these fourteen years. The number of the studies with children has increased since 2010. Even though other samples were not preferred as much as children, there were studies conducted with pre-service teachers (6.9%) and the combination of children and teachers (6.9%), teachers (4.06%), the combination of children and parents (4.06%) and other (2.3%). The results for research sample by journal provided that studying with children continued its popularity in ESM (90.9%), JRME (77.7%), JMB (83.3%), and MTL (80%). Moreover, there were published articles in JMTE conducted with pre-service teachers (75%) and as well as the combination of children and parents (25%). As for ZDM, this journal published the studies conducted with children (50%) and teachers (50%). As for the combination of teachers and children, such studies were published in JMB, JMTE, and MTL. Similarly, the substantial part of the studies in prior Early Years Mathematics WG was conducted with children (60%) and the sample of children continued to be the mostly preferred one in all previous CERME conferences. Other research samples were not studied as much as children. But, there were studies conducted with teachers (14.2%), and the combination of children and parents (11.4%).

DISCUSSION AND CONCLUSION

This study presents the major contributing countries to this research field as English-speaking countries in the context of mathematics education journals. This may be related to the benefits of reporting the scientific papers in a more efficient way than the way non-English speaking researchers do. Yet, the contributions of non-English speaking countries particularly Germany and Israel were striking. Furthermore, these countries became the top countries in previous CERME conferences in terms of their contribution to the research field. Moreover, they provided a significant contribution to the field through their being a research community since the publications of such countries were constructed through a collaborative work.

In this study, majority of the published articles and CERME papers were empirical. Among these papers, qualitative research paradigm was the most utilized one. This may be related to the research sample of the published articles because another finding of this study indicates that studying with children was superior to studying with other kind of samples. Furthermore, using qualitative research methods is the most common way to study with children (Trundle & Saçkes, 2012). This trend was followed by quantitative and mixed research design. Although almost all of the quantitative studies were conducted with children, they mostly preferred to collect data in accordance with the target age group through using mathematical tasks and materials. As for the research type by journal, the majority of the empirical papers adopted qualitative research methods. Yet, the number of quantitative papers was higher than others in MTL. Moreover, as opposed to the dominance of empirical papers, other research types like review papers were rarely presented during these fourteen years and they were published in ESM, JMB, and JMTE. The difference among journals may be related to their aims and scopes. Although CERME accept various research types, there were not any review, theoretical and position study among the CERME papers.

The results also announce the top research topics in ECME research. These top research topics were different in the investigated journals and CERME papers. In the mathematics education journals, the top topics were about teaching and learning of number systems and arithmetics, algebraic thinking, teacher education, designing and implementing tasks for early years mathematics, and comparative studies in mathematics education. Its reason may be related to the goals of ECME such as promoting mathematical thinking and learning and improving qualification through various ways like teacher education and the implementation of tasks (e.g., Clements et al., 2013). Besides, these research topics consistently remained the top topics almost each year. This shows us the insistence of the researchers on these research topics to reach the stated goals of mathematics education. In spite of the significance of teaching various content areas such as geometry and measurement in ECME (NCTM, 2013), learning of number systems and arithmetics and algebraic thinking were the most frequently investigated topics. This may be related to the broad focus of 'numeracy' in early childhood curriculum rather than process skills and affect (Ginsburg &

Golbeck, 2004) and as well as its misinterpretation as generally dealing with numbers (Sarama & Clements, 2004). However, other research topics such as geometrical thinking and affect in early years mathematics were not studied as much as the top topics. Besides, there was no study about remaining topics like technology in early years mathematics, and learning disorders; early identification and intervention in the selected journals and CERME papers though these topics are highlighted to achieve ECME goals, and to provide high-quality education to meet the needs of all learners (Highfield & Goodwin, 2008). Moreover, the top research topics varied per journal. For example, the topic of designing and implementing tasks for early years mathematics was the mostly studied one in ESM. This may not be surprising because the journal focuses on the practitioners in mathematics education through dealing with didactical, theoretical and pedagogical issues. The top research topics (e.g. the role of play and the role of natural language in ECME) in prior CERME were in general different from the investigated journal articles. This may be related to the dynamic in Early Years Mathematics WG and the research interests of group members. Furthermore, CERME papers filled the gap in terms of investigated research topics since there was not any study about the role of natural language in the journals examined. Last but not least, the top ranking research sample was children in both mathematics education journals and CERME papers. Moreover, it is good to reach the studies conducted with other samples. The combination of both children and parents and children and teachers is particularly a good indicator of understanding the relevant research topic through considering the context because the need for such research which explores parents' educational interactions with their children and the role of parents' on children's learning mathematics is pointed out (Ginsburg & Golbeck, 2004). Moreover, the results per journal indicated that some journals like JMTE and MTL publish the studies conducted with the combination of various sample. The findings of this study for each journal particularly introduce the aims and scope of each major journal in the field for ECME researchers who would like to contribute to this field. Thereby, this may play a facilitator role for future studies to fill a gap in the field as well as to determine the right journal in accordance with the kind of topic, design and sample of the studies. In spite of the evolution of this research field in the past decade, the results may also suggest some further research

directions for the improvement of this research field. First of all, the research community in ECME should be internationalised through increasing the number of studies from various countries. Besides, cross-national and cross-cultural studies may contribute to the advancement of this research field. Second, other research types should be drawn attention by the researchers as well as empirical papers because the position, theoretical and review papers play an important role in contributing to the research field. Third, the goals of ECME should be accomplished through studying various research topics rather than the research topics focusing on only some goals of ECME. Particularly, there should be more research topics such as “technology education” for the improvement of children’s mathematical learning, and “transition between preschool and primary school mathematics” for the development of mathematical proficiency (NAEYC, 2010). Last, there should be more studies conducted with various participants like children and parents based on the contributions of family environment to children’s ongoing mathematical learning (Ginsburg & Golbeck, 2004). Furthermore, there is a need for studies conducted with pre-service and in-service early childhood teachers since the findings of such studies may guide teacher educators for the professional development of early childhood teachers in ECME (Lee & Ginsburg, 2007). The findings of the study were limited to the investigated journals in mathematics education and CERME Early Years Mathematics Working Group (WG) papers. Therefore, further review studies could be replicated through including highly refereed early childhood education journals and other international mathematics education conferences as well.

REFERENCES

- Campbell, F. A., Pungello, E. P., Miller-Johnson, S., Burchinal, M., & Ramey, C. T. (2001). The development of cognitive and academic abilities: Growth curves from an early childhood educational experiment. *Developmental Psychology, 37*, 231–242.
- Clements, D. H., & Sarama, J. (2010). Learning trajectories in early mathematics-sequences of acquisition and teaching. *Encyclopedia on Early Childhood Development*, 1–6.
- Clements, D. H., Baroody, A. J., & Sarama, J. (2013). *Background research on early mathematics. Background Research for the National Governor’s Association (NGA) Center Project on Early Mathematics*. Retrieved from <http://www.nga.org/files/live/sites/NGA/files/pdf/2013/1311SEME-Background.pdf>
- Fox, J. L. (2007). International perspectives on early years mathematics. In J. Watson & K. Beswick (Eds.), *Proceedings 30th Annual Conference of the Mathematics Education Research Group of Australasia 2* (pp. 865–869). Tasmania, Australia.
- Ginsburg, H. P., & Golbeck, S. L. (2004). Thoughts on the future research on mathematics and science learning and education. *ECRQ, 19*, 190–200.
- Hachey, A. C. (2013). The early childhood mathematics education revolution. *Early Education and Development, 24*(4), 419–430.
- Highfield, K., & Goodwin, K. (2008). A review of recent research in early mathematics learning and technology. In M. Goos, R. Brown, & K. Makar (Eds.), *Proceedings of the 31st Annual Conference of the Mathematics Education Research Group of Australasia*. MERGA, Inc.
- Howard, G. S., Cole, D.A., & Maxwell, S.E. (1987). Research productivity in psychology based on publication in the journals of the American Psychological Association. *American Psychologist, 42*, 975–986.
- Lee, J. S., & Ginsburg, H. P. (2007). What is appropriate mathematics education for four-year-olds? Pre-kindergarten teachers’ beliefs. *Journal of Early Childhood Research, 5*(1), 2–31.
- Perry, B., & Dockett, S. (2002). Young children’s access to powerful mathematics ideas. In L. D. English (Ed.), *Handbook of International Research in Mathematics Education* (pp. 81–112). Mahwah, NJ: Lawrence Erlbaum.
- Sarama, J., & Clements, D. H. (2004). Building blocks for early childhood mathematics. *Early Childhood Research Quarterly, 19*, 181–189.
- Sarocho, O. N., & Spodek, B. (2009). Educating the young mathematician: The twentieth century and beyond. *Early Childhood Education Journal, 36*, 305–312.
- Stevenson, H. W., & Newman, R. S. (1986). Long term prediction of achievement and attitudes in mathematics and reading. *Child Development, 57*(3), 646–659.
- The Eighth Congress of the European Society for Research in Mathematics Education (CERME8) (2013). 6–10 February, Antalya, Turkey. Retrieved from <http://cerme8.metu.edu.tr/>
- The National Association for the Education of Young Children [NAEYC] (2010). NAEYC position statement: Early childhood mathematics promoting good beginnings. Retrieved from <https://www.naeyc.org/files/naeyc/file/positions/psmath.pdf>
- The National Council of Teachers of Mathematics [NCTM] (2013). Mathematics in early childhood learning. Retrieved from [http://www.nctm.org/uploadedFiles/AbOut_NCTM/PositionStatements/Early%20Childhood%20Mathematics%20\(2013\).pdf](http://www.nctm.org/uploadedFiles/AbOut_NCTM/PositionStatements/Early%20Childhood%20Mathematics%20(2013).pdf)

- Törner, G., & Arzarello, F. (2012, December). Grading mathematics education research journals. *EMS Newsletter*, 52–54.
- Trundle, K. B., & Saçkes, M. (2012). Science and early education. In R. C. Pianta, W. S. Barnett, L. M. Justice, & S. M. Sheridan (Eds.), *Handbook of early childhood education* (pp. 240–258). New York, NY: Guildford Publications, Inc.
- Tsai, C., & Wen, M. L. (2005). Research and trends in science education from 1998 to 2002: A content analysis of publication in selected journals. *International Journal of Science Education*, 27(1), 3–14.