

Available online at ijci.wcci-international.orgInternational Journal of Curriculum and Instruction 11(2)
(2019) 273–284**IJCI**
International Journal of
Curriculum and Instruction

Teaching Mathematical Skills to Individuals with Down Syndrome: A Content Analysis Study

Başak Bağlama^{a *}^a Department of Special Education, Atatürk Faculty of Education, Near East University, North Cyprus, Mersin 10 Turkey

Abstract

The aim of this study is to reveal the trends in studies on teaching mathematical skills and individuals with Down Syndrome (DS) from various perspectives by analyzing the content of scientific research articles in this field. As a result of literature review conducted for this purpose, a total number of 62 articles which can be accessed in full text searched in international databases between 1988-2019 were included in the study. The articles were subjected to content analysis. According to the results of the analysis, the number of studies on mathematics and DS has increased in the recent years and research subjects mainly composed of counting skills, teaching mathematics to individuals with DS in inclusive classrooms and using technology to enhance mathematical skills of individuals with DS. It was found that individuals with DS were preferred as the sample group of the studies examined and qualitative and single-subject research designs were frequently used in the studies. Results are presented with frequencies and percentages and discussed with relevant literature.

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Keywords: Teaching mathematics; Down syndrome; content analysis

1. Introduction

One of the primary objectives of the special education practices is to ensure that individuals with disabilities continue their lives independently. Therefore, in order to prepare students with disabilities to live independently, they need to be taught functional academic skills (Ozak & Diken, 2010; Storey & Miner, 2017). Functional academic skills are the skills used in performing daily life activities (Bouck, 2010). When the educational environments are examined, teaching objectives may differ according to the performance level and needs of each child. However, basic mathematics skills such as using money, controlling time and processing and literacy skills are functional academic skills for every child (Goransson, Hellblom-Thibblin & Axdorph, 2016). Mathematical

* Başak Bağlama. Tel.: +0-392 2236464
E-mail address: basak.baglama@neu.edu.tr

topics include the skills and concepts that the student with disabilities will use functionally throughout his life. In this respect, mathematics has an important place in the education of students with disability (Yikmis, 2016).

Many individuals with disabilities receive education in general education classes, special education classes and separate special education schools and need effective methods and techniques to acquire academic skills. In addition to general education teachers who teach in these institutions, special education teachers want to apply effective methods and techniques in teaching academic skills. Within the academic skills, mathematics skills have been tried to be taught by both teachers to individuals with normal development and individuals with disabilities through various methods and techniques for years. Rietveld (2005) stated that mathematical skills have a great impact on the lives of individuals with DS in terms of maintaining their lives independently.

The level of conceptual development of children with DS will be significantly effective in understanding children's mathematical concepts and skills, making calculations, and performing other tasks. The development of mathematical concepts and the development of mathematical thinking is not only a result of slow development, but also of limited experience of fine and gross motor skills and / or other coordination and manipulation difficulties. Children with DS should spend time in an environment where there are plenty of opportunities to study and move objects in order to acquire pre-mathematical skills at an early age. Mathematics requires extremely high levels of abstract thinking and reasoning skills, and age 7 and later is a critical milestone in this respect. Children with DS may need to practice manual movement of concrete objects for longer periods of time to perform basic mathematical operations before formal written activities (Abdelahmeed, 2007; Cuskelly & Faragher, 2019). Given the importance of teaching mathematical skills to individuals with DS as an important functional skills, it is crucial to understand how individuals with DS acquire math skills and interventions for improving math skills of individuals with DS.

In order to improve the practices for teaching mathematics to individuals with DS and ensuring the continuity of the related studies, general evaluation of the studies conducted in this field is important in order to give an idea to the quality of the researches that have been put forward for that period and to shed light on the subsequent researches. To provide a general idea about the trends in the studies done in this field will give an idea to the researchers about the deficiencies in the dimensions of the field and the urgent needs to be solved and to determine the important issues to be studied. Therefore, it is necessary to examine the scientific articles published in the field of mathematics teaching to individuals with DS in terms of many criteria. Accordingly, this study aims to reveal and determine the current trends in the studies on mathematics and DS. In line with this general aim, answers to the following questions were sought in this study:

1. What is the distribution of the studies on mathematics and DS according to year of publication?
2. What is the distribution of the studies on mathematics and DS according to journal?
3. What is the distribution of the studies on mathematics and DS according to subject?
4. What is the distribution of the studies on mathematics and DS according to research method?
5. What is the distribution of the studies on mathematics and DS according to research sample?
6. What is the distribution of the studies on mathematics and DS according to number of authors?
7. What is the distribution of the studies on mathematics and DS according to data collection tool?
8. What is the distribution of the studies on mathematics and DS according to data analysis method?

2. Method

2.1. Research model

This is a document analysis study and document analysis studies are generally considered as qualitative research. Document analysis is the examination of all written materials that provide information about a research subject (Yildirim & Simsek, 2011). The main purpose of the document analysis is to analyze the sources containing written information about the events or phenomena to be investigated in detail. The scientific articles reached in this study were analyzed within the framework of predetermined criteria and content analysis was carried out to determine the trends in this field.

2.2. Data collection

In order to obtain the published studies on mathematics and DS, international scientific databases including Web of Science, ERIC and Scopus were searched by using the keywords “mathematics” and “Down Syndrome”. A total number of 62 open-access articles were obtained and included in the study. All the articles accessed were examined one by one and only articles containing mathematics and DS were evaluated. Accordingly, 62 articles from 32 journals were found suitable for content analysis and evaluated in the study.

2.3. Data analysis

Following content analysis, all of the obtained data were recorded in a database. This database was formed based on the selection criteria and the results were analyzed in the 20th version of SPSS Statistics Program. The results were visualized with graph, percentage and frequency tables.

3. Results

3.1. Distribution of the studies on mathematics and DS according to year of publication

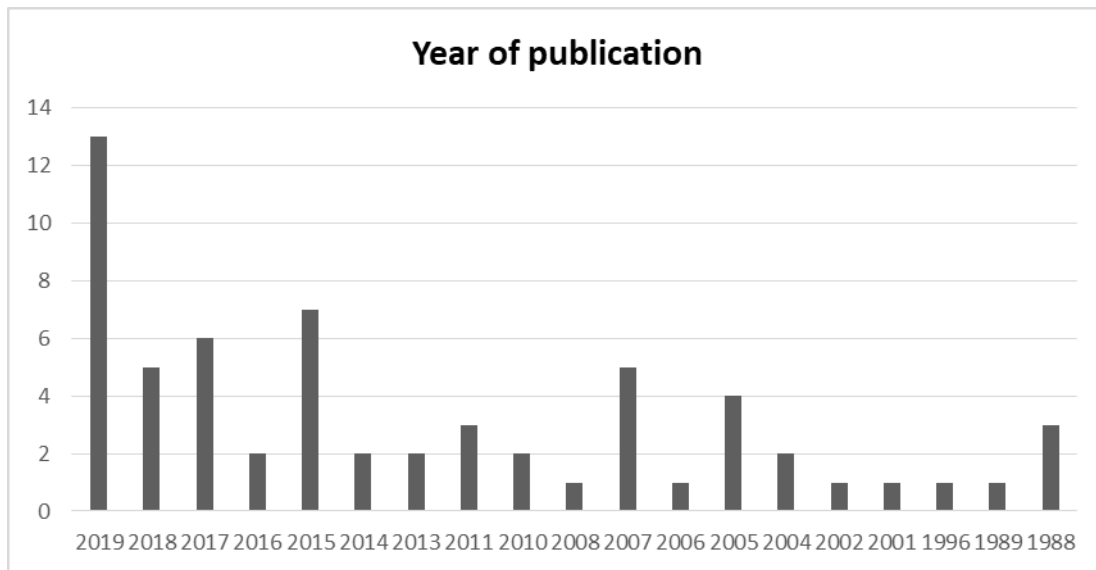


Figure 1. Distribution of studies according to year of publication

Figure 1 shows the distribution of studies on mathematics and DS by year of publication. Results showed that there are studies on mathematics and DS between 1988 and 2019. As it can be seen, there is a steady increase in the studies especially in the last 3 years. However, it is also seen that there are high number of studies in 2015, 2011, 2007, 2005 and 1988. This result shows that teaching mathematics to individuals with DS has become more important from the past to the present.

3.2. Distribution of the studies on mathematics and DS according to journals

Table 1. Distribution of studies by journals

Name of the Journal	f	%
International Journal of Disability, Development and Education	8	12,9
Conference Proceeding	7	11,3
Journal of Intellectual Disability Research	6	9,7
European Journal of Special Needs Education	4	6,5
Research in Developmental Disabilities	4	6,5

Table 1 shows the results on the distribution of the studies on mathematics and DS according to the journals in which the studies were published. The first 5 journals with high frequencies are shown in the table. As it can be seen, *International Journal of Disability, Development and Education* is the first journal with high frequency on the studies related with mathematics and DS. This result is followed with publications as conference proceedings, *Journal of Intellectual Disability Research*, *European Journal of Special Needs Education* and *Research in Developmental Disabilities*. These results revealed that there are different journals which publishes studies on mathematics and DS and this supports the multidisciplinary nature of teaching different academic skills to individuals with intellectual disabilities.

3.3. Distribution of the studies on mathematics and DS according to subject

Table 2. Distribution of studies by subject

Subject	f	%
Counting skills of individuals with DS	19	30,6
Teaching maths skills to individuals with DS in inclusive classrooms	15	24,2
Using technology to enhance math skills of individuals with DS	7	11,3
Maths interventions for individuals with DS	5	8,1
Maths strategies used by individuals with DS	5	8,1
Teaching geometry to individuals with DS	3	4,8
Teachers' practices for teaching math to individuals with DS	2	3,2
Problem solving performances of individuals with DS	2	3,2

Addition and subtraction performances of individuals with DS	1	1,6
Decimal number systems used by individuals with DS	1	1,6
Money counting skills of individuals with DS	1	1,6
Dyscalculia in individuals with DS	1	1,6
Total	62	100

Table 2 shows the distribution of frequently studied subjects in mathematics teaching research for individuals with DS. When the table is examined, it is observed that counting skills (30,6%), teaching maths in inclusive classrooms (24,2%), using technology to enhance math skills of individuals with DS (11,3%), math interventions (8,1%) and math strategies for individuals with DS (8,1%) are the most frequently studied subjects in the studies. However; addition and subtraction, decimal number systems, money counting skills and dyscalculia are less frequently studied. When these results are considered, it can be seen that there are various mathematical skills examined, technology for enhancing math skills of individuals with DS are frequently investigated and there are math skills that need to be more examined. In addition, it is also observed that there is a need for more studies examining the views and practices of teachers and the role of families in teaching mathematics to individuals with DS.

3.4. Distribution of the studies on mathematics and DS according to research method

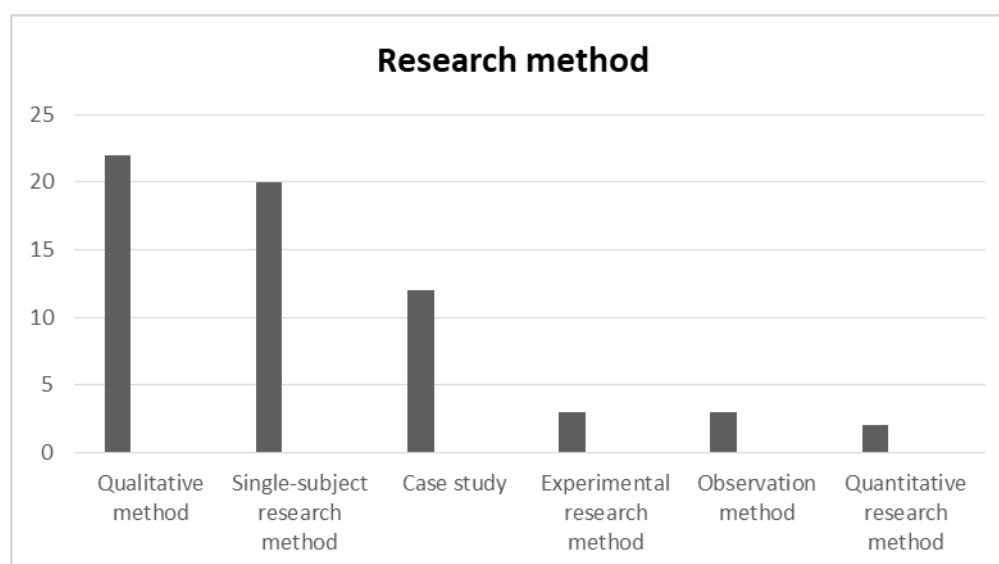


Figure 2. Distribution of studies according to research method

Figure 2 shows the distribution of studies on mathematics and DS by research method. According to the results, it was found that the most commonly used methods were qualitative, single-subject and case study methods. In addition, it was observed that experimental, observation and quantitative research methods were less frequently studied methods. This might be related with the fact that researchers might prefer showing the direct effect of math interventions on performances of individuals with DS through selecting qualitative, single-subject and case study research methods.

3.5. Distribution of the studies on mathematics and DS according to research sample

Table 3. Distribution of studies by sample

Sample	f	%
Individuals with DS	42	67,7
Documents	11	17,7
Primary school teachers	7	11,3
Mathematics teachers	2	3,2
Total	62	100

Table 3 shows the sample that researchers frequently examine. According to the results, most of the studies included individuals with DS (67,7%). In addition, this result is followed by documents (17,7%) in which studies such as content analysis which are not studied with sample. As the sample group studied, it was observed that primary school teachers (11,3%) and mathematics teachers (3,2%) were preferred.

3.6. Distribution of the studies on mathematics and DS according to data collection tool

Table 4. Distribution of studies by data collection tool

Data collection tool	f	%
Document evaluation form	37	59,7
Semi-structured interview form	13	21,0
Math test	11	17,7

Literature	1	1,6
Total	62	100

Table 4 shows the results on the distribution of studies on mathematics and DS by data collection tool. Results indicated that document evaluation form which mostly refers to an evaluation form developed by the researchers was the most frequently used data collection tool. This result is followed by semi-structured interview form, math test and literature.

3.7. Distribution of the studies on mathematics and DS according to data analysis method

Table 5. Distribution of studies by data analysis method

Data analysis method	f	%
Content analysis	29	46,8
Graphical analysis	22	35,5
Scoring	11	17,7
Total	62	100

Table 5 shows the distribution based on data analysis method used in the studies on mathematics and DS. When the results are examined, it is seen that content analysis and graphical analysis were the most frequently used data analysis methods together. This might be related with the fact that content analysis and graphical analysis are mostly used in qualitative and single-subject research methods and therefore researchers preferred using these data analysis methods. Results also revealed that scoring was the other used data analysis method. This might be associated with the situation that especially in math tests, researchers preferred using their scoring systems developed for their data collection tools.

3.8. Distribution of the studies on mathematics and DS according to number of authors

Table 6. Distribution of studies by number of authors

Number of authors	f	%
Single author	22	35,5

Two authors	19	30,6
Three authors	7	11,3
Four authors	9	14,5
Five authors	5	8,1
Total	62	100

Distribution of studies on mathematics and DS by number of authors is shown in Table 6. When the distribution of the examined publications according to the number of authors is examined, it is seen that studies with one author (35,5%) and two authors (30,6%) are in the majority in studies on mathematics and DS. Results revealed that multi-authored studies were less preferred by the researchers.

4. Discussion and Conclusion

In the recent years, interest in research on teaching mathematical skills to individuals with DS has become more evident both at national and international level. However, to determine the trends of the researches conducted and to regulate the researches periodically and to question the information regarding the quality and quantity of these researches, there has become a need to put forward the quality of studies on this area. Therefore, research on mathematics and DS has led to an intensive consideration. When the literature is examined, the limited number of studies on the content analysis of teaching mathematical skills to individuals with DS makes it important and obligatory to determine the trends of the studies conducted in this field in a wide range from various perspectives. In this respect, the present study provides a general framework for all studies conducted in the field of teaching mathematics to individuals with DS.

According to the results of the study, there are studies on mathematics and DS between 1988 and 2019 and there is a steady increase in the studies especially in the recent years. In parallel with these results, Lemons, Powell, King and Davidson (2015) also showed that there are many studies in the literature on mathematics interventions for children and adolescents with DS. Faragher and Clemente (2019) revealed that it is recently more believed that individuals with DS can gain mathematical skills and there is an emerging trend for examining this issue. Results also indicated that there are different journals which publishes studies on mathematics and DS and this supports the multidisciplinary nature of teaching different academic skills to individuals with intellectual disabilities (Barbra & Mutswanga, 2015).

Results showed that there are different research subjects focused in the studies on mathematics and DS. When the literature is examined, there are many studies supporting the results of the present study including counting skills (Sella, Lanfranchi & Zorzi, 2013; Lanfranchi, Aventaggiato, Jerman & Vianello, 2015; Abreu-Mendoza & Arias-Trejo, 2017), teaching maths in inclusive classrooms (Faragher & Clarke, 2016), using technology to enhance math skills of individuals with DS (Ortega- Tudela & Gomez- Ariza, 2006; Ahmad, Muddin & Shafie, 2014; Gonzalez, Noda, Bruno, Moreno & Munoz, 2015), math interventions and math strategies for individuals with DS (King, Powell, Lemons & Davidson, 2017).

According to the results, it was found that the most commonly used methods were qualitative, single-subject and case study methods. This might be related with the fact that researchers might prefer showing the direct effect of math interventions on performances of individuals with DS through selecting qualitative, single-subject and case study research methods. However, Lemons, Powell, King and Dawidson (2015) showed that experimental research design was more preferred in the studies on mathematics interventions for children and adolescents with DS. Furthermore, results of the present study revealed that most of the studies included individuals with DS, documents, primary school teachers and mathematics teachers as research sample.

Results indicated that document evaluation form which mostly refers to an evaluation form developed by the researchers was the most frequently used data collection tool. It was also observed that content analysis and graphical analysis were the most frequently used data analysis methods. This might be related with the fact that content analysis and graphical analysis are mostly used in qualitative and single-subject research methods and therefore researchers preferred using these data analysis methods (Horner, Carr, Halle, McGee, Odom & Wolery, 2005). Results also revealed that scoring was the other used data analysis method. This might be associated with the situation that especially in math tests, researchers preferred using their scoring systems developed for their data collection tools. When the distribution of the examined publications according to the number of authors is examined, it is seen that studies with one author and two authors are in the majority in studies on mathematics and DS and multi-authored studies were less preferred by the researchers. This obtained finding revealed that researchers do not tend to prefer a cooperative process when conducting research on this issue (Demirok, Bağlama & Besgul, 2015). It is suggested that future studies should also make cooperative research in order to be able to provide more comprehensive and objective results.

Overall, the present study tried to reveal and determine the past and current trends in the studies on mathematics and DS. Studies on mathematics and DS published between 1988 and 2019 were analyzed based on previously determined content analysis criteria.

In line with the results of the study, following recommendations for further research and practices are provided below:

- When the needs of individuals with DS are considered, it is clearly seen how much work is needed and how important these studies are. From this research, it is recommended to produce and advance new studies in this direction.
- Supporting teaching practices that take into account the individual differences of individuals with DS, conducting new research and comparing the results, will develop new perspectives and contribute to the literature on teaching mathematical skills to individuals with DS.
- Further research might examine other international academic databases might be analyzed in order to figure out the trends in published documents on teaching mathematical skills to individuals with DS.
- This study might be periodically repeated in order to reveal the current trends and compare past and present trends on studies related with teaching mathematical skills to individuals with DS.

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