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A review of the articles about TouchMath

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Abstract

According to literature, traditional instruction methods remained insufficient in teaching the mathematics skills to the students with special needs. Therefore multi sensory teaching methods must be used in teaching mathematics skills to the students with special needs. TouchMath is a one of the multisensory teaching techniques which is used to teach the mathematics skills especially number sense and four operations skills. The aim of this study is to analyse the studies using TouchMath. In this study the international databases were scanned and 27 articles were found from the databases. The articles were analyzed according to their research models, participants, dependence variables and weather using reliability, social validity, generalization, and maintenance datas. Finally the findings obtained from the articles were discussed and reported.

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1. Introduction

Academic skills are one of the most crucial and functional abilities for the students with special needs to perform the acts required by the social norms and to live effectively and independently in the society. In daily life, it is fairly important to learn mathematics knowledge and skills by the students with special needs and these knowledge and skills should be used by the students independently like the students with normal development.

However, considering the literature derived from research findings, the students with special needs have challenges and deficiencies in achieving the goals of mathematics (Kroesbergen and Van Luit, 2003). Inasmuch as learning these skills by the students with special needs depend on the elements of their programme, organising the content and goals, using appropriate approaches and instruction methods of content. That is mathematics instruction should carry out with individualized goals, using appropriate teaching methods and instructional materials (Gürsel, 1993). This should help learning mathematics concepts and skills by the students with special needs.

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Although deciding appropriate instruction approaches and methods are the first step of planning to learn mathematics by the students with special needs, it is still going on looking for an effective, reliable and systematic instruction method in teaching mathematic skills to the students with special needs (Cavkaytar, 1998). It's easily seen in the literature that some of the instruction methods are to the fore in teaching mathematics skills to the students with special needs. These are;

- Direct Instruction Method
- Interactive Unit Teaching
- Errorless Teaching Method
- CRA (Concrete-Representational-Abstract)

However being a part of cognitive skills and the apprehensions and level differences of the students with special needs are thought, it's clear that being limited by the current instructions above in teaching mathematics content and skills to the students with special needs. Therefore making instructional adaptations and using multisensory instruction methods have become more important in teaching mathematics skills in the last period (Rudolf, 2008). One of the examples that can be given to multisensory approaches is TouchMath.

1.1 TouchMath

Many researchers suggest using multisensory approaches for teaching mathematical skills (Vinson, 2004) and TouchMath responds to this need in teaching basic mathematics skills. TouchMath is a multisensory technique for teaching number sense, addition, subtraction, multiplication and division (Scott, 1993).

The TouchMath program was first developed in 1975 by an elementary school teacher Janet Bullock while searching an appropriate method to increase students success who struggling math concepts. TouchMath is a technique combining vision, movement, hearing and touch senses and is used to teach especially number sense and four operation skills. In TouchMath technique, reference points calling Touch Points are placed on each numbers. These points can help students to see the conceptual meaning of symbolic value.




Figure 1. The numbers with their reference points.

As seen as in the Figure 1, the students see and touch the points of numerals and each point represents the value of each numeral. Numbers from 1 to 5 have single points as their number value and a circle is put around the point in numbers 6 -9. These points with circles are read twice by students while they compute an operation. These touch points express the symbolic imagery of numbers and help students with special needs number in reducing complexity and abstraction of numbers.

Touch Math technique is developed for teaching mathematical skills to individuals with special needs as well as individuals that exhibit normal development. This multisensory technique is especially helpful to students with learning difficulties and mental disabilities for developing mathematical skills (Scoot, 1993). Most useful aspect of this technique for individuals with special needs is that it allows doing addition without finger calculation or having to keep numbers in memory (Miller and Mercer, 1997).

In TouchMath teachers should manage the instruction process and should organise the instruction such as concrete form abstract according to the approach of Bruner (1996). Accordingly; in concrete phase numbers or points should be prepared as concretely and representation should be as touching the numbers and points. In representational phase, points should be put on the symbolic numbers and representation should benefit from the vision of touch points. And last in abstract phase touch points shouldn't be put and students should count by supposing touch points are there. Briefly in concrete phase represents "Touch", representational phase represents "See" and abstract phase represents "Count" without touch points. The samples of TouchMath should be used in the treatments of CRA are shown In the Table 1.

Table 1: Numeral samples in TouchMath

Concrete (Touch)	Representational (See)	Abstract (Count)
	123	123

Briefly, TouchMath program is an appropriate technique for NCTM's "Number and Operations Standard" (Vinson, 2004). Advantages and benefits of TouchMath according to these standards are in the below:

1. TouchMath is a multisensory technique combining vision, movement, hearing and touch senses.
2. Having points help students in conceptual leaning of numbers and operations.
3. It founds a firm foundation in early child age.
4. It remediates learning problems in any regular grade-level classroom.
5. It is used with all types of students to teach math skills.
6. It supports remedial math instruction in high school and adult education classes.

However conceptual teaching of numbers and being useful in four arithmetical operations, TouchMath isn't included exactly to the methods in literature and lesson books in schools, yet. The aim of this research is to present the conceptual content of TouchMath and the place of it in mathematics instruction methods and also reveal the applicability of this technique accordance with specific criterions.

2. Method

In this research a qualitative approach is structured and descriptive analysis were used to analyse the criterions. The articles in 1990 and 2014 were included to this research and 32 articles were found in searching. In this research the articles using TouchMath as main method were selected and after analysing 27 articles were selected as the target articles.

The search procedure was used by Library Databases and electronical databases (EbscoHost, Proquest, National Thesis Centre (www.yok.gov.tr). In search also "TouchMath", "Touch math", "Nokta Belirleme Tekniđi" and "Dokunmatik Matematik" was used as the key words.

3. Findings

The articles about TouchMath was analysed with the selected criterions. The findings were presented in each title including different criterions.

3.1 The findings according to the scientific method.

In these 27 articles three different scientific methods were used. These are experimental studies, single case studies and qualitative studies. The numbers of articles using these scientific methods are shown in the Table 2.

Table 2. The number of the articles using scientific methods

Research Methods	Number Of Articles
Experimental studies	11
Single Case Studies	12
Qualitative studies	4

According to Table 2, %44 of these articles about TouchMath are single case studies, %40 are experimental studies and %11 are qualitative studies. The articles using single case methods are shown in the following Table 3.

Table 3. The articles using single case design

Article	Number Of Participants	Type of Disabilities	Model	Dependent Variable	Results
Avant and Heller,2001	3	Mental Retardation	Multiple Probe Design Across Participants	Addition Operation Up to 20	Effective
Cihak and Foust,2008	3	Autism	Alternating treatments Model	Addition Operation	More Effective
Çalık and Kargin,2010	3	Mental Retardation	Multiple Probe Design Across Participants	Addition Operation	Effective
Eliçin, Emecen andYıkımış,2013	4	Mental Retardation	Multiple Probe Design Across Participants	Addition Operation	Effective

Fall,2010	1	Mental Retardation	Multiple Baseline Design Across Participants	Addition and Subtraction	Effective
Fletcher, Boon and Cihak ,2010	3	Mental Retardation	Alternating treatments Model	Addition with One Digit Numbers	More Effective
Mays,2008	42	Mental Retardation	Multiple Baseline Design Across Participants	Addition with One Digit Numbers	Effective
Newman,1994	4	Down Syndrome	Multiple Probe Design Across Participants	Addition with One Digit Numbers	Effective
Pupo,1994	3	Mental Retardation	Multiple Probe Design Across Participants	Addition with Two Digit Numbers	Effective
Scott,1993	3	Mental Retardation	Multiple Probe Design Across Participants	Addition and Subtraction	Effective
Simon and Hanrahan,2004	3	Learning Disability	Multiple Probe Design Across Participants	Addition Problems	Effective
Waters and Boon,2011	3	Mental Retardation	Multiple Probe Design Across Participants	Money Skills with Including Subtraction	Effective

According to the Table 4, 2 the articles (%16, 65) are comparative studies and in two articles alternating treatments were used. The rest of the single case studies (%83, 4) are effectiveness studies. In these 10 effectiveness research different designs were used. Accordingly, 8 (%66, 7) research used multiple probe design across participants and 2 (%16, 65) research used multiple baseline design across participants. The articles using single experimental methods are shown in the following Table 4.

Table 4. The articles using experimental method

Article	Number Of Participants	Type of Disabilities	Model	Dependent Variable	Results
Bedard,2002	10	Autism	Pretest- Posttest	Addition	More Effective
Dev, Doyle and Valente,2002	11	Learning Disability	Pretest- Posttest	Numbers and Operations	Effective
Dombrowski,2010	7	Learning Disability	Pretest- Posttest	Computation Skills	No Difference
Dulgarion,2000	10	Mental Retardation	Pretest- Posttest	Addition and Subtraction	More Effective
Green,2009	12	Learning Disability	Pretest- Posttest	Test Included Four Arithmetical Operations	Effective
Jhaveri, Verna and Imam,2010	44	Learning Disability	Pretest- Posttest	Addition and Subtraction	More Effective - Less Time
Rudolph,2008	18	Learning Disability	Pretest- Posttest	Addition and Subtraction	Effective
Ulrich,2004	24	Learning Disability	Pretest- Posttest	Addition in hand	Effective -Less Time
Uzomah,2012	100	Normal Development	Pretest- Posttest	Addition	Effective
Velasco,2009	26	Normal Development	Pretest- Posttest	Addition	Effective
Williams,2005	19	Normal Development	Pretest- Posttest	Addition and Subtraction	Effective-Less Time

In Table 4 it's seen easily that pretest-posttest method was used by all of the 11 experimental studies. All of these researches used TouchMath in experimental groups and the traditional methods are used in control groups. And the articles using qualitative methods are shown in the Table 5.

Table 5: The articles using qualitative methods

Article	Number Of Participants	Type of Disabilities	Model	Dependent Variable	Results
Grattino,2004	Teachers	-	Semi-Structured Interview	The View About TouchMath	TouchMath Is Useful
Rains, Kelly and Durham, 2009	Teachers	-	Semi-Structured Interview	The View About TouchMath	TouchMath Is Useful
Vinson,2005	Teachers 505	-	Semi-Structured Interview	The View About TouchMath	TouchMath Is Useful
Wisniewski, Zeda and Smith,2002	4 Students	Mental retardation	Action Research	Addition Operations	Effective- Less Time

In Table 5 four articles are shown using qualitative research model. Three of these articles have used semi structured interview way to collect data. In these researches, researchers laid out a meeting with teachers and asked the teachers' views about TouchMath and its using in treatments. The other research's model is action research. Action research is one of the applied qualitative researches and in this research, researchers studied with students having mental retardation.

3.2. The findings about participants.

27 articles were analysed in this research and the number of students and teachers are shown in Table 6.

Table 6: The number of students and teachers who participated

Number Of Participants	Number Of Articles	Number Of Articles
Students	24	360
Teachers	3	505 and more

According to Table 6, 24 (%89) of the 27 articles studies with the students and 3 articles (%11) studied with teachers. One research of these 3 articles 505 teachers were participated the research and the other articles didn't reveal the number of participated teachers. 24 researches were investigated the effectiveness of TouchMath and because of this number of studies with students are more than qualitative studies.

In this research totally 360 students were participated in 24 articles and the other research point is the school grade of the participants. The findings about school grade of the participants are shown in Table 7.

Table 7: The number of students about their school grade

School Level	Number of Articles	Number Of Students
Pre-school	2	126
Primary School	19	186
Secondary School	2	45
High School	1	3
TOTAL	24	360

In articles 45 secondary school students and in 1 article 3 high school students were participated. In these findings it's easily seen that most of the researches (%79) were studied with primary school students.

The last point about participants is the type of deficiency of students. According to findings of the type of the students are shown in the Table 8.

Table 8: The number of students with different types of deficiency

Type Of Deficiency	Number Of Students
Mental Retardation	91
Learning Disability	107
Down Syndrome	4
Autism	13
Normal Development	145
TOTAL	360

According to Table 8, 145 students (%40) with normal development were participated to the researches. Although students with normal development are the most participated type of deficiency, these participants are just from 3 (%11) of 24 researches. In the second, the number of students with learning difficulties who participated to the researches is 107 in 6 articles (%22). In the third, the number of students with mental retardation is 91 in 12 (%44) articles. Also the number of students with autism is thirteen in 2 articles (%7, 4) and the number of students with Down syndrome is four in 1 article (%4).

3.3. The findings about dependent variable

TouchMath is usually used in number sense and four operation skills in literacy. In this research, the dependent variables are shown in the Table 9.

Table 9: The number of dependent variables

Dependent Variable	Number Of Articles
Addition	14
Addition and Subtraction	6
Computation Skills	3
Money Problems	1
TOTAL	24

As seen as in the Table 9, addition operation skills are the most commonly used as dependent variable. Addition operation skills were used in 14 (%53) articles and the number of addition and subtraction operations skills used with together is following as 6 (%23) articles. 3 (%10) articles were used computation skills and 1 (%4) article used Money problems including subtraction as dependent variable. In qualitative researches no dependent variables used.

3.4. The Findings about Reliability and Validity

In this research inter-observer reliability, generalization, maintenance and social validity data were analysed in the articles. The findings are shown in the Table 10.

Table 10: The number of articles with reliability and validity data

Analysed Data	Number Of Articles
Inter-observer Reliability	12
Generalization	8
Maintenance	10
Social Validity	5

According to Table 10, 12 (%45) articles used inter-observer reliability data in the research. 9 of 12 articles are single case studies and 3 of 12 articles are experimental studies. All of these researches gained %90-100 reliability degrees. The other articles didn't give the reliability data in the researches.

When analysed the generalization data, 8 (%30) articles used generalization data in researches. 7 of 8 articles used single case design, 1 of 8 used experimental way as model and all of them succeeded at generalization.

According to maintenance data, 10 (%37) articles used maintenance data to determine the persistence of TouchMath. All of 10 articles used single case design as model and the maintenance period are changed in a month and four month. 9 of 10 articles were succeeded in maintenance data but 1 article was being unsuccessful in maintenance period.

Social validity data were collected to reveal the views of teachers and parents about the method used in researches. In these researches only 5 (%21) articles collected and 22 (%89) articles didn't collect social validity data. In 5 articles teachers and parents found TouchMath as useful method in Daily and school life.

3.5. The findings about the results of researches

Table 11: The number of articles about their results

Research Method	Effective	Ineffective
Experimental studies	11	-
Single case Studies	12	1
Qualitative studies	4	-
TOTAL	26	1

3 articles are used qualitative research method and in these researches data were collected from teachers. In 3 researches teachers accepted TouchMath as an effective method and they revealed using TouchMath in treatments as 99%, 84% and 54% degree. Also they explained the positive affects if it is used in teaching number sense and four operation skills while studying with students. Another common point in these researches is the representing multi-sensory teaching methods are so important in the opinion of the students' learning.

In single case researches 10 of 12 articles determined the effectiveness directly. 2 of 12 articles compared TouchMath with other methods such as using number line. In 2 comparative researches TouchMath were found as more effective than the other method and TouchMath was also found as an effective technique in all effectiveness (10) studies using single case design.

11 experimental researches and 1 action research were also aimed to determine whether TouchMath's effective or not. In 8 of 12 researches TouchMath was reported as an effective technique to teach the dependent variables and 3 of 12 researches TouchMath was reported more effective than traditional methods and in 1 research no difference was found across the other method. And also a other important result is in 4 articles TouchMath were reported as more efficient technique because of gaining time to teach the dependent variable.

4. Conclusion

In this research 27 articles about TouchMath were analysed which were done in 1990 and 2014. Accordingly, it is seen that the number of experimental studies and single case design researches are nearly same and qualitative researches are less than these two research model. An also pretest-posttest model was selected in all of the experimental researches are important for the literature. However in single case design researches, three different model were used such as multiple baseline across participants, multiple probe design across participants and alternating treatment model. According to these findings; the other models in experimental researches and comparative researches in single case design about TouchMath should be more in the future.

According to the properties of the participant who participated to the researches, one of the most important finding is participating primary school students in most of the researches (12). This finding can be explained that TouchMath is commonly used to teach primary school goals in mathematics such as number sense and four operation skills. Although using TouchMath in high school students is normal, the presence of just a few researches about TouchMath in teaching preschool (Velasco, 2009; Uzomach, 2012) and secondary school (Mays, 2008; Pupo, 1994) is important for literature about TouchMath. In the future it can be told that researches with preschool and secondary school students should be more.

Another finding in the research is the most number of participated group is students with normal development, but this is because of one researches having large number of participants with normal development students. Students with learning disabilities followed students with normal development and students with mental retardation were ranked. Although students with mental retardation were participated to 12 researches, participating less number of students were caused by designing with single case model. For all that participating all of the types of students with special needs and students with normal development is another useful findings about TouchMath.

According to findings about dependent variable, 20 researches used addition as dependent value. In these researches addition was used both single method or used with subtraction. But it's an important finding that no researches used just subtraction, multiplication and division. It is explained that these operation skills should be used in the researches about TouchMath in the near future. Furthermore, if these skills are used in the researches, the

participants in preschool and secondary school students should be raise in the researches as participant.

When reliability, maintenance, generalization and social validity data analysed, it was clear that researches didn't give place exactly to these data. This is a so important finding about TouchMath and the validity of the researches. However in the recent single case designed researches variable, generalization and maintenance data were begun to use and it is thought a positive finding to notify that these data should be taken place more in the future researches. Therefore it is hard to think like the others. For the percentage of using social validity in the all type of researches isn't enough to think positively for the future.

In the end it is clear that TouchMath is an effective technique as a multi-sensory method and it is stated exactly in different researches designing with experimental, single case designed and qualitative researches. Especially after effectiveness of TouchMath was stated in each type of researches, it was important to accept that it was a useful technique to teach number sense and four operation skills in three qualitative researches by teachers was important. Finally according the findings about the results of the researches, TouchMath should be accepted as a researched based technique to teach number sense and four operation skills.

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