European Journal of Special Education Research
ISSN: 2501 - 2428
ISSN-L: 2501 - 2428
Available on-line at: www.oapub.org/edu

doi: 10.5281/zenodo.1326894 Volume 3 | Issue 4 | 2018

EFFECTIVENESS OF TOUCH MATH TECHNIQUE: META-ANALYSIS STUDY

Mehtap Kot,
Nesime Kübra Terzioğlu,
Burcu Aktaş,
Ahmet Yıkmış[i]
Bolu Abant İzzet Baysal University,
Faculty of Education,
Special Education Department,
Turkey

Abstract:
This research was carried out in order to establish a general opinion on the effect of the teaching technique, which is referred to as the Touch Math, on the academic achievement of special needs students in mathematics courses. To this end, graduate thesis, doctoral dissertation and articles, which were made between 1990-2017, and which have statistical data that can be included in the meta-analysis study in accordance with the research problem, have been examined in national and international databases. For the collection of data, the inclusion criteria were determined and the coding form was prepared. Within the scope of the research, 11 researches have been examined and the researches that are appropriate to the inclusion criteria have been combined with the meta-analysis method. Descriptive analysis and meta-analysis findings of the study show that the touch math technique is effective in teaching acquisition addition skills of children with special needs.

Keywords: mathematics teaching, special needs individual, meta-analysis, addition operations

1. Introduction

The need to understand and use mathematics is constantly increasing (Çiltaş and Işık, 2013) because mathematical skills are one of the most important tools we use to solve problems in our daily lives (Baykul, 2009). Although mathematical skills are of such a great importance in everyday life, they are considered difficult to acquire all over the world (Baykul, 2009; Çıltaş and Işık, 2013; Umay, 1996; Tall and Razali, 1993). It is thought that this difficulty stems from the nature of Mathematics and from the negative

[i] Correspondence: email yikmis_a@ibu.edu.tr

attitudes of the students towards it. However, research on mathematical skills in recent years has shown that the success in mathematics can be improved by taking effective methods and techniques into the field (Umay, 1996).

Mathematical skills are important for individuals with special needs as well as for individuals with normal development. Because mathematics is part of everyday life and learning these skills helps individuals with special needs acquire independent life skills. Individuals who differ significantly from their peers in terms of their individual characteristics and educational qualifications for various reasons are called individuals with special needs (Ministry of National Education [MEB], 2004).

Special needs individuals fail to learn mathematical skills because of ineffective teaching, verbal language problems, cognitive factors, low reading skills, affective factors, inadequate visual perception, inattention, and inadequate motor skills (Spinelli, 2002; Bryant, Smith and Bryant, 2008). In order to make effective teaching for these students, adaptations and changes should be made in course plans, course contents, instructional techniques, tools and evaluation applications (Gürsel, 2017).

Teachers should use the most effective and efficient ways of developing and implementing mathematics programs for individuals who do not perform adequately in mathematical skills. For this reason, teachers working with special needs students can get better results if they base their mathematics teaching on valid research practices (Gürsel, 2017). In recent years, various researches on mathematics teaching have been made to special needs students and effective method and technique searches are underway.

Methods and techniques used in teaching mathematics to special needs students; we can list them as errorless teaching methods, interaction unit, peer-mediated teaching and direct teaching method, number line technique, concrete-semi-abstract teaching technique, video model teaching and touch math technique.

Touch math technique is a teaching technique that is used to teach mathematical skills, especially for students with special needs, to be able to perform operations, and to include points such as the number value in the direction of the figure drawn on each figüre (Eliçin et al., 2012; Fletcher et al., 2010; Scott, 1993; Waters and Boon, 2011).

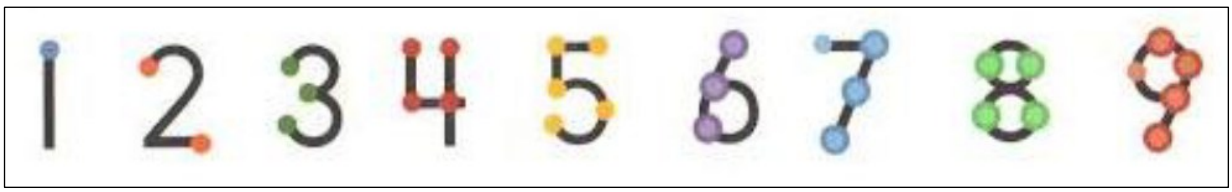

Figure 1: Touch Math Technique

As shown in Figure 1, in the touch math technique, the numbers 1 through 5 contain as much points as their value, while circles that appear around the dots begin to take place after 6, which means that the dots will be counted twice (Bullock et al., 1989, Cihak and Foust, 2008, Waters and Boon, 2011, Wisniewski and Skarbek, 2002). It is suggested that the touch math technique should be used in the field for reasons such as tracking a flow

through a concrete abstract, appealing to more than one sense, removing the process by counting the fingers.

When literature is examined, there are many studies related to touch math technique in mathematics teaching for special needs students. These studies were designed with experimental, semi-experimental and qualitative research methods. However, no meta-analysis work has been done in this regard. Meta analysis studies are important in terms of strengthening the validity of the results of existing studies with similar findings, and in terms of explaining the reasons for these differences if there are differences in the results. A meta analysis method was used to combine semi-experimental results with touch math technique in this study, since a meta analysis study related to spot touch math was not achieved in the field of field-writing and meta analysis studies were important in many respects.

However, the use of scientifically based practices in the education of children with special needs is crucial. Touch Math technique is among the promising applications according to NPDC (2013). It is thought that calculating the impact size of the research using touch math technique will contribute to the field-writing.

The purpose of this study is to calculate the effect size of the teaching of addition procedures based on semi-experimental models using touch math technique and to determine the effect of this technique on the academic achievement of students with special needs in mathematics courses. In addition, in the study, the effect of point detection technique on academic achievement; the number of participants, the year of publication, the person performing the application, the number of participants, and their variables.

2. Method

2.1. Identification of Researches

In this research, researches made with touch math technique in teaching mathematical skills and concepts to special needs individuals; descriptive analysis via descriptive summaries, meta-analysis with effect size calculation. As electronic databases for scanning, the Google Academic search engine, the National Thesis Center website of the Higher Education Council and Abant Izzet Baysal University Library were used. These databases were scanned using key words such as "touch math technique", "touch points", "Touch Math", "addition process" and the searches were extended to the references of the articles and theses reached. As a result of the screening, 26 surveys were conducted. The prerequisite for the research included in the study is that: a) it has been done between 1990-2017, b) It has been designed according to the single-subject research methods, c) it has been used to determine the point in the teaching of the process of gathering students with special needs. 26 studies were evaluated according to these criteria, and 11 studies that included the results of this evaluation were included in this study.

Table 1: Research Features

Source	Dependent Variable	Independent Variable	Participants		Research	Finding
			Number	Diagnosis		
Newman, 1994	Basic addition operation	TM	4	DS	MPDAP	Effective
Simon ve Hanrahan, 2004	Addition operation	TM	3	LD	MPDAP	Effective
Çalık, 2008	Addition operation	TM	3	MR	MPDAP	Effective
Cihak ve Foust, 2008	Addition operation	TM & NL	3	ASD	ATM	TM is more effective and efficient
Fletcher, Boon ve Cihak, 2010	Addition operation	TM & NL	4	MR-ASD	ATM	TM is more effective and efficient
Avant ve Heller, 2011	Basic addition operation	TM	3	PD	MPDAP	Effective
Eliçin, Dağseven- Emecen ve Yıkmış, 2013	Addition operation	TM	3	MR	MPDAP	Effective
Kot, Sönmez, Yıkmış ve Cora-İnce, 2016	Addition operation	TM	3	HD	MPDAP	Effective
Yıkmış, 2016	Addition operation	TM	3	ASD	MPDAP	Effective
Kot, Sönmez ve Yıkmış, 2017	Basic addition operation	TM & NL	2	MR	ATM	TM is more effective and efficient
Research Involving Addition And Subtraction						
Scott, 1993	Addition and Subtraction	TM	3	MR	MPDAB	Effective

TM: Touch Math, NL: Number Line, MR: Mental Retardation, DS: Down Syndrome, LD: Learning Disability, ASD: Autism Spectrum Disorder, PD: Physical Disability, HD: Hearing Disability, MPDAB: Multiple Probe Designs Across Behaviors, MPDAP: Multiple Probe Designs Across Participants, ATM: Alternating Treatments Model.

2.2. Descriptive Analysis Process

The 11 studies included in the study were examined in accordance with the Research Review Form developed by the researchers. Surveys were evaluated from a) the dependent variable b) the independent variable, c) the diagnostic characteristics of the participants, d) the research design, e) publication year and f) the findings. The investigated investigations are given in Table 1.

2.3. Meta Analysis Process

After the descriptive analysis was completed within the scope of the research, the meta-analysis process was started. Effect size calculations were performed using the Percentage of Non-overlapping Data (PND) method in order to perform the effects of the studies on the effectiveness of the studies based on visual analysis. To calculate the effect size, a line is drawn from the data point with the highest start level in the research graph to the application phase in parallel with the horizontal axis, and the remaining data points at the top of this drawn line are divided by the total number of data in the application run. The result is multiplied by 100 and the percentage of the effect size is calculated.

2.4. Inter-Coding Reliability Process

The reliability study of the descriptive analysis process was carried out by selecting all of the determined research and using the research evaluation form by the second researcher in detail within the scope of the criteria determined. The reliability of the meta-analysis process was also determined by selecting all the research and comparing the data obtained by the first and second researchers. Inter-coding reliability, calculation was performed using the formula [consensus / (consensus + disagreement) x 100] and inter-encoders reliability was determined as 100%.

3. Results

As a result of the survey of the field literature, it was decided to include 11 research into the meta analysis. The results of these studies were analyzed under two headings as descriptive analysis and meta-analysis findings.

3.1. Descriptive Analysis Findings

Descriptive analysis findings of 11 studies were explained in the topics of dependent-independent variables, participants, research patterns, year of publication and findings.

3.1.1. Dependent Variables

A screening was done according to the dependent variables used in the researches investigated within the scope of the research. Table 2 contains the dependent variables used in this study.

Table 2: Dependent Variables Used in Research

Variables	Frequency
Addition	10
Addition and Subtraction	1

When Table 2 above is examined, it is seen that the most commonly used dependent variable in the selected studies is the instruction of addition (f = 10). In one study, it is observed that both collecting and subtracting were taught.

3.1.2. Independent Variables

One of the prerequisites for the studies to be included in the study is the use of "touch math technique". For this reason, the independent variable of all the studies included in the study is the "touch math technique".

3.1.3. Participants

Participants in the investigated studies were assessed by considering the diagnostic variables. Details of the participants' diagnoses are given in Table 3.

Table 3: Participants' Diagnostic Information

Variables		Frequency
Diagnosis	Intellectual Disabilities	15
	Down Syndrome	4
	Autism Spectrum Disorders	6
	Hearing Disability	3
	Learning Disabilities	3
	Physical Disability	3

A total of 34 participants appear to be involved in the research. When the participants in the investigated studies were examined in terms of diagnostic variables, 15 participants were found to be suffering from mental impairment, 6 with autism spectrum disorder, 3 with hearing impairment, 3 with learning disability and 3 with physical impairment.

3.1.4. Research Patterns

In this study, one of the criteria in the study of determining the investigations investigated is the use of single-subject research designs. In this respect, Table 4 contains the single-test experimental designs used in the research.

Table 4: Single-Subject Research Patterns Used In Research

Variables	Frequency
Multiple Probe Designs Across Participants	7
Multiple Probe Designs Across Behaviors	1
Alternating Treatments Model	3

When the above Table 4 is examined, it is found that the most used single-participant experimental design used in the selected studies is the multiple probe designs across participants (f = 7) and it is followed by the alternating treatments model (f = 3).

3.1.5. Publication Year

The distribution of the researches included in the scope of the research was analyzed by years. Figure 1 shows the distribution of the research by years.

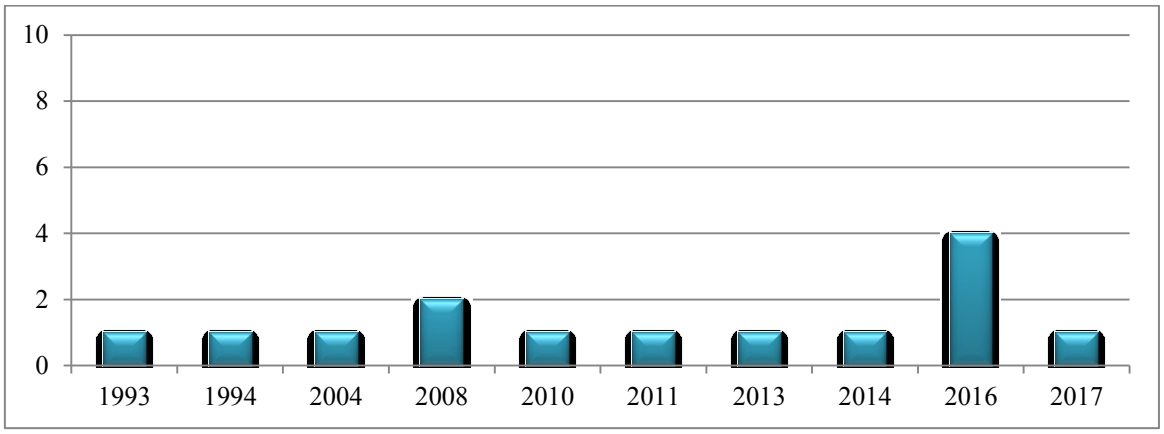

Figure 1: Distribution of work done with point determination technique according to years

When Figure 1 is examined, it is seen that the distribution of the studies done with the touch math in which single-study research designs are used is shown according to years. The first study with touch math using single-subject research patterns was conducted in 1993. Furthermore, it was concluded that the studies carried out increased in 2016 and reached the highest level compared to the years.

3.1.6. Findings

In 11 studies included in the study, it was stated that the point determination technique was effective in the teaching of addition students with special needs.

3.2. Meta-Analysis Findings

In all studies investigated in this study, effect size calculation was performed by using the Percentage of Non-Overlapping Data (PND) technique. The PND calculation was applied separately for each subject in all the investigated studies. In the studies where there are more than one experiment, PND calculation was done separately for each subject but the averages were taken and processed into the table. Table 5 shows the data on the PND and impact size calculations of the surveys.

Table 5: Calculation of ÖVY and Impact Size of Researches

Researches	PND	Effect Size
Avant ve Heller, (2011)	**92.59**	**Effective**
Cihak ve Foust, (2008)	**97.22**	**Effective**
Yıkmış, (2016)	**88.69**	**Effective**
Elçin, Emecen ve Yıkmış, (2013)	**73.61**	**Medium Effective**

Fletcher, Boon ve Cihak, (2010)	**100**	Effective
Kot, Sönmez, Yıkmış ve İnce, (2016)	**95.83**	Effective
Scott, (1993)	**100**	Effective
Simon ve Hanrahan, (2004)	**100**	Effective
Çalık, (2008)	**100**	Effective
Newman, (1994)	**97.77**	Effective
Kot, Sönmez ve Yıkmış, (2016)	**95.83**	Effective
Average PND Score	**94.68**	**Effective**

The relationship between PND and the independent variable applied is directly proportional. In other words, the greater the percentage of PND in a study, the greater the effect on the dependent variable (Tekin-İftar, 2012). Research in terms of impact levels; 25% and below are ineffective, up to 50% are classified as moderate, and 75% as over effective (Scruggs, Mastropieri and Casto 1987; Karasu, 2009).

When the meta-analysis results obtained from this survey are examined, it is seen that 10 of the studies have changed between 88.69% and 100% of the impact size calculations. The independent variable is effective in these studies. One of the investigated studies (Eliçin, Emecen and Kırıkmış, 2013) has an effect level of 73.61. This study is moderately effective because the non-overlap percentage is below 75%. The meta-analysis findings obtained; shows that the percentage of non-overlapping data of studies included in the study is 94.68% of the averages. According to the criteria determined by Scruggs, Mastropieri and Casto (1987), it can be said that the "touch math technique" is effective in the teaching of the addition of special needs children.

4. Discussion and Conclusion

In this study, it is aimed to determine the effect size of semi-experimental studies with touch math technique and to determine the general effect of this technique on the academic success of special needs students in mathematics courses. In line with this objective, descriptive and meta-analysis of the research in which the touch math technique was used in the field literature between 1990-2017 was performed. In this section, findings for descriptive analysis and meta-analysis are presented under separate titles and are supported by relevant research.

4.1. Evaluation of Descriptive Analysis Findings

In the context of the descriptive analysis findings, the majority of participants were children who were affected by mental disability (N = 15, 44.11%) when examining the participants' identities in the study groups of related studies. In addition to this, the other participants were diagnosed as having autism (N = 6, 17,64%), Down syndrome (N = 4, 11,76%) hearing impairment (N = 3, 8,82%) and physical impairment (N = 3, 8,82%). Although touch math technique is used in various types of disabilities, it is observed that it is used in individuals with mental impairments. In accordance with the relevant research and the findings of this research, it can be said that touch math technique is an effective method in teaching the skills of gathering children with mental disabilities.

It was observed that the independent variables of the related research were teaching the ability to addition (n=9, 69.23%). In one study, both the addition and subtraction process were taught (n=1, 7.69%).

When the related researches are evaluated in terms of publishing year, it is seen that the most frequent publication (30,76%) was made in 2016. The increase in the frequency of publications starting in 1993 (7, 69%) indicates that touch math techniques are among the preferred methods in children with special needs.

4.2. Evaluation of Meta-Analysis Findings

In this study, 11 single subject researches were examined and PND calculations were made. According to the findings obtained from PND calculations, it is seen that the effect sizes of only one study (9.09%) are 'moderate effective' whereas the other studies (N = 11, 90,90) have effect sizes 'effective'.

In this respect, considering the average value (94.68), it can be concluded that the touch math technique used in the teaching of the addition skills is 'effective'.

In conclusion, the findings of the descriptive analysis and meta-analysis obtained from this research show that the touch math technique is effective in the teaching of the addition process skills to the children with special needs.

References

1. Avant, M. J. T. ve Heller, K.W. (2010). Examining the Effectiveness of TouchMath with Students with Physical Disabilities. *Remedial and Special Education. 32 (4) 309-321.*
2. Badır, T. (2014). *Zihin Engelli Bireylere Çıkarma İşlemi Öğretiminde Sabit Bekleme Süreli Öğretimle Sunulan Nokta Belirleme Tekniğinin Etkililiği.* Yayınlanmamış Yüksek Lisans Tezi. Abant İzzet Baysal Üniversitesi, Eğitim Bilimleri Enstitüsü, Bolu.
3. Baykul, Y. (2009). *İlköğretimde matematik öğretimi (10. Baskı).*Ankara: MEB.
4. Bruner, J. S. (1966). Toward a Theory of Instruction, Cambridge: Belkapp Press.
5. Bryant, D. P., Smith, D.D., & Bryant, B.R. (2008). Teaching Students with Special Needs in Inclusive Classrooms. Boston, MA: Pearson Allyn and Bacon.
6. Bullock, J. K., Pierce, S., & McClelland, L. (1989). Touch Math. Colorado Springs, CO: Innovative Learning Concepts, Inc.
7. Cihak, D. F., ve Foust, J. L. (2008). Comparing Number Lines and Touch Points to Teach Addition Facts to Students with Autism. *Focus On Autism and Other Developmental Disabilities, 23, 131–137.*
8. Çalık, N. (2008). *Genel eğitim sınıflarında eğitim gören zihin engelli öğrencilere temel toplama becerilerinin öğretiminde nokta belirleme stratejisinin etkililiğinin incelenmesi.* Yayınlanmamış Yüksek Lisans Tezi. Ankara Üniversitesi, Eğitim Bilimleri Enstitüsü, Ankara.

9. Çiltaş, A. ve Işık, A. (2013). Matematiksel modelleme yoluyla öğretimin ilköğretim matematik öğretmeni adaylarının modelleme becerileri üzerine etkisi. *Kuram ve Uygulamada Eğitim Bilimleri, 13*(2), 1177-1194.
10. Eliçin, Ö., Dağseven-Emecen, D. ve Yıkmış, A. (2013). Zihin Engelli Çocuklara Doğrudan Öğretim Yöntemiyle Temel Toplama İşlemlerinin Öğretiminde Nokta Belirleme Tekniği Kullanılarak Yapılan Öğretimin Etkililiği. *M.Ü. Atatürk Eğitim Fakültesi Eğitim Bilimleri Dergisi, 37, 118-136.*
11. Fletcher, D., Boon., R. T., & Cihak, D. F. (2010). Effects of The TouchMath Program Compared To A Number Line Strategy To Teach Addition Facts To Middle School Students With Moderate Intellectual Disabilities. *Education and Training in Autism and Developmental Disabilities, 45(3), 449-458.*
12. Gürsel, O. (2017). *Özel Gereksinimli Öğrencilere Matematik Beceri ve Kavramlarının Öğretimini Planlama ve Uygulama (1. Baskı).* Ankara: Vize Yayıncılık.
13. Keskin, N. K. (2016). *Otizm Spektrum Bozukluğu Olan Öğrencilere Temel Çıkarma İşlemi Öğretiminde Nokta Belirleme Tekniğinin Etkililiği.* Yayınlanmamış Yüksek Lisans Tezi, Abant İzzet Baysal Üniversitesi, Eğitim Bilimleri Enstitüsü, Bolu.
14. Kramer, T., & Krug, D. A. (1973). A rationale and procedure for teaching addition. *Education and Training of the Mentally Retarded, 10, 96-101.*
15. Kot, M., Sönmez, S., Yıkmış, A. ve Cora-İnce, N. (2016). İşitme Yetersizliği Olan Öğrencilere Eldeli Toplama İşlemi Öğretiminde Nokta Belirleme Tekniğinin Etkililiği. *Current Research in Education, 2(1), 17-28.*
16. Kot, M., Sönmez, S., Yıkmış, A. (2017). Zihinsel Yetersizliği Olan Öğrencilere Toplama İşlemi Öğretiminde Doğrudan Öğretim Yöntemiyle Sunulan Nokta Belirleme Tekniği ile Sayı Doğrusu Stratejisinin Karşılaştırılması. *Ankara Üniversitesi Eğitim Bilimleri Fakültesi Özel Eğitim Dergisi, 18 (2), 253-269.*
17. Nuhoğlu, H ve Eliçin, Ö. (2012). *"Matematik Becerilerinin Öğretiminde Nokta Belirleme Tekniği (TouchMath): Literatür Taraması"* 21. Eğitim Bilimleri Kongresi, İstanbul, Eylül 12-14.
18. Karasu, N. (2009). Özel Eğitimde Delile Dayalı Yöntemlerin Belirlenmesi: Tek Denekli Çalışma Analizleri ve Karşılaştırmaları. *Türk Eğitim Bilimleri Dergisi, 7(1), 143-163.*
19. Kot, M., Sönmez, S., & Yıkmış, A. (2017). Zihinsel yetersizliği olan öğrencilere toplama işlemi öğretiminde doğrudan öğretim yöntemiyle sunulan nokta belirleme tekniği ile sayı doğrusu stratejisinin karşılaştırılması. *Ankara Üniversitesi Eğitim Bilimleri Fakültesi Özel Eğitim Dergisi, 18(2), 253-269.*
20. Newman, T. M. (1994). *The effectiveness of a Multisensory Approach for Teaching Addition to Children with Down Syndrome.* Yayınlanmamı Ç Yüksek Lisans Tezi, McGill University.
21. Öztürk, H. Z. (2016). *Tablet Bilgisayar Üzerinde Eş Zamanlı İpucuyla Sunulan Nokta Belirleme Tekniğinin Rakam-Nesne Eşlemesi Öğretiminde Etkililiği.* Yayınlanmamış Yüksek Lisans Tezi, Abant İzzet Baysal Üniversitesi, Eğitim Bilimleri Enstitüsü, Bolu.

22. Scott, K. S. (1993). Multisensory Mathematics for Children with Mild Disabilities. *Exceptionally, 4, 97-111.*
23. Simon, R. & Hanrahan, J. (2004). An evaluation of the Touch Math method for teaching addition to students with learning disabilities in mathematics. *European Journal of Special Needs Education, 19(2), 191-209.*
24. Spinell, C. G. (2002). Classroom assessment for students with special needs in inclusive setting. New Jersey: Merril Prentice Hall.
25. Tall, D. ve Rashidi-Razali, M. (1993). Diagnosing students' difficulties in learning mathematics. *International Journal of Mathematical Education in Science and Technology, 24*(2), 209–222.
26. Tekin-İftar, E. (2012). *Eğitim ve Davranış Bilimlerinde Tek Denekli Araştırmalar.* Türk Psikologları Derneği, Ankara.
27. Umay, A. (1996). Matematik eğitimi ve ölçülmesi. *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi, 12*, 145-149.
28. Waters, H. E. ve Boon, R. T. (2011). Teaching money computation skills to high school students with mild intellectual disabilities via the TouchMath Program: A multi-sensory approach. *Education and Training in Autism and Developmental Disabilities*, *46*(4), 544–555.
29. Wisniewski, Z. G., ve Skarbek, D. (2002). *How effective is touchmath for improving students with special needs academic achievement on math addition mad minute timed tests.* 18 Haziran 2016 tarihinde http://www.touchmath.com/pdf/Wisniewski-SkarbekPaper.pdf, adresinden erişildi.
30. Vinson, B. M. (2004). A foundational research base for the touchmath program. Retrieved from Touchmath Website: http://www.TouchMath.com.
31. Yıkmış, A. (2016). Effectiveness of the Touch Math Technique in Teaching Basic Addition to Children with Autism. *Educatıonal Scıences: Theory & Practıce, 16(3),1005-1025.*