Elementary Education Online, 11(4), 1121-1130, 2012.
İlköğretim Online, 11(4), 1121-1130, 2012. [Online]: http://ilkogretim-online.org.tr

Pedagogical Materials Use of Primary Grade Teachers in Mathematics Education

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ABSTRACT.As having both visual and tactile appeal, the rationale under the use of manipulative materials is to represent abstract mathematical ideas in an explicit and concrete manner. The focus of the study was on geometry-related course materials indicated in the course curriculum. In this study, the teachers of 4th and 5th grade in mathematics lessons were questioned on their use of instructional materials. The data gathered through an adopted questionnaire form and its use consent was obtained. The sample of the research is 137 teachers of 4th and 5th grades in the 25 primary schools in Kirikkale in 2011-2012 academic year. The findings of the study revealed that primary grade teachers' actual utilization of course materials is not satisfactorily high. Suggestions were made on further research and the limitations of the study discussed as well.
Keywords: Learning aids, pedagogical materials, manipulatives, mathematics education

INTRODUCTION

Learning aids are believed to reinforce the learning since they stimulate, motivate, and activate learners within instructional process. Learning aids, which include visual aids, audio-visual aids, real objects and many others, are instructional materials and devices through which teaching and learning are conducted in educational settings. The use of concrete materials as learning aids has always been intuitively appealing (Thompson, 1999). Today there seems to be a common agreement that effective mathematics instruction in the elementary grades incorporates liberal use of manipulatives as learning aids.

Proposed solutions to overcome the abstractness of mathematics in primary grades education have somehow been linked to the active involvement of children in the learning process and utilization of manipulatives as tangible educational materials since the inventions of ancient counting devices made of beans and stones (Castro, 2006; Driscoll, 1981; Hartshorn & Sue, 1990; Heddens, 1986; NCTM, 1989; Remillard, 2000; Sowell, 1989; Suydam & Higgins, 1977; Uttal, Scudder, & DeLoache, 1997). In the current educational scope, Friedrich Froebel and Maria Montessori have contributed enormously in the idea that manipulatives are important to education by designing several materials to help elementary students learn the basic ideas of math exemplifying geometric building blocks and pattern activity blocks. "Whether termed manipulatives, concrete materials, or concrete objects, physical materials are widely touted as crucial to the improvement of mathematics learning" (Ball, 1992, p. 16). The current study seeks for answers on how frequently manipulatives are being exploited by Turkish classroom teachers for the sake of pedagogical goals at primary settings.

Manipulatives as thinking tools in learning

The concept of educational materials is expected to serve pedagogical goals of the curriculums as developing ideas in depth, promoting sense making, engaging students, and motivating learning. Piaget (1952) implied that children do not possess the mental maturity to grasp abstract mathematical concepts presented in words or symbols alone and require various experiences with concrete materials and drawings for learning to take place. Bruner (1960, 1986) underlined the role of physical objects by maintaining that children present their understandings in three stages of representation as the terms enactive, iconic and symbolic.

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Skemp's (1987) postulations upholded the belief that students' early experiences and interactions with physical objects formed the basis for later learning at the abstract level.

Prior to the early 1990s, manipulatives and learner collaboration were not adequately implemented in elementary mathematics education. The decision of National Council of Teachers of Mathematics (NTCM, 1989) on promoting the use of concrete materials in mathematics teaching played a critical role on the creativity began to emerge in implementation of manipulatives into educational environments. In response to NCTM's (2000) recommendations regarding the improvement of mathematics instruction, manipulatives have become highly popular and very detailed sources of both content and pedagogical information (Trafton, Reys, & Wasman, 2001). This intensive attention on using manipulatives took the form of manipulatives that modeled the addition, subtraction, multiplication, and division students used to have to memorize from practice. In fact, manipulatives can come in a variety of forms and they are often defined as "physical objects that are used as teaching tools to engage students in the hands-on learning of mathematics" (Boggan, Harper, & Whitmire, 2010). Mathematical manipulatives can be classified as commercials and/or teacher-produced ones. Commercial manipulatives are those including tangrams; cuisenaire rods; numicon patterns; Dienes' blocks; interlocking cubes; base ten blocks; pattern blocks; colored chips; links; fraction strips, blocks, or stacks; color tiles; and geo boards (Van de Walle & Lovin, 2005). Teacher-made manipulatives used in teaching place value are listed as beans, bean stick, and popsicle sticks.

In order to help students to construct geometric ideas, concrete educational materials such as geometry rods, geo board, isometric papers, symmetry mirrors etc. are to utilized. This utilization also provides an opportunity for the teacher to assess and meet the needs of primary school students as they construct personal mathematical knowledge. The ultimate goal of using manipulatives in maths instruction is to help children handle abstract concepts and the symbols that are used to represent these concepts. Heddens (1986) claims that 'since all mathematics comes from the real world, the real situation must be translated into the symbolism of mathematics for calculating. Dienes (1961) emphasizes using manipulative in order to provide a concrete referent for a concept, often at more than one level, instead of a referent for a given abstract idea or procedure. Heddens (1986) summarizes the pedagogical influences of using manipulative materials in teaching mathematics as helping students learn: to relate real world situations to mathematics symbolism, to work together cooperatively in solving problems, to discuss mathematical ideas and concepts, to verbalize their mathematics thinking, and to make presentations in front of a large group. The author also maintains that there are many different ways to solve problems and that mathematics problems can be symbolized in many different ways.

On the other hand, as a component of the course curriculum in Turkish primary education program, dynamic geometry software aiding learners in discovering geometry's nature and developing their problem solving skills is regarded as a supportive factor in overall achievement in geometry tasks as a result of some research carried out in the discipline (Battista, 2001; Güven & Karataş, 2003; Johnson, 2002;). Exemplifying, while Breen (2000) found out that computer supported geometry instruction affects 8th graders geometry skills and conceptual development in a positive way, Sarı (2010) obtained the same conclusion with 4th graders.

Considerably, as teacher education programs aim to develop teachers' knowledge of mathematics and their knowledge of students as learners, these programs "should develop teachers' knowledge of and ability to use and evaluate instructional materials and resources" (NCTM, 1989, p. 151). Incorporating the use of manipulative materials in mathematics supports teachers in learning to direct their attention toward the facilitation of students' understanding and conceptualization rather than drill and practice of rote procedures. Mathematical manipulatives play a key role in young children's mathematics understanding and development. These concrete objects facilitate children's understanding of important math concepts, and then later help them link these ideas to representations and abstract ideas. In addition, children often

lead to use manipulatives in a rote fashion, with little emphasis and understanding of the mathematical concepts behind the procedures (Hiebert & Wearne, 1992). Thus, students need to learn to use manipulatives that support and scaffold children's leaming, as opposed to simply making mathematics fun and applicable to children's everyday lives.

Research on Manipulatives in Mathematics

Over the past few decades, researchers have studied the use of manipulatives in several different grade levels and in several different countries (Boggan, Harper & Whitmire, 2010; Cain-Caston, 1996; Castro, 2006; Kelly, 2006). The majority of the studies indicate that mathematics achievement increases when manipulatives are put to good use. Many studies also suggest that manipulatives improve children's long-term and short-term retention of math. Cain-Caston's (1996) research indicates that using manipulatives helps improve the environment in math classrooms. Kelly, (2006, p. 188) posits that "teachers need to know when, why, and how to use manipulatives effectively in the classroom as well as opportunities to observe, first-hand, the impact of allowing learning through exploration with concrete objects". In a study investigating the impact of curriculum materials on the change in teachers' practice revealed that using the materials has changed teachers' instructional practice (Edwards, 1995). Castro (2006) also studied with elementary pre-service teachers and discussed how manipulatives as educational materials are used. The study including the descriptions of learners on how these materials can be used in the classroom pointed out two major outcomes: some students thought that curriculum materials could be used to help students learn, others saw these materials as tools that can support teachers' instructional decisions.

To sum up, while the findings of much research has shown that students who use manipulatives during mathematics instruction outperform students who do not (Driscoll, 1981; Sowell, 1989; Suydam, 1986), some others have shown student achievement levels to be related to teachers' experience in using manipulatives (Sowell, 1989; Raphael and Wahlstrom, 1989). Admittedly, the most important responsibility belongs to the teacher at the point of using of the teaching materials at the teaching process. The teachers who are the practitioners of the curriculum and facilitators of learning environment should be consciously aware of the critical impact of learning materials on providing the pupils with problem solving skills. On the other hand, using concrete materials to teach mathematics is currently a well-established pedagogical strategy throughout the world though, there's no concrete information on how Turkish teachers implement them into their actual teachings. By aiming to purport the manipulative use of Turkish classroom teachers at primary education settings, the current study may serve to raise educational stakeholders' awareness towards the importance of incorporating the manipulatives in mathematical learning process with a focus on geometry.

METHOD

The study aims to determine the views of 4^{th} and 5^{th} grade elementary school teachers about their using level of the teaching materials expressed in Elementary Mathematics Curriculum (1-5 Grades). This survey type research was conducted with 137 classroom teachers who work with 4th and 5th grades in primary schools in Kirikkale. As Karasar (2003, p. 77) expressed, survey type research aim to describe the situation existing as it is. A questionnaire developed by Çekirdekçi (2010) was utilized to gather data by means of authors' written consent. The questionnaire form used in the study contains two parts. First part consists of personal information about the teachers like gender, age, graduation school, and experience. The second part of the instrument consists of a Likert-scale aiming to measure how frequently the participating teachers use materials indicated in the course curriculum. Thus, the items took place in the instrument were determined according to the materials proposed by the curriculum. The items of the likert-type scale ranged from never (1) to always (5). The research question of the study was formulated as below;

1. What are the course materials use frequencies of Turkish classroom teachers at primary grades in mathematics education?

There have been 25 schools, determined by means of an online randomizer tool way, provided information to the current study. The gender and age features of participants were given in Table 1.

Table 1. *Gender and Age Features of the Participants*

Gender	
Male	81
Female	56
Age	
21-30	11
31-40	39
41-50	55
51+	32
Experience	
1-5	5
6-10	14
11-15	29
16-20	24
21+	65

Table 1 portrays the gender, age, and experience features of the participating teachers. According to the table, there are 81 male and 56 female teachers contributed into the study. The age levels of the participating teachers were in the range of 21 to 51 and more but the intensity of the age was observed in 41-50 slot with a number of 55 teachers which also means that the sample is an experienced group of the profession. The third section of the table supports the previously mentioned situation that more than half of the participants spent more than 20 years of their lives with teaching activity.

Table 2 depicts the information on participant teachers' graduation schools and the grades they currently teach.

Table 2. *Graduation Schools of the Participants*

Graduation	
Teacher Training Vocational High School	2
Teachers College	46
Faculty of Arts and Sciences	6
Faculty of Education	70
Others	12
Grade	
4th Grade	62
5th Grade	75

Table 2 points out that while more than half of the participants were graduates of faculty of education, a significant number of them graduated from teacher training high schools which were deceased to serve in Turkey a few decades ago. The tabulation of the grades which were taught by the teachers implies us that there is a balance between the sources of the data in terms

of the grades. The following section will elaborate on the statistical analysis of the collected data.

Data Analyses

The data collected within the current study were analyzed with SPSS 15.0 software package. Chi-square and descriptive statistics including percentages, frequencies, mean, and standard deviation have been used to analyze the data.

The results of chi-square, which is a statistical test commonly used to compare observed data with data the researcher would expect to obtain according to a specific hypothesis, provided no significance and verified the null hypothesis that there is no variance through the data causing from any independent variables such as age, gender, experience, graduation, and grades.

FINDINGS

Table 3. *Descriptives of the Participants' Responses toward the Items in the Instrument*

	Never		Rarely		Sometimes		Usually		Always			
	f	**%**	**f**	**%**	**f**	**%**	**f**	**%**	**f**	**%**	**Mean**	**sd**
Game stamps	12	8.8	19	13.9	66	**48.2**	35	25.5	5	3.6	3.01	.94
Dotted papers	3	2.2	22	15.9	57	**41.3**	37	26.8	19	13.8	3.34	.97
Geometry board	19	13.8	33	23.9	28	20.3	44	**31.9**	14	10.1	3.00	1.23
Isometric paper	9	6.5	18	13.0	40	**29.0**	50	**36.2**	21	15.2	3.40	1.09
Squared paper	1	.7	7	5.1	18	13.0	38	**27.5**	74	**53.6**	4.28	.92
Symmetric mirror	19	13.8	32	23.2	56	**40.6**	28	20.3	3	2.2	2.73	1.00
Graded circle	30	**21.7**	30	21.7	48	**34.8**	24	17.4	6	4.3	2.60	1.13
Circle with hundred	32	**23.2**	32	23.2	37	26.8	32	23.2	5	3.6	2.60	1.18
Table with hundred	8	5.8	25	18.1	31	22.5	52	37.7	22	15.9	3.39	1.13
Tangram	7	5.1	45	**32.6**	44	**31.9**	30	21.7	12	8.7	2.96	1.04
Unit of cube	2	1.4	16	11.6	52	**37.7**	37	26.8	31	22.5	3.57	1.01
Pair cubes	2	1.5	25	18.4	45	**33.1**	41	**30.1**	23	16.9	3.45	1.02
Square	1	.7	3	2.2	26	18.8	41	**29.7**	67	**48.6**	4.23	.88
Tape-measure	14	10.1	21	15.2	48	**34.8**	36	26.1	19	13.8	3.18	1.16
Angle measure	1	.7	4	2.9	18	13.1	41	**29.9**	73	**53.3**	4.32	.86
Real objects and models	3	2.2	3	2.2	22	15.9	50	**36.2**	60	**43.5**	4.16	.92
Geometry software	34	**24.8**	26	19.0	28	20.4	22	16.1	27	19.7	2.86	1.45
Plastic materials	11	8.0	21	15.2	33	23.9	32	23.2	41	29.7	3.51	1.28

One of the prominently attentive results in the table is about teachers' frequency of using squared papers in while focusing on geometry in mathematics courses. The teachers' major responses to the item as always (53.6%) and usually (27.5%) were 81.1% in total.

Similarly, participants' responses of always and usually were observed as 78.3% in total toward the item on frequency of using square in teaching mathematics. Another significant outcome observed in the table is about the use of angle measure that the total of participants' responses as always and usually is over 80% which is a high ratio in essence. The following outstanding result is related to the participants' use of concrete real materials from daily routines including boxes and sugar cubes. The participants who responded this question with always were observed as 43.5% and usually as 36.2%. The total of these two responses was calculated as 79.7%. All these above mentioned materials were reported as being used by more than 75% of the participants at a high frequency in their professional efforts of facilitating pupils' mathematical learning. These findings also supports the study of Çekirdekçi (2010) on the investigation of classroom teachers' use levels of materials indicated within the curriculum. The reason on why teachers prefer to use these materials can be explained with the expanding availability of these materials in the current conditions of Turkish primary level educational settings. Similarly, Toptaş (2008) argues that teachers are tend to use daily materials while helping the learners to get on the target.

In terms of the other items took place in the instrument, teachers underlined that they usually prefer to use geometry boards at a rate of 31.9% in the course. Teachers' responses toward the question of how frequently do they use isometric paper were as follows: always (15.2%), usually (36.2%), sometimes (29.0%), rarely (13.0 %), and never (6.5%). Thus, the highest score of frequency was observed in the response of sometimes in terms of using isometric papers. As showed in the table, teachers' responses toward the item questioning their frequency of using game stamps intensified at the level of sometimes with a percentage of 48.2 which is nearly half of the participant group. This finding may imply that game stamps are not commonly utilized by participant teachers comparing to the other materials in the program.

In terms of the dotted papers, 41.3% of the teachers indicated that they sometimes them in their teachings. The responses of the teachers were intensified in the option of sometimes though, the options of the always and usually were also checked at high rates in total. These findings may be understood as a result of the activity-centered aspect of the new curriculum. Olkun et al., (2008) concluded that activities and real materials have a positive effect on 3rd grades problem solving and comprehension skills. 40.6% of the participants replied the question of 'how frequently do you use symmetric mirror in your teaching?' by checking the 'sometimes' option. Hence, symmetric mirror is not regarded as a required material in the course by the participants of the current study. The rates of the sometimes option decreased to 34.8% when the question is related to the frequency of using graded circle. The items which were checked at the highest rate toward the questions of how frequently do the teachers use unit and pair cube was also sometimes (37.7% and 33.1%) was responded by the participants. The question of 'how frequently do you use tape measure? was also responded by the participants at a higher rate in the option of 'sometimes' (34.8%).

As the third classification of the comments on the data given above, the highest rates of 'never' option was gathered on the item questioning how frequently do the participants use tangram while focusing into geometry teaching in their course (32.6 %). That is to say, the use of tangram is not being preferred by the teachers participated into the current study. Moreover, the data provided in the table 3 also posit that teachers' responses as 'never' towards the items including graded circle, circle with hundred, and dynamic geometry software were constantly remained over 20 %. This relative intensity of the 'never' option implies that mentioned items are not widely considered as vital in teaching mathematics.

DISCUSSION AND CONCLUSION

Use of materials is a key issue for mathematics education in answering the question of how children can be supported in shifting from 'because it looks right' or 'because it works in these cases' to convincing arguments which work in general. The overall implication that can be derived from the discussion above, the materials use of fourth and fifth grades teachers are not

satisfactorily high on teaching geometry as a sub learning domain of mathematics. The general finding of the current study also supports the relevant literature indicating that teachers do know the efficiency of using course materials though; many of them are not so willing to use them (Hamurcu, 2000; Özdemir, 2000; Uçar, 1998; Teker, 2002).

As a destructive factor on the improvement of pupils' mathematical learnings, poor utilization of pedagogical materials in geometry education led some prospective problems in learners' preceding educational periods. In fact, the inadequate attention on geometry education within Turkish education system led a significant low consequence within international measurements of such skills. The relevant literature also maintains that "geometry instruction in Turkish contexts does have some limitations and failures in terms of being comprehended by the pupils" (Yılmaz, Keşan & Nizamoğlu, 2000, p. 569). Respectively, international research reports such as TIMSS and PISA underlines the low achievement levels of Turkish learners. The TIMSS reports published in 1999 clearly points out the degree of Turkey as 31 in Mathematics and 34. in geometry branch (Olkun & Aydoğdu, 2003, p.1). There's also a significant body of research indicating the solid inadequacy of Turkish schoolers in terms of the acquisition of mathematics and geometry (Ardahan & Ersoy, 2004; Olkun & Aydoğdu, 2003; Toptaş, 2008).

In the mathematics classroom, the practical issues of when and how to use dynamic geometry software are also critical. Much previous research with dynamic geometry software has elaborated in students at upper secondary schools where they have received considerable instructional input in geometry, including the proving of elementary theorems, but are new to the particular software tool. The research study reported in this paper also reveals the shortage of using dynamic geometry software. As documented by this study, Turkish classroom teachers are not tend to use dynamic geometry use in teaching in similar with the concrete course materials. The evidence from this study indicates that limited use of dynamic geometry software prevents students to get access to the world of geometrical theorems as a consequence.

In the actual teaching environment, it is no matter how talented all these course materials are. Indeed, the core role of fostering productivity by the help of course materials belongs to the teacher. If the teacher does not fully aware of the educational benefits of these course materials, he might not be so motivated to implement them into the course (Yalın, 1997). That is to say, teacher training programs should focus on providing prospective teachers with a scope of using educational materials efficiently.

A number of caveats need to be noted regarding the present study. The most important limitation lies in the fact that the current study does not have a scope of a profound investigation of the actual use of these materials in terms of effectiveness. The current research was not specifically designed to evaluate factors related to the ways these course materials have been used. This research has thrown up many questions in need of further investigation. Considerably, more work will need to be done to determine the effective techniques to implement manipulatives and other course materials in mathematics education.

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Matematik Derslerinde Sınıf Öğretmenlerinin Öğretim Materyallerini Kullanımı

ÖZ.Materyaller hem görsel hem de dokunsal olarak ilgi çekici olmakla birlikte, açık ve somut bir şekilde soyut matematiksel fikirleri temsil ederler.Bu çalışmanın odak noktası ilköğretim matematik programında belirtilen materyallerdir.Bu çalışmada 4. ve 5. Sınıf öğretmenlerinin matematik derslerinde materyal kullanımlarını sorgulamaktır. Çalışmanın verileri kullanımı için izin alınmış bir anket formu ile elde edilmiştir. Çalışmanın katılımcılarını 2011-2012 eğitim öğretim yılında Kırıkkale il merkezindeki 25 ilköğretim okulunda çalışan 137 4. ve 5. Sınıf öğretmenleri oluşturmaktadır. Çalışmanın bulguları sınıf öğretmenlerinin materyalleri kullanımları yeterli düzeyde yüksek değildir. Çalışmanın bulgularına dayanarak öneriler sunulmuş ve çalışmanın sınırlılıkları tartışılmıştır.
Anahtar Kelimeler: Öğrenme yardımcıları, öğretim materyalleri, matematik eğitimi

ÖZET

Amaç ve önem: Öğrenme araçları, eğitim sürecinde öğrenenleri motive ettiği, onları aktif hale getirdiği için öğrenmeyi teşvik eder ve öğrenme sürecinde öğrenenlere yardımcı olur. Bu öğrenme araçları görsel,işitsel materyaller veya gerçek nesneler olabilir. Öğrenme öğretme sürecinde materyal kullanımının etkili matematik eğitimindeki önemi bugün birçok araştırmacı tarafından belirtilmektedir.Yapılan araştırmalar matematik eğitiminde öğrenme sürecinde materyal kullanan öğrencilerin kullanmayanlara oranla daha başarılı olduklarını göstermiştir(Driscoll, 1981; Sowell, 1989; Suydam, 1986),bunun yanı sıra başka bir araştırmada da öğrencilerin başarı düzeylerinin öğretmenlerin materyal kullanımları ile ilişkili olduğunu göstermiştir(Sowell, 1989; Raphael and Wahlstrom, 1989). Programın uygulayıcısı olan öğretmenlerin materyallerin öğrencilerin öğrenme düzeyleri üzerindeki ve problem çözme becerileri üzerindeki kritik etkisinin farkında olmaları gerekmektedir.Bu nedenle öğretmenleri matematik programında belirtilen materyalleri kullanım düzeylerini görmek adına bu çalışma gerekli ve öenmli görülmektedir.Bu amaçla araştırmanın problem cümlesi'4. ve 5. Sınıf Öğretmenlerinin İlköğretim Matematik Programında belirtilen materyalleri kullanım düzeyleri nedir?' şeklindedir.

Yöntem: Tarama modelinde desenlenen bu araştırmaya Kırıkkale'de 4. ve 5. Sınıf öğretmeni olarak görev yapan 137 sınıf öğretmeni katılmıştır.Karasar'ın (2003,p.77) belirttiği gibi tarama modelindeki araştırmalar mevcut olan durumu ortaya koymayı amaçlar. Araştırmada veriler Çekirdekçi(2010) tarafından geliştirilen bir anket ile toplanmıştır. Kullanılan anket iki bölümden oluşmaktadır,birinci bölümde öğretmenlerin yaşı,cinsiyeti,deneyimleri ve mezun oldukları okullar gibi kişisel bilgiler yer alırken ikinci bölümde öğretmenlerin matematik programında belirtilen materyaller ile ilgili kapalı uçlu sorulardan oluşan beşli likert tipi ölçek(1=hiçbir zaman, 5=her zaman) yer almaktadır. Elde edilen veriler SPSS 15.0 paket program ile çözümlenmiştir.

Sonuç: Araştırmada elde edilen sonuçlara gore öğretmenlerin matematik (1-5) programında belirtilen materyalleri kullanma düzeylerinin yüksek olmadığı görülmektedir.Elde edilen bulgular literatürde yer alan benzer çalışmaların sonuçları ile örtüşmekte olduğu görülmüştür((Hamurcu, 2000; Özdemir, 2000; Uçar, 1998; Teker, 2002).Bu çalışmalarda da öğretmenlerin materyal kullanmanın önemini belirttikleri fakat buna rağmen materyal kullanım düzeylerinin düşük olduğu belirtilmiştir.Bu çalışmada da benzer sonuçlar elde edilmiştir. Çalışmada aynı zamanda dinamik geometri yazılımlarının öğretmenler tarafından az kullanıldığı görülmektedir

Tartışma ve öneriler: Matematik eğitimi sürecinde materyal kullanımı öğrencilerin kalıcı öğrenmelerini desteklemek adına önemlidir fakat araştırmanın sonuçlarına bakıldığı zaman öğretmenlerin yeteri düzeyde materyal kullanmadıkları görülmektedir.Bu konuyla ilgili daha fazla ve uzun surely çalışmalar yapılmalıdır.Bunun yanı sıra materyallerin daha etkili bir şekilde matematik eğitiminde nasıl kullanılabileceği üzerine çalışmalar yapılması önerilebilir.