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ICT INTEGRATION INTO GEOMETRY INSTRUCTION: REFLECTIONS FROM A MIXED-MODEL INQUIRY*

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Abstract

This study aimed to investigate the effects of computer aided instructional applications on mathematics teacher candidates' geometry success and determine their perceptions on learning and teaching geometry supported by software. The study is a parallel-simultaneous mixed method research due to use of qualitative and quantitative data together. Within the scope of the research conducted, 30 teacher candidates attending Department of Elementary Mathematics Education at Eskişehir Osmangazi University Faculty of Education were selected as the participants of the study. The results of the research show that Geometer's Sketchpad (GSP) course applications ensure teacher candidates to increase their geometry success with also respect to t-test results. It is understood teacher candidates find the software activities and spreadsheets sufficient, especially in demonstration of proofs. The computer aided –student centered instructional method used in this research takes positive reaction by the candidates and software language, tutorial time and the physical characteristics of schools take attention as the critique aspects of applying software tutorials. The participants also noted that the way of development of software activities and spreadsheets affects the way of choosing suitable approach for the instruction.

Keywords: Computer aided instruction, mixed-model inquiry, geometry instruction.

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GEOMETRİ ÖĞRETİMİNE TEKNOLOJİ ENTEGRASYONU: BİR KARMA MODEL İNCELEMESİNDEN YANSIMALAR

Özet

Bu araştırmanın amacı bilgisayar destekli öğretim uygulamalarının öğretmen adaylarının geometri başarıları üzerindeki etkisini ve yazılım destekli geometri öğrenme ve öğretmeye yönelik görüşlerini belirlemektir. Nitel ve nicel verilerin aynı süreçte toplanmasından ötürü çalışma paralel-simültane karma model bir araştırma olarak desenlenmiştir. Araştırmanın çalışma grubunu Eskişehir Osmangazi Üniversitesi Eğitim Fakültesi İlköğretim Matematik Öğretmenliği Programı'nda öğrenim gören dördüncü sınıf öğrencisi 30 katılımcı oluşturmuştur. Çalışmanın sonuçları deneysel desen kapsamında toplanan verilerden nicel olanların çözümlenmesi sonucunda, Geometer's Sketchpad (GSP) ders uygulamalarının öğretmen adaylarının geometri başarılarını arttırmada ön test son test puan ortalamalarında anlamlı farklılık yaratmıştır. Nitel yordamın izlendiği bölümde ise gerek araştırmacı günlüğü gerekse katılımcıların görüşlerinde yazılım etkinliklerinin ve çalışma yapraklarının yeterli görüldüğü, özellikle kanıtların gösteriminde yararlı olacağı görüşünün hakim olduğu ortaya çıkmıştır. Araştırmacı tarafından işe koşulan öğrenci merkezli bilgisayar destekli yöntem olumlu karşılanmış, katılımcılar yazılım dili, tanıtım haftalarının kısalığı ve fiziksel şartların yazılım uygulamalarını etkileyen unsurlar olduklarını belirtmişlerdir. Katılımcılar aynı zamanda yazılım etkinlikleri ve çalışma yapraklarının düzenlenme biçiminin öğretmen olduklarında kendi seçecekleri öğretim anlayışını etkileyeceğini belirtmişlerdir.

Anahtar Kelimeler: Bilgisayar destekli öğretim, karma model incelemesi, geometri öğretimi.

Summary

Learning geometry is an important part of mathematical ability. Computer algebra systems and geometry softwares present quite advantageous samples for manipulating geometric and numeric realities. Among these, Geometers Sketchpad is an example for tools manipulating geometric objects. For applying such tools for instruction, it is important to determine how eager teacher candidates are for using this technology in their lessons and, to what extent they improve their achievement scores by using such tool in order to determine their level. In this regard, this study aimed to determine the outcomes of software use within the context of geometry instruction. Participants consisted of 30 fourth-year elementary mathematics teacher candidates attending Eskişehir Osmangazi University, Faculty Of Education. A parallel-simultaneous mixed methodology was conducted to collect both qualitative and quantitative data at the same time. The experimental part of the study is designed by pretest-posttest experimental design without a control group and one researcher used a diary during all nine-week research process. After the intervention, a semi-constructed interview was conducted to collect additional qualitative data.

The instruments of the study are the Geometry Achievement Test (GAT) and a semi-constructed interview form developed by the researchers. GAT consisted of 20 multiple-choice questions and was developed to determine geometric achievement related to the sub-learning areas “Geometric Locus”, “Polygons”, “Angles”, “Circle”, “Transformation Geometry”, ”Triangle” and “Trigonometry”. After the pilot study, KR-20 method was applied and the reliability coefficient of the test was found 0,782. The second instrument of the study is the semi-constructed interview form including ten questions. The two-part form’s first part is about software activities and spreadsheets and another part consisted of five questions aiming to collect qualitative data about participant views on computer aided instruction method applied by the instructor.

The results of the study show that GSP course applications ensure teacher candidates to improve their geometry success with also respect to the t-test results. There was a significant difference between pretest and posttest scores related to the GAT. On the other hand, the results of descriptive analysis of the qualitative data show all participants receive the instructional process positively. The participants mostly emphasize on the concepts “instructional relevance”, “instructional value”, “ease of use”, “eagerness”, “classroom management”, “guidance”, “interaction”, “time” and “hardware conditions”. Taking into account these concepts and accompanying themes, it is suggested to conduct descriptive studies by using the themes and concepts as the preliminary components of quantitative instruments. İt is suggested to develop more comprehensive manuals and Turkish packages for softwares in order to make the interfaces more clear.

Introduction

It seems that teachers' "guidance counselor" role and students' "basic skills" are emphasized for the most part of the new practice with a general outlook on the elementary mathematics curriculum in Turkey from 2004 to nowadays. Teachers are expected to play a leading and facilitating role, interact with students personally and guide them taking into account their learning styles and basic skills. Besides, a positive understanding about personal qualifications is important for performance in this new age.

As is known, newly developed tools affect technical aspects of technology while technology produces new tools. This "simbiotic pair" also affects education and instruction. There are surprising developments in technology making every researcher need to be more competent about information technologies and develop an understanding about technology in universities. In geometry, having various visual components, benefiting from the advantages of technology is becoming more and more important from the point of instruction. One of the most challenging aspects of integrating technology into education in Turkey is to classify the concepts "computer aided instruction" and "computer aided education". On the other hand, there are studies emphasizing seemly correct language about use of computers. In a study about computer aided instruction, two types of computer use are emphasized:

1- Computers for education
2- Education for computer (Çetin, 2007).

Within the scope of the mathematics curriculums, there are various suggestions related to technology. Owing to the fact that constructing geometric shapes, demonstrations of theories and measurements require more specific environments for teaching and learning; teachers are suggested to use dynamic geometry softwares for geometry learning area and sub-learning areas. Geometer's Sketchpad (GSP), Cabri and Cinderella are three most common software packages applicable for dynamic geometry in terms of their advantages. Functional use of technology gains importance every day, owing to the fact that information technologies are "agents of knowledge". The rate in the shrinking half-life of knowledge requires both more urgent, creative decisions related to technology integration, and also conducting studies aiming to point out several outcomes of this process. There are various recent studies emphasizing on different perspectives related to technology integration and its effects on the stakeholders of education (Baytak, Tarman and Ayas, 2011; Divaharan, 2011; Herron, 2010; Hock, 2008; Javeri and Persichitte, 2007; Koh and Divaharan, 2011; Searson, Laferriere and Nikolow, 2011 and Yidana, 2007.) With a general outlook on these studies it can be said that successful applications related to integrating technology into education requires attentive planning and expertise. The results of the studies also make the stakeholders rethink instructional design with respect to the suggestions.

Rogers' (2003) Theory of Diffusion of Innovations (DoI) provided a theoretical framework for this study. According to Rogers (2003), the diffusion is defined as "the process by which an innovation makes it through a social system" (p.5) and the innovation is defined as "an idea, practice or object that is percieved as new by the individual"(p.12).

Rogers (2003) also describes the different categories of adopters of technology. The innovators have the ability to understand complex technical knowledge and the ability to cope with a high degree of uncertainty. Early majority serve as role models for the other members of the society and considered opinion leaders. Another group is the early majority who rarely hold positions of leadership opinion. Opposite to early majority, late majority is cautious and unwilling to risk scarce resources. Finally the laggards are the last group who hold on traditional values. A classroom as a social system can discuss an innovation from different perspectives. As newly learnt softwares, technological tools and ideas are integrated into classroom settings, adopters of technology can present good examples for researchers and practitioners. Taking into account these thoughts, it might be said teacher candidates are an important community for reflecting the impressions of technology integration, especially for the qualitative part of this study. On the other hand, in order to make the adopters of technology learn the content knowledge comprehensively, there are several theoretical approaches and models to refer to the research processes. In this direction, another framework for this study can be derived from advance organizer models. Further research on advance organizers after the thesis indicates that spreadsheets used within the context of computer aided instruction is related to advance organizers. In this direction, a more current model suggested by Joyce, Weil and Calhoun (2000) has three phases as follows:

Phase I (includes presentation of the advance organizer)

- Clarify the aims of the lesson
- Presentation of the advance organizer
- Prompting awareness of relevant knowledge

Phase II (includes making links to/from the organizer)

- Presentation of the learning task or learning material
- Make organization and logical order of learning material explicit

Phase III (strengthening of the cognitive organization)

- Integrative reconciliation and active reception learning
- Elicit critical approach to subject matter.

The advance organizers model suggested here meshes with the spreadsheet use during the lessons aided by GSP software. Especially the first item of each phase directly describes why this study used spreadsheets as advance organizers. During the use of spreadsheets, the instructor clarified the aims, explained the learning material and the context of the activities and gave further examples about each topic. Ubuz and Üstün (2004) examined the effectiveness of spreadsheets on GSP aided seventh grade Geometry lessons by applying a pretest-posttest experimental design with a control group. The findings of the study show there was no significant difference between groups within the context of software application.

For the past two decades, the quality of learning outcomes related to computer aided instruction has shown rapid growth due to the developments in technology and technology

integration. These two issues have many effects on both quantitative and also qualitative research studies. The changing world becomes more and more challenging and applications promoting learning and studies purposing to increase the quality of instruction gain importance.

Spatial visualization and visualization itself play important roles for manipulating dynamic geometry objects. Dixon (1995), conducted a quasi-experimental study about limited English proficiency and spatial visualization ability effects on middle school students constructing the concepts of reflection and rotation. 2D visualization skills on dynamic geometry environment are examined and the case of difference between the group with high English proficiency and the group with limited English proficiency according to aforementioned skills was tried to be determined. According to the findings test results show that courses aided by GSP software help students increase their levels related to rotation and reflection topics. Another finding is that there was no significant difference between limited English proficiency group and the group which the students are good at English.

Choosing a strategy about how to teach geometry is closely related with having an understanding about elements of geometry and approaches applied for instruction.

> "Give a man a fish and he will eat for a day. Teach him to fish and he will eat for a life time."
>
> *Chinese Proverb*

The most important advantage of computer aided education is probably that students can explore instructional content with their own pace and practice the topics (Baki and Öztekin, 2003). This advantage can also be seen in new constructivist curriculums. Teachers should not begin their lessons taking into account what they know on their own. They should begin taking into account what students know exactly (Titiz, 2005). It is also thought that teachers should give a chance to make them reason, explore and make mistakes about instructional content. Especially for exploration phase, geometry has several interceptions with dynamic geometry softwares. Softwares like Geometer's Sketchpad, Cabri and Cinderella are important by means of their manipulation feature. The biggest advantage of this feature is probably that students can interact with instructional content related to the geometric topic.

Tuluk (1997), conducted a study about Logo Mathematics effects on teacher candidates purposing to make them gain experience in learning and teaching mathematics concepts with Logo. The course called Logo-Mathematics lasted 12 weeks and polygons, circumference, area calculations and geometric transformation topics were studied on a Logo based environment. An ethnographic methodology with observations, diaries and interviews were used. The results show that teacher candidates have positive reactions towards Logo and they seem to use computer aided instruction in the future. At the end of the activities teacher candidates begin to look from a conceptual view on elementary mathematics. Thanks to experiences in applications teacher candidates who were not accustomed to "drill and practice" began to reason their own mathematics learning strategies. Besides, it is thought that determining how eager and prepared the teacher

candidates are for applying dynamic geometry software should be discussed as a preliminary study. All these thoughts and importance of the study lead the researchers to the following problem statement and sub-problem statements arisen.

Problem Statement

How the dynamic geometry software experiences of elementary mathematics teacher candidates affect their geometry achievement and what views do they have on such a practice?

Sub-Problems

1- Is there any significant difference between pretest and posttest scores related to "Geometry Achievement Test"?
2- How do teacher candidates construct their knowledge in the lessons aided by dynamic geometry software?
3- What views do teacher candidates have about the software activities and instructional content used in the study?

Significance Of The Study

The following aspects make this study important for literature and practitioners:

- There are a few comprehensive studies emphasizing that there is a need for experimental studies within the context of educational technology literature (Nolen, 2009; Ross, Morrison and Lowther, 2010). Rather than making a comparison as in the true experimental designs, this study aims to determine whether educational use of the dynamic geometry software is an effective and yielding way to learn or not. Thus, the experimental design here investigates the effectiveness and the qualitative part emphasizes on educational yields.
- Within the scope of the study, it is aimed to develop a source booklet including activities and spreadsheets for both students and lecturers.
- The handout for the software may be helpful for people who are interested in dynamic geometry softwares. Also, the instructional content developed may be useful for educators who apply dynamic geometry into instruction.
- The results of the study are important to the stakeholders of both educational technology researchers and mathematics education researchers, as it has been designed as a mixed-model study.

Limitations

Although the study has researcher qualifications and hardwares-software potentially, there are certain limitations as well. These limitations can be specified as follows:

- 30 fourth-year, elementary mathematics education students attending Eskişehir Osmangazi University, Faculty of Education,

- The characteristics of items and questions involved in the Geometry Achievement Test (GAT) and the semi-structured interview form,
- The hardware and software conditions of the laboratory that the participants used and
- The content of the spreadsheets and the handout developed by the researchers.

Methodology

Within the context of this study the effect of computer aided instruction method teacher candidates' experiences and views regarding the intervention period were investigated. A mixed method research approach was used to implement the study. Sng and Gribovskaya (2008) note that conducting mixed method studies in universities is useful for evaluating teacher training curriculums and such interpretative studies contribute various experiences related to specific applications. The main methodology used for this research study consists of an experimental design with no control group, accompanied by interviews and research diaries. The qualitative part of the study served a supportive character for quantitative process, and intended an evaluative comprehension.

The participants of the study consisted of thirty elementary mathematics teacher candidates selected purposely from Eskişehir Osmangazi University, Faculty of Education. Participants were attending their fourth year at the university in 2007-2008 academic year. A pre-interview was conducted and teacher candidates commenting having no dynamic geometry software experience were selected for intervention to implement the experimental phase. A stratified sampling method was used to select the interview group. A threesome level group answering the GAT as the pretest and posttest was formed and every group had three teacher candidates ranked in the top three in high, average and low achievement scores. After selecting nine participants a teacher candidate ranked fourth in the average score level that had the same score with the thirth candidate in their level was added to the interview group. Thereby ten teacher candidates were interviewed to collect qualitative data about the experimental design. The names of the participants were remained confidential and changed randomly for whole of the study period.

The main instrument of this experimental study is the "Geometry Success Test" (GST) developed by the researchers. GST consists of 20 multiple choice test items related to topics in geometry learning area in secondary school mathematics curriculum in Turkey (National Ministry of Education, 2009). The test items were prepared with respect to sample characteristics in order to present a suitable framework. To achieve this goal, two experts of the field were asked for advice and after the reducement of the number of the items, test was ready to use. After the pilot study KR-20 method was applied and the reliability coefficient of the test was found 0,782.

The spreadsheets presented with GSP activities in computer aided lessons were another instrument for this study. The development of the spreadsheets was conducted with respect to topics in geometry learning area in elementary school mathematics curriculum in Turkey (National Ministry of Education, 2009). The instruments were organized carefully in order to design a suitable framework for the software activities.

In order to collect data about the views on GSP course and computer aided instruction method a semi-constructed interview was made. According to Patton (2001), such interview ensures every participant to take place in the same framework. The interviewer is free to explore, deepen and ask questions about a particular subject. The following principles were taken into account while preparing the interview form (Yıldırım and Şimşek, 2006):

- Write out apparent questions
- Prepare specific questions
- Ask open-ended questions and avoid to guide the participants
- Prepare alternative questions and probes
- Arrange questions in a feasible way and write out different questions.

There are ten questions in the interview form five of them are related to the software activities and spreadsheets and another five were asked to collect data about views on computer aided instruction process. Both of two interview sections had alternative questions like “Another issue to emphasize?” or “Any suggestions?” to make participants more open.

The researchers made pre-interviews with three teacher candidates in order to examine whether interview questions present a suitable framework. After the interviews two experienced instructors were asked to indicate the validity of the form. To prevent missing data during the pre-interviews all three interviews were recorded by a sound recorder. During nine weeks of research process impressions about participants’ experiences were written out by the researchers. Such research diaries included not only things remembered related to lessons but also notes taken during activities. Based on some cases encountered during lessons impressions about pleasing or challenging characteristics of the lessons were noted. At the beginning of the research process teacher candidates were made a pre-interview in order to determine whether they have any experiences in using GSP software. Teacher candidates having no GSP experience were presented GAT test as the pre-test and these participants were selected as the study group of the research. During nine weeks of GSP lessons participants’ experiences during software activities and spreadsheets were observed in a participative manner. These observations were recorded and revised in a diary. After the GSP lessons teacher candidates were presented the posttest. The stratified sampling implemented with respect to the posttest and pretest score differences as aforementioned in the instruments section. The researcher used a sound recorder and the views recorded were written simultaneously. The answers to interview questions were carefully transcribed and thematized by the researchers. Two main themes were interpreted together with the diary notes. The whole study was implemented according to a parallel-simultaneous mixed method approach and Figure-1 summarizes the research process for the study:

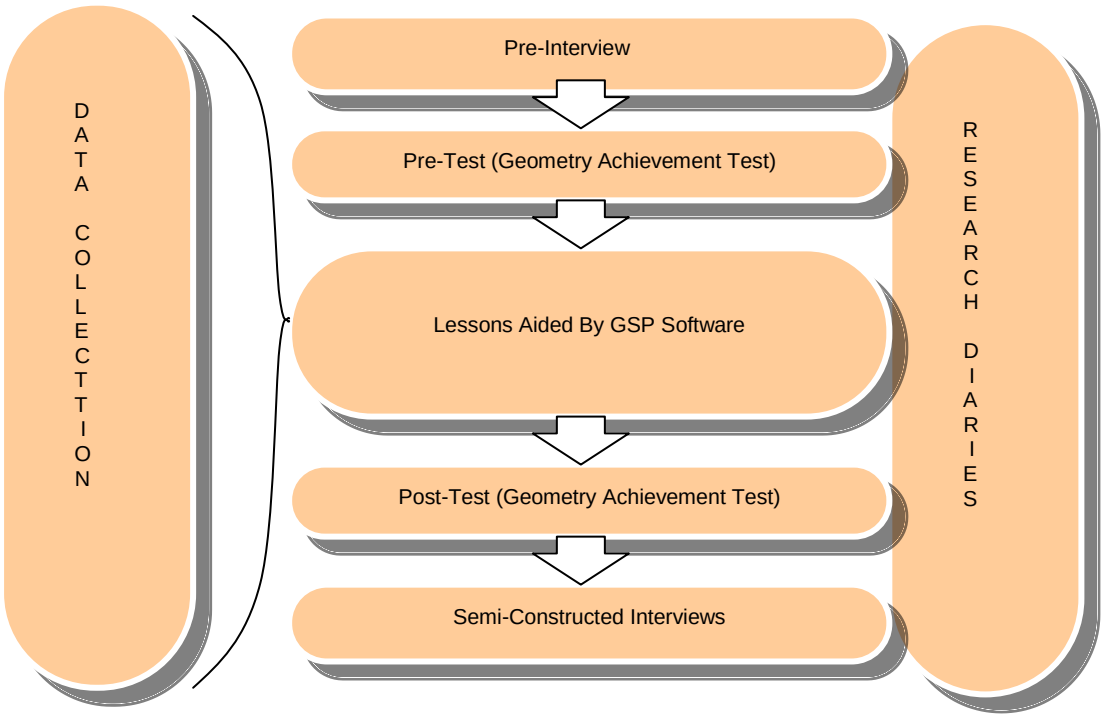

Figure 1. Parallel-Simultaneous Research Process

Data collected for the experimental phase of the study were analyzed by SPSS 15.0 and paired samples t-test was conducted to determine whether there was a significant difference between pretest and posttest scores. Next, the qualitative phase of the study began with descriptive analysis of the comments of participants in order to discover sub-themes and concepts related to the sub problem statements. As aforementioned research process also includes collecting data from the research diaries and descriptive analysis of the qualitative data. For these analyses, all qualitative data were arranged with respect to the two main themes: “Effects of The Instructional Content” and “Effects of The Computer Aided Instruction Method”.

Findings

In this section, teacher candidates’ interactions and achievement related to the technologically aided environment and how they feel about the applications will be explained with respect to the data analyzed.

Change in Teacher Candidates’ Geometry Achievement

The pre-interview showed that none of thirty teacher candidates attending experimental phase had no GSP experience before. With respect to the experimental design, whether pretest and posttest scores have significant difference was examined by use of paired samples t test. Table 1 shows the test results:

Table 1: The effect of GSP aided course applications on teacher candidates' geometry achievement

Instrument	N	X	Std. dev.	t	p
Pretest	30	12,30	2,21	-12,280	p<0,001
Posttest	30	16,46	1,54		

Findings of Table-1 show that GSP aided course application had a positive effect on teacher candidates geometry preparedness with respect to the t test results (p<0,05). According to the method of scoring (20 the most) posttest mean score is 33,82 per cent higher than pretest mean score, which increased from 12,30 to 16,46.

Knowledge Construction During Lessons

During the first two weeks of the experimental phase, teacher candidates were given notes about the software interface and menus. When they began to study on these introductory activities they hesitated to interact and thought that they had a full plate but when they were given the first activity the feeling instantly recognizable as a drawback dwindled. The researcher touched on this case in his diary as follows:

> "I am very glad of students' attitudes today. But i think the English interface may cause some problems. I was surprised when Onur wanted a list of the command of the software. I will pay attention to be careful about this situation next week. I was trying to use familiar words but I must deepen my deal of introduction."
>
> (Diary Notes-Week One)

Teacher candidates were more confident during the second week of the experimental phase and apart themselves from the bias of the first week. They had difficulty in interacting with the empty screen first week but during the second lesson they were more capable of coping with the interface problems. The following notes reflect the feelings about second week:

> "We completed the introductory activities today. The animation activity made students attendant and this makes me be excited about next week. All the students draw the parabola by animation commands. I think they were successful in describing points important for constructing the animation. For example Deniz was the most successful participant in expressing the animation process. "
>
> (Diary Notes-Week Two)

By the end of the first three weeks of experimental phase, teacher candidates were aware that GSP was not very different from the paper-based work and compatible with postulates of Euclidean Geometry. GSP additionally enables the user to manipulate the geometric objects and examine theorems and also proofs.

Views on GSP Software and Instructional Content

Most of the participants evaluate GSP aided lessons taking into account their practical training at secondary schools. Ayla, commented with these feelings as follows:

> "This software is useful, I think. We forgot some commands as we attend this lesson once a week. I would be more capable of doing the activities if i have the software. Actually I am interested in softwares like GSP. I learnt MS Excel on my own. I think we should work on the activities ourselves more but with your help it was also all right."

The above views of Ayla can be interpreted as she is interested in software but however she had problems about software language and criticized the lesson duration for each software activity. On the other hand Sencer made an interpretation about sub-learning areas and this witnesses to the concept "instructional suitability":

> "We can lecture about angle measurements lengths and correlates. These activities can enable students to construct shapes."

Most of the teacher candidates thought some additional features and theorems in GSP can be integrated to the curriculum. For example Nursel and Ahmet thought Euler Line can be integrated as it is eye-catching and Ayla agreed with them commenting that it can improve students' interest. Ismet stated that Bottema Theorem can be fun for students. On the other hand, Özgün complained that they did not encounter with sufficient number of proofs:

> "These theorems should be integrated to the curriculum. We for example, did not use any activities like these before and when we attend lessons at university we understood that we imagine a totally different ball game."

Secondary school mathematics curriculum has various inter-disciplinary and within-disciplines associations and "Patterns and Tesselations" sub learning area is one of these associations. Sencer, having homework in another course about patterns and tessellations sub learning area did his homework also with the help of GSP and made an interpretation about this help:

> "We know that when we divide any term following the thirteenth term with the previous one in a Fibonacci sequence we get the Golden Ratio. So when we first teach this we can tell golden ratios on quadrilaterals and pentagons with GSP."

Teacher candidates tried to comprehend the theorems they did not know with the help of GSP and geometric principles they already know. The density of the instructions in the

spreadsheets was more important because of this adaptation process. Özgün and Ahmet thought that the density of the spreadsheets was low and Ayla, finding spreadsheets suitable, thought that they should be evaluated in terms of their importance and the number of spreadsheets should not always be increased in order to ensure instruction of good quality.

Views on Computer Aided Instructional Method

The answers to the questions "How did you find the strategies while conducting the lessons?" and "What would you do if you were me?" showed that teacher candidates give importance to the technical aspects of the method. Sencer made the following comment:

> "It was quite impressive when you first explain what we will do and taking care of every student is a positive and important characteristic of this lesson, I think. If I were you the way of teaching would be connected with the level of my experience of GSP but I could not be interested as you are. I would give importance to interesting examples because even a story makes students more curious about the lesson. I mean I would make them dabblers about that and then I would teach them by practice."

Sencer's views show that he gives value to the computer aided instructional method and thinks that teachers should be as active as the students. Indeed, teacher candidates performances related to the lessons of the theorem demonstrations were quite satisfying. The diary notes about this situation are summarized as follows:

> "Most of the students were more successful than previous weeks. The interpretations about Pythagorean Theorem were better than those they made about elements of triangles. I think they have enough time to teach like this and may prefer to lecture with respect to geometry tests."
>
> (Diary Notes-Week 7)

Lecturing with respect to the traditional approaches may be easier for some teacher candidates. Or they may take the teacher at the training school they attend this year as an example. Also this situation may be addressed to already-known competitive educational system. Some of the participants commented they might prefer traditional and new approaches together for that reason. Teacher candidates were a bit surprised about what they saw during this course. Sencer's views about this situation are summarized as follows:

> "Geometry is one of the most enjoyable courses of my life. I felt very excited with this software and lessons and I understand that I can do my best this strengthened my past feelings."

By the end of the interviews teacher candidates were asked whether they know software evaluation criterion or not. Although none of them commented they know the criterion, their thematized views characterized and got along with the criterion. The themes gained from the views were addressed to the concepts “ease of use” and “instructional value” and combined with the themes “a visual software”, “the belief related to memorability”, “noticeability” and the belief related to “instructional progress”. Figure 2 summatizes all comments leading to a structure, emphasizing on media and method:

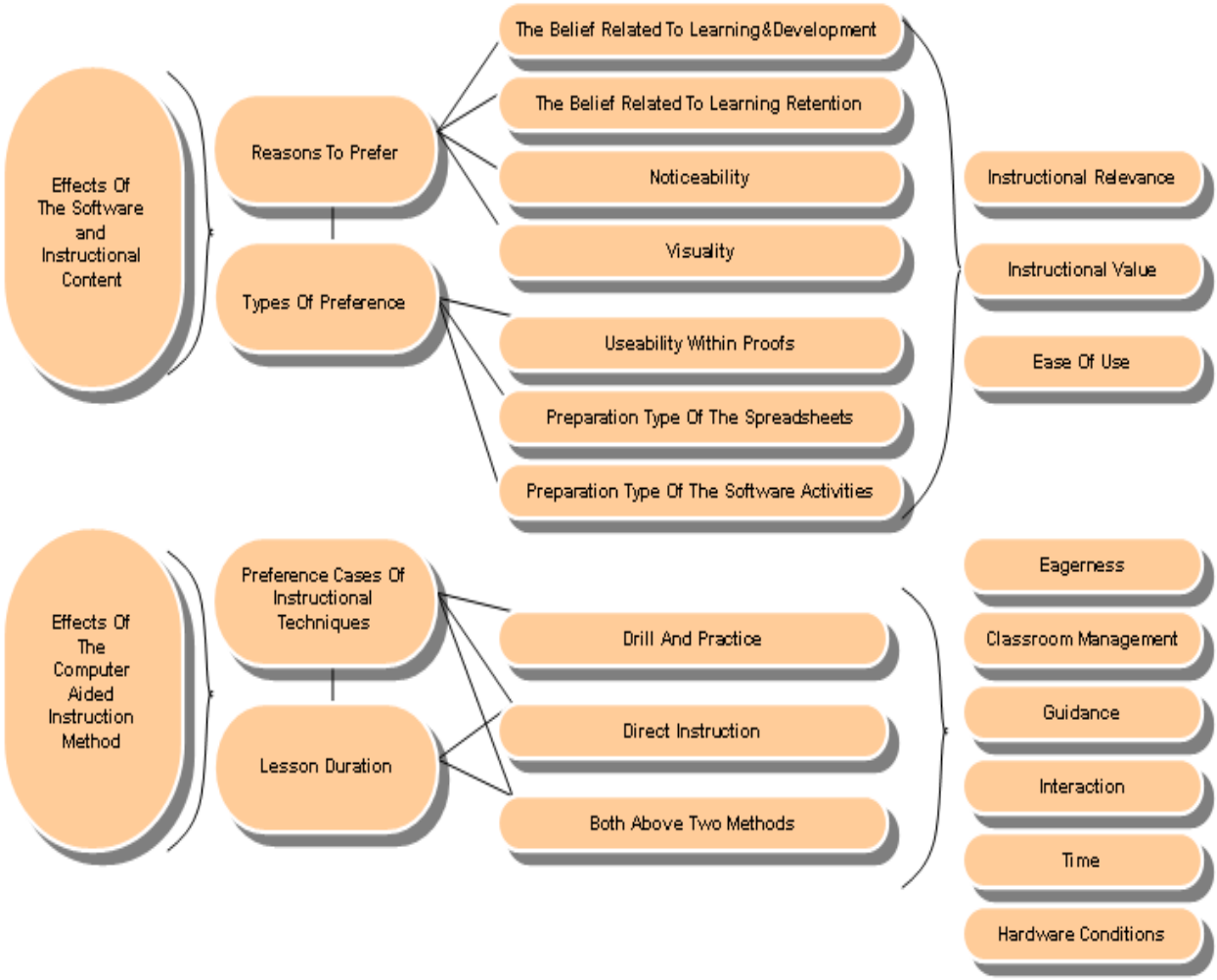

Figure 2. Themes and Concepts

With a general outlook on this research, one can say CAI method made teacher candidates make effort to learn the software and interpret theorems. They sometimes made self-evaluations and draw attention to the conditions of the instructional environment.

Conclusion and Recommendations

The results of this study show that geometry lessons aided by dynamic geometry software enhance teacher candidates’ achievement. Also their views on the whole study seem quite positive. The strong bias at the beginning of the lessons was less when the post test was implemented. As opposed to these positive impacts, there were some

disadvantages of the software usage as the students had difficulty in remembering the interface and menus at the beginning of the lessons. Although the students were accustomed to spreadsheets this difficulty caused some disadvantages during the first lesson. Even so, most of the students completed the spreadsheets correctly.

One important result of the study is that all of the teacher candidates found software activities useful, especially for proofs. They also associated this with theme “instructional value”. Answers to the interview questions seeking whether teacher candidates would prefer using software activities and instructional content at schools show they appreciate technical aspects of the software. The type of preparing the activities affects the type of preferring the software according to the comments.

Evaluating the computer aided instructional method; teacher candidates pointed out those using spreadsheets during the activities would make the students more eager to take place in a participative lesson. They strongly lay emphasis on “interaction with the instructor” and “guidance” issues.

The most conspicious concept in the answers to the interview questions was “time”. As a result, teacher candidates believe duration of a lesson determines the primary method of instruction. Another point to be considered was that cognitive complexity the students had during the lessons because of the interface language. It is suggested that additional Turkish packages should be used or Turkish manuals to the software should be delivered.

The current study offered teacher candidates an opportunity to experience a new technology-supported learning environment and touched on both their previous experiences with technology in geometry learning and teaching, and also the newly-learnt approach to geometry. The findings of the study could also serve as a guide for future studies on technology integration in Turkish universities and institutions of education. Researchers are suggested to design studies with at least two intervention groups in order to apply a true experimental research comparing the possible effects. Besides, teachers are suggested to determine students’ geometry achievement levels taking into account their ability of imagining geometric shapes and studying direct and indirect proofs. Preparing flexible and practical activities and being a role model for students, teachers should make students adapt to personalized learning methods and present examples of programmed instruction for them. It is believed that this will prevent the approach “Just lecture tediously and go on with another exercise”.

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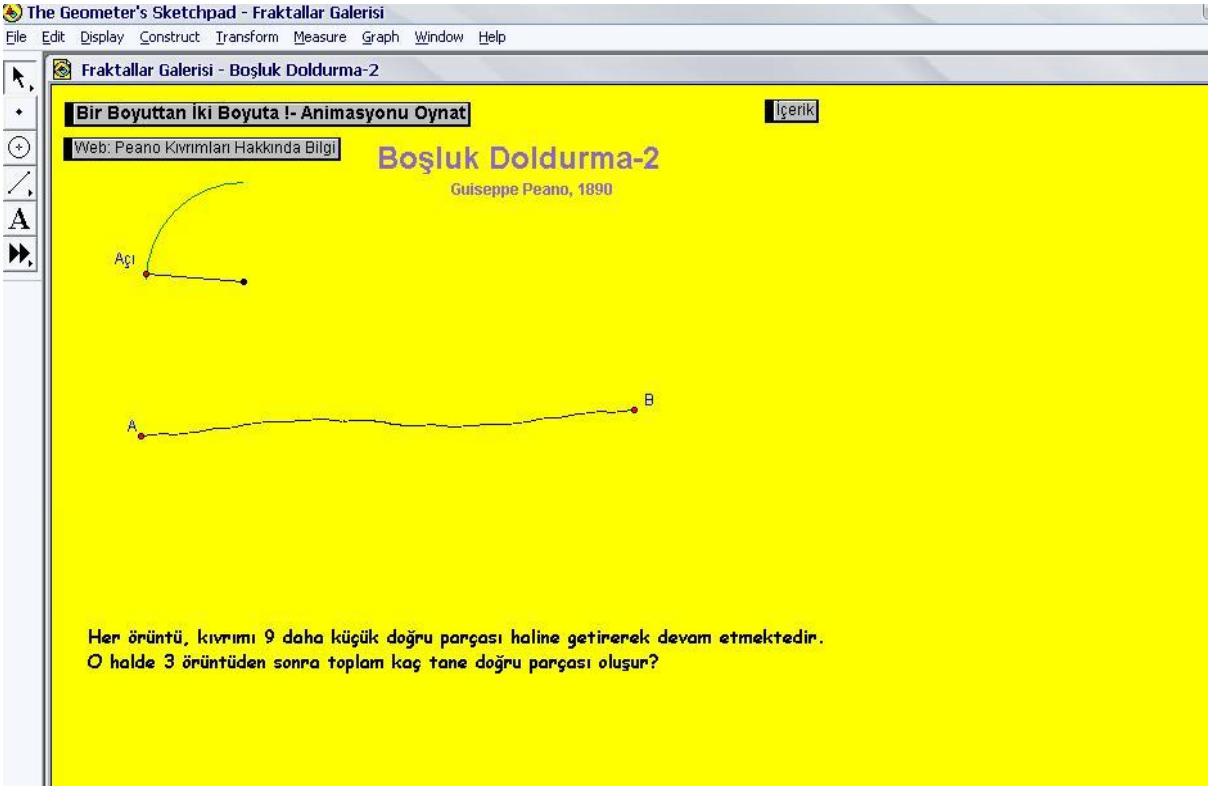
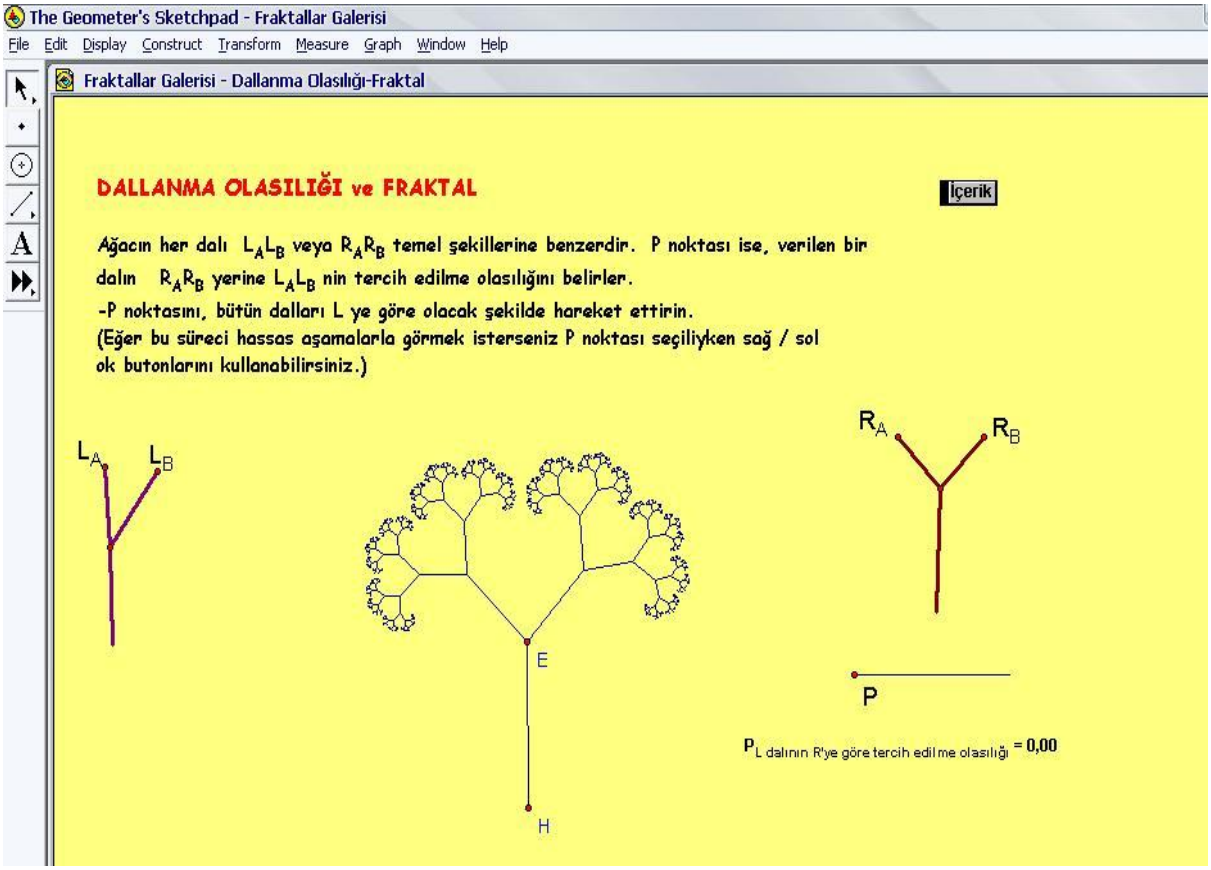
Appendix A- Sample Spreadsheets And Software Activities*

Week Eight: Transformation Geometry, Iteration and Tesselations





* Software activities were chosen and translated from legal content, from the public domain sites: http://jwilson.coe.uga.edu/EMT668/GSP.library.html and http://www.dynamicgeometry.com.

SPREADSHEET-6

Lesson: Transformation Geometry, Iteration And Tesselations

Purpose : Help learn how to transform and iterate, touch on interesting features of tesselations.

Learning Area : Transformation Geometry, Iteration And Tesselations

Competencies : **1.** Explains the reflection
2. Explains the rotational movement
3. Rotates and draws shapes with respect to a particular angle and about a point in a plane.
4. Determines the symmetries of geometric objects.

Exercise-1: Kaleidoscope and Transformation Geometry

1) Open the activity "Kaleidoscope-1".

- Change BAC angle by dragging B or C edges. You can use left or right arrow in order to get more sensitive angle measurements.
- Now can you make two generalizations about reflections you made? Fill in the blanks in the table below and test yourself.
  (Hint: BA and CA segments are reflection directions.

BAC Angle (degree)	Number Of Couple Of The Shapes That Reflect	Number Of Total Reflection Directions
45^0	8	
60^0		6
	5	5
120^0		3

*90^0 and 180^0 are not here due to a possible confusion about determining the number of reflection directions and mirrors.

Generalizations I Made:……..
……
……

2) Now you can make a kaleidoscope animation by applying the following instructions. Make more transformations in order to increase the attraction of the kaleidoscope.

- Construct three telescopic circles that have similar radius.
- Hide the points on the circles and place points one for each.
- Construct quadrilateral edges on three points and center. Paint inside of the quadrilateral.
- Now use Rotation movement and increase the number of the quadrilaterals.

A question: What should you be careful about in order not to overlap two quadrilaterals? (What should you do before determining the rotation angle?)

……
……

- Give different colours to the quadrilaterals

Soru: Is there another transformation to incrase the number of the quadrilaterals? Explain how.

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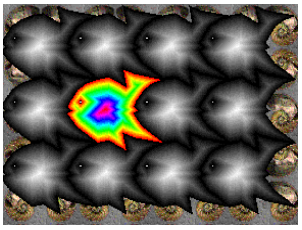
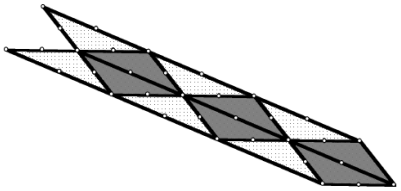
- Now select the three points on the circles and apply Display > Animate Points

Exercise-2: Iteration And Tesselations



1) Which transformation geometry was used in the "Fish tesselation"? Explain the transformation.

2) Explain the transformation(s) made in the tesselation on the right. (All the triangles are equal.)



3) Open the "Fractals Gallery" activity.

-Write down the iteration rule applied in the "Gap Filling-1" activity.

-The iteration in the "Gap Filling-2" activity is made by a rule based upon constructing nine smaller segment of the loop, at every turn. Then, How many segments do you get after three iteration process?
(You can see the first segments by applying Display > Show All Hidden.)