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Evaluation of use of Graphics Interchange Format (GIF) animations in mathematics education

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This study investigates opinions of Grade 12 students about the use of Graphics Interchange Format (GIF) animations in mathematics lessons. It explores the ways of making mathematics easier and more understandable for students by demonstrating whether or not GIF animations that emerged from the integration of technology into mathematics education appeal to students both visually and educationally, and how mathematics education can be made more visual and educational through GIF animations. Here, survey model was selected and used from research models. The research sample consisted of forty-one science students in two schools (Anatolian High School and Science High School) affiliated to the Ministry of National Education in Igdir in the 2016-2017 academic year. 20 GIF animations taken from various local and foreign sites were used as materials. For data gathering, an evaluation form was used in which the participants were asked to assess whether the GIFs were educationally and visually competent, and if not, to express their reasons. The results revealed that five GIF animations were visually inadequate in general by students whereas ten GIF animations were found to be educationally inadequate. The students stated that the reasons for visual inadequacy were: containing foreign words, being too fast, being slow and boring, being colorless and not being understandable. The reasons for educational inadequacy were: not being academically clear and understandable, being confusing, lacking numerical values, writings not being in Turkish, and being irrelevant to everyday life. Students said that they encounter GIF animations more in social media, and were surprised to see GIF animations used in mathematics education, but after the application they thought that it would be useful.

Key words: GIF, mathematics education, geometry, visuality, instructiveness.

INTRODUCTION

Learning environments that are changing along with technological and scientific developments bring into question multi-learning environments that appeal to more than one sensory organ and require interaction with the

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student. In addition, it enriches teaching environments by facilitating the design of teaching materials suitable for different student characteristics, and creates efficient learning environments by facilitating access to teaching environments (Akkoyunlu and Yilmaz, 2005).

A substantial amount of money is spent on technology by schools, families and policymakers with the hope of improving educational outcomes (Bulman and Fairlie, 2016). This is because the ability of students to use information and communication technologies effectively and efficiently can be achieved through the integration of these technologies into classroom environments (Ozan and Tasgin, 2017). In order to be able to educate individuals who access and use information, teachers should use educational technologies effectively in the teaching-learning process, have necessary knowledge, skills and attitudes, and also have teaching environments equipped with adequate educational technologies (Adiguzel, 2010).

Today, the use of technology in educational environments is generally done through computers. Computers are of great importance in terms of bringing abstract mathematical concepts to the screen and materializing them (Baki, 1996). The recall rate of the information presented in a computer environment is 50% or more, and all of the learning styles other than motion and sensory behavior are realized better in the computer environment. This is because the activities in the virtual environment assist motor behavior in grasping reality (Karadogan and Arslan, 2004).

The ability to move mathematical formulas, relations, and algorithms to the screen facilitates analytical understanding while enabling symbolic and graphical transitions. As calculations, solutions, models, graphics are transferred to electronic environments; they lead to new insights, predictions, generalizations and discoveries (Baki, 2006). Computer-aided visualization of mathematical operations and algorithms that are difficult to understand and explain facilitates learning. At this point, some changes and different points of view in mathematics education have taken place. One of these changes is the use of animated Graphics Interchange Formats (GIFs) in mathematics education. Animated GIFs have recently gained more popularity on social networking sites. But even with advances in video technology and access to higher bandwidth connections, tiny low-resolution, silent, motion pictures are increasingly popular online. These animated images named as Graphics Interchange Format (GIF) have become a common part of everyday Internet life. Animated GIFs play increasingly important roles in social media, delivering breaking news, telling stories through photo-journalism, and enabling new ways to express emotions (Bakhshi et al., 2016).

Animation, interpreted as visualization in Turkey (Bingol, 2004), is the artificial animation of many pictures and graphics within certain scenarios (Celik, 2007; Bingol, 2004). The feeling of motion is created by juxtaposing same images and graphics with small differences and displaying these rapidly, and animated images and graphics enable us to obtain videos that are impossible to capture in real life due to their size, speed and complexity (Bingol, 2014). GIF animation is a kind of picture, which is created by displaying a sequence of frames (Karadogan and Arslan, 2004), composed of several pictures where we see these pictures in sequence (Bulbul and Ilgun, 2015). Today 'GIF' is typically used to mean an animated GIF file or an otherwise short, silent, looping, untitled moving image. It has a creator who is unknown or deemphasized; it is encountered by an individual viewer on a personal screen where it is surrounded by text and other media; and it is shared casually as a form of identity-making, known as a cinema of affiliation (Eppink, 2014).

In the study of Maruya et al. (2016), it was concluded that using a visual stimulus was found to have a significant effect. Animation presentation was found to provide understanding of information and to facilitate learning. Animations must be slow and clear enough for observers to perceive movements, changes, and their timing, and to understand the changes in relations between the parts and the sequence of events (Tversky et al., 2002).

In their study, Bulbul and Ilgun (2015) showed 20 Animated GIFs to 75 teacher candidates and identified some GIFs as adequate and others as inadequate (4, 7, 12 and 20). Being incomparable, lack of clarity, faintness, not having a purpose, not being interesting, lack of information, discoloration, unnecessary drawing, not using three-dimensional drawing, uneven size or smallness, amateurism of drawings were identified as causes of visual inadequacy. For educational inadequacy, lack of information, being too fast, inappropriate level, wrong information, missing explanation, wrong arrangement, lack of detail, not being catchy, not being fit for every situation, not being provided in a known context, and foreign words were prominent causes of inadequacy. When these inadequacies were evaluated, not being clear, discoloration, being confusing, not being attention grabbing, and being too fast were specified for visual inadequacies; while not being at the appropriate level, not being focused, lack of detail, not having a purpose, insufficient duration, wrong information and missing information were brought forward as causes of educational inadequacy.

The current study is important in terms of exploring the ways of making mathematics easier and more understandable for students by demonstrating whether or not GIF animations that emerge from the integration of technology into mathematics education appeal to students both visually and educationally, and how mathematics education can be made more visual and educational through GIF animations. In addition, it is

thought that this study will serve as a reference for making GIFs more suitable, organizing GIFs for mathematics education, and production of new GIFs that are more suitable for their purpose, by revealing advantages and disadvantages, both educational and visual, of GIFs that can be used in mathematics lessons in accordance with the views and opinions of the students. Moreover, because of the lack of such studies in Turkey, it is also innovative and it is thought to contribute to the body of literature. The purpose of this study is to investigate the opinions of Grade 12 students about the use of animated GIFs in mathematics lessons. From these explanations, the problem statement of this study can be expressed as follows: What are the opinions of students about GIF animations used in mathematics lessons? The sub-problems are as follows:

1. What are the ideas of students about GIFs as visual and educational?
2. What are the visual inefficacy reasons of students about GIFs?
3. What are the educational inefficacy reasons of students about GIFs?
4. What are the evaluations of students about animated GIFs in the consequence of interviews?
5. Is there a significant relation between the evaluations of students about GIFs? (In terms of visual and educational efficiency)

METHODOLOGY

Research model

In this study, survey model was used from research models. Survey models describe a situation in the past or present as it is. The individual, subject or object that is being investigated is defined as it exists in its own conditions, and no effort is made to alter or influence it. The important thing is to be able to observe and determine what is being investigated in an appropriate way (Karatas, 2012). In order to investigate the effectiveness of GIF animations in the 12th grade mathematics education of secondary schools, to demonstrate both the visual and educational shortcomings and advantages, and to guide those who will benefit from these GIFs as well as to present the features to be looked for in existing GIFs, the written feedbacks obtained from the evaluation forms filled out by the participant students were evaluated and the problem statement of the study was attempted to be answered.

Population and sample

The population of the present study was composed of 12th grade students in science classes of all Anatolian and Science High Schools in the city of Igdir. The sample of the research consisted of a total of forty-one 12th grade students who receive education in science classes in two schools (Anatolian High School and Science High School) affiliated to the Ministry of National Education in Igdir in the academic year of 2016-2017. The participants were senior students at high schools and they were seventeen years old. Fifteen of the participants were male and twenty six of them were female. In order to ensure that participants' responses to GIFs are more reliable, the study was conducted during the undergraduate placement exam preparation period after the transition to higher education examination, towards the end of the semester. The study has been carried out with mathematics teacher candidates before by Bulbul and Ilgun (2015), and evaluations of high school students on the topics regarding the GIF animations have been taken within the scope of the present study. In this study, the related GIF animations will be assessed by students as both visual and educational advantages and disadvantages will be revealed. The students who attended the present study were from Anatolian and Science High Schools in Turkey. The students were settled to these schools by an exam called the exam of transition from primary to secondary education. The students in these kinds of schools are successful and selected students. In obtaining reliable data about GIFs, it is important to work with these kinds of students. This is the reason why purposive sampling was used in the present study. Purposive sampling involves selection of rich cases in terms of information in the context of the purpose of the research for making in-depth investigation (Buyukozturk, 2012).

Materials and research process

GIF animations were shown to students using Power Point software. Each GIF animation was placed on a separate Power Point slide, and assigned a number. Each GIF was watched twice by students. In the first viewing, no explanation was given for the related GIF, and after the second viewing, all students were asked to give their opinion, that is, discuss the subject that the GIF was about, its deficiencies and good aspects. On top of this, sufficient time was awarded and participants were asked to write their thoughts in the specific section for the relevant GIF animation. Same procedure was followed for all GIFs. No information and comments were given during the application, and the teacher performing the application acted only as a guide. The mathematics teachers of the so called students made the application mentioned and got the evaluation forms from students at the end of the application. While getting the ideas of students, the same math teachers noted the answers of students. Within the scope of the research, 20 GIF Animations were used as materials. These GIFs were taken from various domestic and foreign sites and their sources are listed below for guidance to readers (Table 1). These GIFs were preferred because they were very common in various digital environments (especially social networking sites) and were compatible with the high school curriculum. These GIFs, which teachers and students will often come across and want to benefit from in mathematics education, have been evaluated in terms of their visual and educational adequacy and shortcomings within the framework of this study. In this context, it is thought to be a guide for both teachers and students.

Data collection tool

As a data collection tool, a GIF evaluation form prepared by Bulbul and Ilgun (2015) aiming to reveal the participants' opinions about GIFs was used. In this evaluation form, participants were asked to evaluate whether the 20 GIF animations used in the study are educationally and visually adequate, and if not, to express the reasons. That is, the evaluation form was divided into 2 sections, "Visually" and "Educationally", and each section had adequate-inadequate choices and a comment section that could be filled out for any option. The participants were asked to write their opinions in these sections. The reliability analysis of the evaluation form was made for the present sample. The Cronbach alfa value was found as 0.865. It means that the reliability of it is quite high. The evaluation form is as seen in Figure 1.

Data analysis

In this study on whether the GIF animations that can be used in the

Table 1. Subject and access information of used GIFs.

Subject of GIF	Source accessed
1.Derivative of Sinus	https://onedio.com/haber/calculus-dersinde-ogretilenden-daha-iyi-matematik-konsepti-anlatan-gifler-351429
2.Matrix transposition	https://en.wikipedia.org/wiki/File:Matrix_transpose.gif
3.Radiant	https://en.wikipedia.org/wiki/Radian#mediaviewer/File:Circle_radians.gif
4.Hyperboloid	http://media.tumblr.com/c89bb90680fdc87ecd132937bf01b0e9/tumblr_inline_n78cu4p15H1s1jww5.gif
5.Outer angles of polygons	https://onedio.com/haber/calculus-dersinde-ogretilenden-daha-iyi-matematik-konsepti-anlatan-gifler-351429
6.Sin & Cos	http://www.akampus.com/matematik-derslerinde-size-yardimci-olabilecek-birbirinden-ilginc-11-gif
7.Hyperboloid	https://onedio.com/haber/calculus-dersinde-ogretilenden-daha-iyi-matematik-konsepti-anlatan-gifler-351429
8.Hyperbola	https://giphy.com/gifs/hyperbola-13fQobpekBVfMs
9.Pythagorean Theorem	https://giphy.com/gifs/animated-math-nerdgasm-FGN3UskNkgG76
10.Factorization	http://image.mathcaptain.com/cms/images/40/foilmethod.gif
11.Ellipsis	https://giphy.com/gifs/educational-ellipse-Qk5fIr8LRYACI
12.Reimann Sum	https://giphy.com/gifs/math-mathematics-calculus-zTGUlIASZx83u
13.Tangent Lines	https://giphy.com/gifs/make-finance-mNc1D6DZJ7dkY
14.Pascal triangle	https://en.wikipedia.org/wiki/Pascal%27s_triangle#mediaviewer/File:PascalTriangleAnimated2.gif
15.Pi number	https://commons.wikimedia.org/wiki/File:Pi-unrolled.gif
16.Projection	https://onedio.com/haber/calculus-dersinde-ogretilenden-daha-iyi-matematik-konsepti-anlatan-gifler-351429
17.Circle Projection	http://www.businessinsider.com/7-gifs-trigonometry-sine-cosine-2013-5
18. Conversion from Cartesian to multiple coordinates	https://en.wikipedia.org/wiki/User:LucasVB/Gallery#mediaviewer/File:Cartesian_to_polar.gif
19.Parabola	https://giphy.com/gifs/educational-definition-parabola-rVKNdcrBEihUs
20.Sin & Cos Triangles	https://giphy.com/gifs/make-finance-CqLieMymr6ztK

12th grade mathematics education of secondary school are visually and educationally adequate, in which GIFs that are deemed inadequate are justified by the students, percentage distributions of the answers were performed with the aim of providing a guide for both teachers and students. In addition, deficiencies have been identified by taking into account the comments made by students regarding GIF animations that were deemed visually or educationally inadequate.

FINDINGS

In order to determine the adequacies related to GIF animations, the evaluation form was applied to the student groups in the two schools as a data collection tool. Adequate-inadequate options for each GIF animation to be evaluated educationally and visually were taken into account, and the percentage, frequency table was prepared (Table 2). Looking at Table 2, it can be seen that GIFs 16, 13, 20, 10, and 5 were deemed visually inadequate by a majority of the students as indicated by the analysis based on the adequate-inadequate options. Educationally, GIF animations 16, 4, 7, 5, 17, 8, 15, 18, 2 and 20 were found to be inadequate. In order to enable a high level of utilization of GIF animations, a threshold of 35% and above was set, and GIFs that were found to be inadequate were listed. In addition, when the overall responses were taken into account, GIFs 3, 9, 14, 12, 6 and 19 were found to be considerably adequate on the visual scale. GIFs 9, 12, 3, 6, 14 and 19 were found to be considerably adequate on the educational scale. In addition, looking at the comments given by students for each corresponding GIF animation in the evaluation form, the reasons for visual inadequacy can be listed as shown in Table 3. Looking at Table 3, the reasons for visual inadequacy and the percentages of answers are as follows: containing foreign words (10%), being too fast (11%), being slow (7%), boring (11%), being colorless (8.3%) and not being understandable (53%). Also, looking at the comments given by students for each corresponding GIF animation in the evaluation form, the reasons for educational inadequacy can be listed as shown in Table 4.

* Üniversite, fakülte, bölüm, anabilim dalı, il, ülke
** Üniversite, fakülte, bölüm, anabilim dalı, il, ülke

GIF Evaluation Form						
GIF	As Visual			As Educational		
	Sufficient	Insufficient	Because…	Sufficient	Insufficient	Because…
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						

Figure 1. GIF evaluation form.

Table 2. Percentage frequency distribution of the data obtained from the evaluation form.

GIF animation	Categories							
	Visually				Educationally			
	Adequate		Inadequate		Adequate		Inadequate	
	f	%	f	%	f	%	f	%
1. Derivative of Sinus	32	78	9	22	30	73	11	27
2. Matrix Transposition	29	70	12	30	27	65	14	35
3. Radiant	40	97	1	3	33	80	8	20
4. Hyperboloid	33	80	8	20	24	58	17	42
5. Outer angles of polygons	27	65	14	35	25	60	16	40
6. Sin & Cos	36	87	5	13	33	80	8	20
7. Hyperboloid	31	75	10	25	24	58	17	42
8. Hyperbola	29	70	12	30	26	63	15	37
9. Pythagorean Theorem	38	92	3	8	34	82	7	18
10. Factorization	27	65	14	35	30	73	11	27
11. Ellipsis	34	82	7	18	29	70	12	30
12. Riemann Sum	37	90	4	10	34	82	7	18
13. Tangent Lines	26	63	15	37	28	68	13	32
14. Pascal Triangle	38	92	3	8	33	80	8	20
15. Pi Number	35	85	6	15	26	63	15	37
16. Projection	23	56	18	44	18	43	23	57
17. Circle Projection	31	75	10	25	25	60	16	40
18. Conversion from Cartesian to multiple coordinates	33	80	8	20	26	63	21	37
19. Parabola	36	87	5	13	33	80	28	20
20. Sin & Cos Triangle	26	63	15	37	27	65	14	35

* Üniversite, fakülte, bölüm, anabilim dalı, il, ülke
** Üniversite, fakülte, bölüm, anabilim dalı, il, ülke

Table 3. Reasons for visual inadequacy

Reasons	f	%
Containing foreign words	7	10
Being too fast	8	11
Being slow	5	7
Boring	8	11
Being colorless	6	8.3
Not being understandable	38	53

Table 4. Reasons for educational inadequacy.

Reasons	f	%
Not being academically clear and understandable	32	41
Being confusing	13	24
Lacking numerical values	9	12
Writings not being in Turkish	6	8
Being irrelevant to everyday life.	12	15.3

Looking at Table 4, reasons for educational inadequacy and the percentages of answers are as follows: not being academically clear and understandable (41%), being confusing (24%), lacking numerical values (12%), writings not being in Turkish (8%) and being irrelevant to everyday life (15.3%).

In the interviews made with students in both schools after the application, students stated that they encounter GIF animations more in social media, they were surprised to see GIF animations used in mathematics education, but after the application they thought that it would be useful. When the students were asked for the reasons for this, they stated that specific topics and graphical changes that are extremely difficult and time consuming to draw, that need to be demonstrated in a step-by-step manner, or explained in a way where the verbal definition is given but no concrete example is provided, actually become more understandable via GIF animations.

Based on the interviews made in the classroom, it was found that the most intriguing and educational GIF animations according to the students were the ones related to Riemann sum, derivative of sinus, exterior of polygons, factorization, angles, Pi number, Pascal triangle, radiant and Pythagorean theorem. For example, in the GIF animation related to Riemann sum, when the area between the function and the axes is calculated, the difference in the area can be clearly seen by the students as the number of rectangles drawn increases. Another point that draws the attention of students related to this GIF is that rectangles can be drawn with different dimensions. GIF animation related to the derivation of the sinus function corresponds to the geometric representation in multi-representation. The most common criticism raised for this GIF by students was that it was too fast. Pythagorean theorem is a theorem that is frequently confronted in the secondary education curriculum and said to be simple, but often not fully understood by the students. In this study, the GIF animation that demonstrates the relationship between the Pythagorean theorem and area-volume was found to be educational and interesting by the students.

Table 5. Chi-square independence test related to evaluations of students about GIFs.

Parameter	Value	p
Pearson Chi-Square	570,185	0.000

Looking at Table 5, it can be said that there is a significant relation between evaluations of students about GIFs (in terms of visual and educational efficiency) (X^2=570,185, p<0.01).

CONCLUSION AND SUGGESTIONS

The current study questions the usability of GIF animations, a technological tool that is rarely used in mathematics education. GIFs 16, 13, 20, 10, and 5 were deemed visually inadequate by a majority of the students. Educationally, GIF animations 16, 4, 7, 5, 17, 8, 15, 18, 2 and 20 were found to be inadequate. In addition, when the overall responses were taken into account, GIFs 3, 9, 14, 12, 6 and 19 were found to be considerably adequate on the visual scale. GIFs 9, 12, 3, 6, 14 and 19 were found to be considerably adequate on the educational scale.

Based on the application and the data obtained, it was found that using GIF animations can be useful in learning mathematical concepts, algorithms, relations and structures. In addition, visual and educational inadequacies and deficiencies of some existing GIF animations used in this study were identified. To repeat these, it can be listed as being too fast, containing foreign words, being slow and boring, lack of numerical values, being confusion, being colorless, not being clear and understandable, and not being related to everyday life. Also, there is a significant relation between evaluations of students about GIFs (in terms of visual and educational efficiency).

The current study is in line with Maruya et al. (2016) and Tversky et al. (2002) because of the students' views that GIF animations can be useful to learn mathematical concepts, algorithms, relationships and structures, that is, to facilitate learning and enable perception. The study is also in line with Bulbul and Ilgun (2015) due to the students' reasons that GIFs contain foreign words, they are slow, they are not clear, they are confusing, they are discolored and they are boring.

Within the scope of the current study, the following recommendations can be made:

(i) One of the conclusions of the literature review is the limited number of GIF animation examples for mathematics education. This leads to problems such as using GIF animations, recognizing and accessing them. This situation is one of the reasons that led to this study. One of the recommendations that can be expressed in this context is the diversification and development of GIF animations that can be used in education by people who are in the field of mathematics education (especially academics, teachers, etc.). In the process of teacher training and in-service training given to teachers, how to prepare a GIF animation on any mathematical subject or concept can be included in the curriculum within the scope of Technological Field Information or Material Development courses. If the most common misconceptions in the literature are investigated, the subjects on which GIF animations need to be prepared can be identified. Increasing amount of academic work on GIF animations and the sharing of findings and results of these studies will allow for better utilization of GIF animations.

(ii) New GIF animations can be created in class activities via group work with the help of applications about concepts and subjects that are not understood or hard to understand. Thus, students are actively involved in learning activities. In addition, project or performance tasks can be given on mathematical concepts after the necessary preliminary information is provided.

(iii) In today's rapidly changing and developing world, in order to keep up with this change and development, we have to raise who can understand mathematics, know the terminology of mathematics, use mathematics knowledge and skills in daily life problems, have basic mathematical skills such as problem solving, association and reasoning, who are able to analyze, and generalize by making assumptions. One of the most important conditions to fulfill this obligation is to use technology in mathematics education correctly, in place and effectively. Educational materials should also show development in parallel with technology. The fact that materials in mathematics education are abundant and useful makes it easy to transfer information as well as to activate learning environments. Learning will be permanent if the material used has visual and educational characteristics that are relevant to the topic. In order to create educational environments that are suitable for their purpose, it is necessary to employ computers in general and Internet and software applications in particular.

(iv)Taking into account the results of the research carried out, it is recommended that the necessary arrangements be made in line with the views submitted on the relevant GIFs or the establishment of new GIFs in this respect. It is also recommended that appropriate GIFs be prepared or existing ones be translated, taking into account the foreign language levels of the participants.

(v)The so called GIFs found visually and educationally adequate can be suggested to be used by all mathematics educators from high schools and universities for better understanding.

(vi)The study is limited with 20 GIFs popular on websites and 41 students evaluating them. That is why we recommend that the number of GIFs can be increased and the participations can vary (especially academicians, teacher candidates, students in several grades…). So, GIFs can be evaluated and new mathematics materials can show up. The workbooks can be supported by CDs full of GIFs from different topics in mathematics.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

REFERENCES

Adıguzel A (2010). Ilkogretim okullarinda ogretim teknolojilerinin durumu ve sinif ogretmenlerinin bu teknolojileri kullanma duzeyleri. Dicle University J. Ziya Gokalp Faculty Educ. 15:1-17.

Akkoyunlu B, Yılmaz M (2005) Türetimci çoklu ortam öğrenme kuramı. Hacettepe University J. Educ. 28:9-18.

Bakhshi S, Shamma DA, Kennedy L, Song Y, de Juan P, Kaye JJ (2016, May). Fast, cheap, and good: Why animated GIFs engage us. In Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems. ACM. pp. 575-586.

Baki A (1996). Matematik öğretiminde bilgisayar her şey midir? Hacettepe University J. Educ. 12:135-143.

Baki A (2006). Kuramdan uygulamaya matematik eğitimi. Trabzon:Derya Bookstore.

Bingol B (2014). Coklu ortam (multimedya) tasarimi ıceren lisans derslerinde ogrencilerin video ve animasyon konulari hakkindaki bilgi düzeyi: Görsel ıletisim tasarimi ogretimi uzerine bir arastirma. Dumlupinar University J. Soc. Sci. 39:159-172.

Bulman G, Fairlie RW (2016). Technology and education: Computers, software, and the internet. National Bureau of Economic Research (NBER) Woking Paper Series.

Retrieved from http://www.nber.org/papers/w22237.pdf 27.08.2017.
Bulbul MŞ, Ilgun Ş (2015). Matematik egitiminde kullanilabilecek bazi gif animasyonlarindaki gorsel ve egitsel ozellikler. Sustainable and Accessible Sci. Educ. Magazine 1(1):11-20.
Buyukozturk S (2012). Örnekleme yöntemleri. Retrieved from http://w3.balikesir.edu.tr/~msackes/wp/wp-content/uploads/2012/03/BAY-Final-Konulari.pdf
Celik E (2007). Ortaogretim cografya derslerinde bilgisayar destekli animasyon kullaniminin ogrenci basarisina etkisi. (Unpublished master's thesis) Marmara University Institute of Educational Sciences, Istanbul.
Eppink J (2014). A brief history of the GIF (so far). J. Visual Culture. 13(3):298-306. Retrieved from http://journals.sagepub.com/doi/pdf/10.1177/1470412914553365
Karadogan S, Arslan H (2004). Cografya egitiminde etkilesimli coklu ortam (mm) uygulamalari, animasyonlar ve onemi. East Geography Magazine. 11:247-260.
Karatas S (2012). Bilimsel arastirma yontemleri. Retrieved from file:///C:/Users/User/Downloads/B%C4%B0L%C4%B0MSEL+ARA%C5%9ETIRMA.pdf
Maruya T, Tano SI, Hashiyama T (2016, July). Preliminary quantitative evaluation of effect of learning from text, illustrations, and animations on understanding. In International Conference on Human-Computer Interaction. Springer International Publishing. pp. 249-254.
Ozan C, Tasgin A (2017). Ogretmen adaylarinin egitim teknolojisi standartlarina yonelik oz yeterliklerinin incelenmesi. Educ. Technol. Theory Practice. 7(2):236-253.
Tversky B, Morrison JB, Betrancourt M (2002). Animation: can it facilitate? Int. J. Human-Computer Stud. Special issue: Interactive Graph. Commun. 57(4):247-262.