Effect of Teaching Geometry by Slow-Motion Videos on the 8th Graders' Achievement

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Abstract—This study aims to investigate the effect of slow-motion videos use on the 8th graders' achievement in geometry and identify the students' views about the slow-motion. The study was carried out in a quasi-experimental environment on 74 eighth graders of two different classes. One of the classes was designated as the experimental group (n=38). The other class (n=36) were designated as the control group, the results showed that the achievement level of the students who attended the geometry lessons using the slow-motion mode was higher than those who attended the traditional method lessons. Furthermore, the results showed that the experimental group students found that learning through slow-motion was information, easily understandable, beneficial, instructive, stimulating, enjoyable, very creative.

Keywords—Bruner Model, Geometry, Lesh Model, Mathematical Achievement, Slow-motion

1 Introduction

Slow-motion animation videos (SMV) are a new teaching method, developed over the last decade in the classes of science teaching in Wollongong University (Hoban, 2009, 2005; Hoban and Nielsen, 2011). Animations are among the most used technologies in teaching, and most affecting and attractive of the children's attention, and thus could be invested in their teaching (Hoban, Ferry, Knoza & Vialle, 2007, McKnight, Hoban & Nielsen, 2011).

Therefore, this study is seeking to develop the geometry and measurement unit of the eighth basic grade, based on the slow-motion animation technology. The study depends on its theoretical framework on Bruner's model (1966), and on the model of Lesh, Cramer, Doerr, Post & Zawojewski (2003) for the intellectual representations. It also relies on the cognition model of the technological, pedagogical content knowledge framework (T-Pack).

Bruner argues that good knowledge focuses on understanding rather than performance. This means that it is not sufficient to obtain knowledge (with the concepts, facts and principles it includes) the way it is represented, but it should be organized so that the individual could expand and deepen his/her knowledge, and transmit what he/she learned to other life situations (Takaya, 2008).

In this concern, Bruner sees that the teacher's role is to translate what could be taught into a form that suits the learner's intellectual level, so that he/she will absorb it (Bruner, 1966). Bruner places great attention to the active aspect of learning, where the learner is able to interpret his/her procedures and thinking ways, relying on his/her own learning style. He is also interested in how to represent the concepts the learner attempts to acquire through practice, in order to develop his/her ability to process the information he/she obtains.

In a related context, Lesh highlights the role played by the external representations (all the items presented to the learner, such as pictures, drawings, paintings, tables, models, and symbols to learn a certain concept), and the internal representations (intellectual images the learner builds about the math concepts and ideas), to enhance the acquisition and understanding of mathematical concepts (Chahine, 2011; Lesh, Cramer, Doerr, Post & Zawojewski, 2003).

The technological, pedagogical content knowledge framework (T-Pack) refers to knowledge in three main domains (content knowledge, technological knowledge, and pedagogical knowledge). It is a framework to understand and describe types of knowledge the teachers need to provide an active pedagogy in a technology enhanced learning environment. This model aims at explaining the efficiencies the teachers need to enable them to integrate technology into teaching (Doering, Valestianos, Scharber & Miller, 2009, Niess et al., 2009; Harris & Hofer, 2011).

Slow-motion animations, in their content, seek to employ this model to contribute to the increase of the students' participation and their understanding of the content (Keast, Cooper, Berry, Loughran & Hoban, 2010; Paige, Bentley & Dobson, 2016). They use technology to represent and explain certain content through suitable drawings and pictures to conceptualize the ideas and explain the content, including its knowledge and concepts in an organized matter, which attracts the students and trigger them to unleash the imagination (Hoban, 2007; Hoban & Nielsen, 2014). This technology is further interested in linking the previous knowledge with the context of daily life (Hoban & Nielsen, 2014).

Gambari, Falode & Adegberro, (2014) conducted a study to verify the effectiveness of the computerized animations on the students' achievement in mathematics and retaining what they learnt at the long run. The results showed that the performance of the students who studied using the computerized animations was better than their peers who studied the same topic through the traditional way. Kaplan & Ozturk (2015) carried out a study to identify the effect of the educational animations on the 6th graders' achievement in the division and primary numbers subjects. The results showed that those who studied using the animations outperformed the others who did not use them in studying these subjects.

In a related issue, Chu (2012) used animations in his teaching, and the results produced three perspectives. First, animations provided a positive classroom environment, and the students' performance was better in the tasks and activities they carried out.

Second, it created a new teaching method in which there is a type of effective participation, followed by a discussion with the other students. Third, it assisted in utilizing the class time more efficiently, and made the student more focusing during the course of the class.

The study of Akhas, Burut & Yulsel (2011) aimed at verifying the effect of animations and different computer activities on the students' achievement in the patterns. According to the study results, there was an increase in the students' academic performance, who studied using animations and computer activities about the patterns.

The current study emphasizes the use of slow-motion animations in math teaching, especially the geometry subjects. In spite of the importance of geometry, yet it is the most difficult math subject for the students. Many studies pointed out that students of different educational stages suffer from or are weak in geometry learning. This may be attributed to many reasons related to the general weakness in possessing fundamental math requirements, such as the difficulty of the geometry subjects in the textbook; poor abilities of the teacher in teaching it; lack of the student's basic concepts in geometry; student's inability to link geometry with the daily life; and use of traditional methods, instead of the modern methods that make geometry teaching-learning more interesting (Berch & Mazzocco, 2007, Tambychik & Meerah, 2010).

Accordingly, this study represents an attempt to use modern teaching modes to improve the students' level in mathematics, in general, and geometry in particular. Furthermore, the study aims to answer the following two questions:

1. What is the effect of slow-motion animation use on the 8^{th} graders' achievement in the geometry subject?
2. What are the students' perspectives about the use of animations in geometry teaching?

The significance of this study is in that it contributes to the utilization of an aspect widely loved by the children, which does not need more enhancements to use, namely, the passion and attachment of these children to the mobile devices, and using them as a means to keep abreast to the scientific development (Ekici, Cakmak & Ekici, 2014). Therefore, this study employed the slow-motion animations technique as a technological means to teach the different geometry subjects.

2 Method

When we want to analyze the effects of the educational materials or teaching methods in different schools, semesters, and classes, it will be easier to employ the quasi-experimental research design. In this type of research design, the academic semesters are not organized based on a certain purpose; rather, they are taken in the research area as are, in their particular conditions. This is a beneficial and practical way when the sample selection is not made based on the equality of the groups (McMillan & Schumacher, 2006). Hence, this research was conducted in a quasi-experimental structure, unequal groups, and applied the pre-posttests.

2.1 Population

This research was conducted with the participation of 74 students of two different 8th grades of a school located at the downtown of Zarqa City, during the second semester of the academic year 2018/2019. One of the two classes was assigned to be the experimental group and to use the slow-motion animation method (n=38). The other class was considered a control group, where the traditional teaching was dominant, which focuses on the teacher (n=36). The research was carried out in two different classes, with the same physical facilities and environmental conditions, over a three-week period (5 hours per week).

2.2 Instruments

The researcher measured the dependent variables, which are the academic achievement, and the students' views on teaching (animation technique). Meanwhile, the teaching methods were the independent variables (teaching through the animation techniques, and traditional teaching).

To achieve the study purposes and answer its questions, the researcher constructed the following instruments:

1) Assignments and activities were developed and constructed based on the slow-motion animation technology so that the concepts and theories the geometry unit presents in the form of a slow-motion video and explanatory audio recording, are represented. (The film includes an audio recording to explain the teaching content during the film show. A part of the film was presented, then it was stopped, followed by an explanation or brief clarification of what was watched. Then the film is run till the end, with parts of it are sometimes replayed, once there is any ambiguity or lack of understanding. Sometimes, the film is stopped to posit questions to the students).

   - These developed assignments and activities, based on the slow-motion animations, were presented to a group of long experienced and distinguished math teachers in different schools, to review according to the set educational objectives.
   - The amendments they proposed were simple, such as the inclusion of other concepts in the film that were not mentioned, time and speed of the show, too slow or too fast, giving priority of an idea over another during the film show, and clarity of the sound and picture.
   - The researcher further presented the assignments and activities to another expertise group in information technology to check them in terms of quality and technological aspects. Their comments and amendments were carried out as per their views to make the films clearer and of better quality.
   - In the animation group, the unit subjects were taught using animation techniques. The first five minutes of the lesson were used to ask the students questions, to probe their prior knowledge about the subject. Then the lesson is

taught through the slow-motion techniques, where the animations were presented through the mobile devices and data-show device over equal periods (5 minutes each) (Fleer & Hoban, 2012; Turan, 2013).
   - Following the show, questions related to the subject were posited over 15 minutes. Parts of the fully un-understood subjects were defined according to the answers, which were clarified anew using the animations. (See for instance, the links): https://youtu.be/u7kre9Z-Znk, https://youtu.be/kHVHN1RoGqI

2) Achievement test that aims to measure the 8th graders' achievement in the stereograph's unit, which was constructed based on the table of specifications. The test consisted of (36) items of the multiple-choice type, with one grade for each item. It was built according to the following procedures:

   - Analysis of the stereographs unit content by phrasing the educational objectives of every lesson of the unit, which included seven lessons as follows: Networks, Size and surface area of the triangular prism, Size and surface area of the cylinder, Size and surface area of the cone, Size and surface area of the pyramid, Size and surface area of the ball, and Variation coefficient.
   - The objectives were categorized into three levels: knowledge, application, and inference.
   - The test items were written so that they include the objectives they were set for.
   - The test validity was verified by presenting it to a pool of reviewers, who were requested to provide their views and suggestions. The test items were amended in the light of their comments. The test was applied to an exploratory sample and the reviewers calculated the difficulty factors, which ranged between (0.30 – 0.77), as well as discrimination coefficients, which were between (0.28 – 0.79). The test reliability was also verified using the Cronbach Alpha coefficient, which was (0.85) that represents an educationally acceptable value.
   - The test was applied before the experiment to assure the parity between the experimental and control groups, and after the experiment to identify the statically significant differences between the two groups.

3) The views of the students were measured using the student opinion scale (SOS), which Doymug, Simsek, and Bayrakecken (2004) used, and was applied to identify the students' views about the teaching method using the animation techniques. Finally, the test reliability was verified by applying the Cronbach Alpha coefficient, which amounted (0.88), an educationally acceptable value.

2.3 Group parity

To ensure the group parity, the researcher calculated the T-test value, which amounted (0.54), and the statistical significance was (0.59), which imply the nonexistence of differences between the two groups in the application of the achievement pretest. This result shows that the students of both the control and experimental groups were similar in terms of achievement before applying the teaching methods.

3 Results

1. What is the effect of slow-motion animation use on the 8th graders' achievement in the geometry subject?

The mean and standard deviation of the students' scores in the posttest were calculated, and then an independent sample T-test was carried out. The mean of the experimental groups was 32.27 and the standard deviation was 1.54, while the mean and standard deviation of the control group were 21.19 and 1.41, respectively. On the other hand, the T value was 20.63 and p=0.00, which indicates that there were differences between the two groups in the achievement posttest. This result shows that the experimental group students' achievement was better than the control group students. We further found that the academic achievement levels of the students who attended the geometry lessons, based on the slow-motion animations (animation group), were higher than those who attended lessons through the traditional method (control group), as shown in Table (1).

Table 1. T-Test Results of the Posttest Achievement of the Independent Samples

Group	M	SD	T-Value	Sig.
Experimental	33.27	1.54	20.63	0.00
Control	26.19	1.41		

2. What are the students' perspectives about the use of animations in geometry teaching?

This test was given to the experimental group by the end of the study to identify their views about the use of slow-motion animation technology. The percentages and means of the scores of the students' responses are displayed in Table (2).

i. Was the use of the animation method during the lesson beneficial for you? The students' responses are shown in Table (2).

Table 2. Views about the Use of Animation Technology in the Lesson

Score	Response	Percentage
5	Very well	65
4	Well	35
3	Satisfactory	-
2	Not too well	-
1	Poorly	-

As illustrated in Table (2), the results show that the students adopted the use of slow-motion animation. The data of the table shows that 100% of the students evaluate this technology as "very good", and "good". The results further show that the scores mean in this question was 4.60, which is higher than the midpoint (3), which, in turn, indicates the positive views of the students about the slow-motion animation technology.

ii. What is your opinion about learning through slow-motion animations? The students' answers were as illustrated in Table (3). The figures of the table show that the percentages of the students range between 91-99% as per the point 4 and 5, respectively, and that the score mean of all the views was higher than the midpoint (3).

Table 3. Statistical Values of the Views about Question 2 "Learning Through Animations"

Opinions	Scores						Opinions
	1	2	3	4	5	x	
No information	-	2	6	10	82	4.77	Information
Difficult	-	-	3	10	87	4.84	Easy understandable
Not Beneficial	-	-	1	5	94	4.93	Beneficial
A poor instructive	-	-	7	13	80	4.73	Instructive
Dull	-	1	5	6	88	4.81	Stimulating
Not enjoyable	-	-	5	18	77	4.72	Enjoyable
Not creative	-	2	10	18	70	4.56	Very creative

X indicates score mean on a 5-point scale; other figure indicates percentage

The results obtained from Table (3) show that the students found learning through slow-motion animation: beneficial, easily understandable, very creative, enjoyable, stimulating, and instructive. However, the results of this question are in line with those of Hoban and Nielsen, 2012; Dasdemir, Doymus, Simsek & Karacop, 2008. Therefore, we can conclude that the animation method was adopted by the students.

4 Discussion and Conclusion

The results showed that the use of slow-motion animations in teaching geometry has a positive effect on the students' achievement level. These results are in agreement with those of the studies of Gambari, Falode and Adegbenro, 2014; Kaplan and Ozlurk, 2015, which aimed to verify the effectiveness of the computerized animations on the students' achievement and retaining what they learned on the long run. The results further showed that the experimental group students outperformed those of the control group; and that the use of animation is an effective method in teaching different math subjects. The positive effects of using this method in geometry lessons were further supported by the students' views. In addition, these positive effects that are related to the animations techniques are in line with the results of Marbach-AD, Rotbain and Stavy (2008).

The results of this study are also in line with those of Cho's (2012), who used animations in teaching his students. He found that the students' performance level was high in the tasks and activities they were exposed to recently and left a type of active participation in the classroom. It is worth mentioning that many studies in the educational literature emphasized the effectiveness of the scientific animations of different kinds in improving the students' performance in mathematics in general (Wang, Chung & Tang, 2014).

This positive effect of the use of slow-motion animations in math teaching may be ascribed to that the information in these films is shown in an organized manner. They enable the individual further expand his/her knowledge with more efficiency. In this concern, the multiple representations, upon which the films are based in displaying knowledge (sound, picture, moving pictures, motion) form the wide difference between teaching using the traditional way and teaching using the slow-motion animations method. Interest in the way to represent the concepts the learner attempts to acquire through his/her practice, helps him/her develop his/her ability to process the information obtained (Bruner, 1996, Takaya, 2008). These results were also in agreement with those of Salim & Tiawa (2015).

In addition, the positive effect of the use of slow-motion animations could be further attributed to that these films may assist the student to stop at any point of time during the display to verify the information. They also create an effective discussion process with the other students to discuss the information displayed in the film and attempt deepening their understandings. In a similar context, Cho (2012) stated that the slow-motion animations produced a positive classroom environment. Such an environment has a type of active participation followed by discussion with the other students. As a result, it helps students better utilize the time of the class more effectively and with more focus during the course of the lesson. It also provides the students an opportunity to depend on themselves in learning and developing their thinking (Gambari, Falode & Adegbenro, 2014; Kaplan & Ozturk, 2015; Wang, Chung & Yang, 2014).

In this concern, Hoban & Nielsen, 2014; Hoban & Nielsen, 2012; Hoban, Loughran & Nielsen, 2011 stated that providing information and knowledge within these films offers every student an opportunity to learn and obtain the information anytime he/she so wishes. This is quite different from the traditional way in which the student needs to ask continuously to understand what he/she stopped bewildered beside. This is not always available due to the tight time of the lesson and the increasing numbers of students in the classroom, which render the teacher unable to answer all the students' questions, either due to the student's lack of attention, or inability to understand because the teacher did not take into account the different levels of the students.

In addition, teaching geometry through slow-motion animations has its unique advantages, such as enhancing motivation, easy understanding, and contribution to the development of cognitive skills. in light of the results of the academic achievements and the students' views, the study recommends defining the duration of the animation shows. This could be obtained by taking the students' development characteristics into consideration, carrying out more studies on the use of the slow-motion animations in the primary education stages, and adding certain activities to the courses of the faculties of education, which assist in developing the skills of using the slow-motion techniques.

5 References

[1] Aktas, M. Bulut, M. & Yuksel, T. (2011). The Effect of Using Computer Animation and Activities about Teaching Patterns in Primary Mathematics. TOJET: The Turkish Online Journal of Educational Technology, 10(3), 273-277.

[2] Berch, D. & Mazzocco M. (2007). Why is math so hard for some children? The Nature and Origins of Mathematical Learning Difficulties and Disabilities. Maryland: Paul H. Brookes Publishing Co.
[3] Bruner, J. (1966). Toward a Theory of Instruction. New York, Norton & Company. INC.
[4] Chahine, I. (2011). The Role of Translations between and within Representations on the Conceptual Understanding of Fraction Knowledge: A Tran Cultural Study. Journal of Mathematics Education. 4(1), 45-56.
[5] Cho, H. (2012). The Use Cartoons as Teaching a Tool in Middle School Mathematics. Unpublished Doctor's thesis. College of Art and Science, Columbia University: Columbia.
[6] Daşdemir, I., Doymuş, K., Simşek, U. & Karaçöp, A., (2008). The effects of animation technique on teaching of acids and bases topics. Journal of Turkish science education. 5(2), 60-69.
[7] Doering, A., Veletsianos, G., Scharber, C. & Miller, C. (2009). Using the Technological, Pedagogical, and Content Knowledge Framework to design online Learning Environments and Professional Development. Journal of Educational computing Research, 41(3), 319-346. https://doi.org/10.2190/ec.41.3.d
[8] Doymuş, K., Şimşek, Ü. & Bayrakçeken, S. (2004). The Effect of Cooperative Learning on Attitude and Academic Achievement in Science Lessons. Journal of Turkish Science Education, 1(2), 103-115.
[9] Ekici, F., Cakmak, N. & Ekici, E. (2014). Using Slow-motion as a Teaching Approach and its effect on biology achievements of pre-service science teachers. The Eurasia Proceedings of Educational & Social Sciences (EPESS), 1, 316-321.
[10] Fleer, M. & Hoban, G. (2012). Using Slow motion for intentional teaching in early childhood centres: Possibilities and imaginings. Australasian Journal of Early Childhood. 37 (3), 61-70. https://doi.org/10.1177/183693911203700309
[11] Gambari, I., Falode, O. & Adegbenro, A. (2014). Effectiveness of computer animation and geometrical instructional model on mathematics achievement and retention among junior secondary school students. European Journal of Science and Mathematics Education, 2(2), 127-146.
[12] Harries, J. & Hofer, M. (2011). Technological Pedagogical Content Knowledge (TPACK) in Action: A Descriptive Study of Secondary Teachers' Curriculum-Based, Technology-Related Instructional Planning. Journal of Research on Technology in Education, 43(3), 211-229. https://doi.org/10.1080/15391523.2011.10782570
[13] Hoban, G. & Nielsen, W. (2011). Engaging preservice primary teachers in creating multiple modal representations of science concepts with Slow motion. Research in Science Education. 42, 1101–1119. https://doi.org/10.1007/s11165-011-9236-3
[14] Hoban, G. & Nielsen, W. (2012): Learning Science through Creating a 'Slow motion ': A case study of preservice primary teachers, International Journal of Science Education, https://doi.org/10.1080/09500693.2012.670286
[15] Hoban, G. & Nielsen, W. (2014). Creating a narrated stop-motion animation to explain science: The affordances of "Slow motion" for generating discussion. Teaching and Teacher Education, 42, 68-78. https://doi.org/10.1016/j.tate.2014.04.007
[16] Hoban, G. (2005). From Claymation to Slow motion: A teaching procedure to develop students' science understandings. Teaching Science: Australian Science Teachers' Journal, 51(2), 26–30.
[17] Hoban, G. (2007). Using Slow motion to Engage Preservice Elementary Teachers in Understanding Science Content Knowledge. Contemporary Issues in Technology and Teacher Education, 7(2), 75-91.

[18] Hoban, G. (2009). Facilitating learner-generated animations with Slow motion. In L. Lockyer, S. Bennett, S. Agostino, & B. Harper (Eds.), Handbook of research on learning design and learning objects: Issues, applications and technologies (pp. 313–330). Hershey, PA: IGI Global. https://doi.org/10.4018/978-1-59904-861-1.ch015
[19] Hoban, G., Ferry, B., Konza, D. & Vialle, W. (2007). Slow motion: exploring a new teaching approach in primary school classrooms. In J. Kiggins, L. K. Kervin & J. Mantei (Eds.), Quality in Teacher Education: Considering different perspectives and agendas. Proceedings of the 2007 Australian Teacher Education Association National Conference Wollongong: Australian Teacher Education Association.
[20] Hoban, G., Loughran, J., & Nielsen, W. (2011). Slow motion: Preservice elementary teachers representing science knowledge through creating multimodal digital animations. Journal of Research in Science Teaching, 48(9), 985–1009. https://doi.org/10.1002/tea.20436.
[21] Kaplan, A. & Ozturk, M. (2015). The effect of Concept Cartoons to Academic Achievement in Instruction on the Topics of Divisibility. International Electronic Journal of Mathematics Education, 10(2), 67-76. http:// doi: 10.12973/mathedu.2015.105a
[22] Keast, S., Cooper, R., Berry, A., Loughran, J. & Hoban, G. (2010). Slow motion as a pedagogical scaffold for improving science teaching and learning. Brunei International Journal of Science and Mathematics Education, 2 (1), 1-15.
[23] Lesh, R., Cramer, K., Doerr, H., Post, T. & Zawojewski, J., (2003) Using a translation model for curriculum development and classroom instruction. Models and Modeling Perspectives on Mathematics Problem Solving, Learning, and Teaching. Retrieved from: http://www.cehd.umn.edu/rational number project/03_1.html, on 14/3/ 2019.
[24] Marbach-Ad, G., Rotbain, Y. & Stavy, R. (2008). Using computer animation and illustration activities to improve high school students' achievement in molecular genetics. Journal of Research in Science Teaching, 45: 273–292. https://doi.org/10.1002/tea.20222
[25] McKnight, A., Hoban, G. & Nielsen, W. (2011), Using Slowmotion for animated storytelling to represent non-Aboriginal pre-service teachers' awareness of relatedness to country, Australasian Journal of Educational Technology, 27(1), 41-54. https://doi.org/10.14742/ajet.981
[26] McMillan, J. & Schumacher, S. (2006). Research in education: Evidence-based inquiry (6th ed.). Boston, MA: Allyn and Bacon.
[27] Niess, M., Ronau, R., Shafer, K., Driskell, S., Harper S., Johnston, C., Browning, C., Özgün-Koca, S. & Kersaint, G. (2009). Mathematics teacher TPACK standards and development model. Contemporary Issues in Technology and Teacher Education, 9(1), 4-24.
[28] Paige, K., Bentley, B., & Dobson, S. (2016). Slow motion: An Innovative Twenty-First Century Teaching and Learning Tool for Science and Mathematics Pre-service Teachers. Australian Journal of Teacher Education, 41(2), 1-15 http://doi.org/10.14221/ajte.2016v41n2.1
[29] Salim. K. & Tiawa. H. (2015). The Student's Perceptions of Learning Mathematics using Flash Animation Secondary School in Indonesia. Journal of Education and Practice, 34(6), 76-80.
[30] Takaya, K. (2008). Jerome Bruner's Theory of Education: From Early Bruner to Later Bruner. Interchange, 39(1), 1-19. https://doi.org/10.1007/s10780-008-9039-2
[31] Tambychik, T. & Meerah, T. (2010). Students' difficulties in mathematics problem-solving: What do they say? Procedia Social and Behavioral Sciences.8 (2010), 142-151. https://doi.org/10.1016/j.sbspro.2010.12.020.
[32] Turan, B. (2013). The Opinions of Teachers on the Use of Cartoon Character in the Mathematics Lesson. Journal of Social and Behavioral Sciences, 141(25), 1386-1391. https://doi.org/10.1016/j.sbspro.2014.05.239

[33] Wang, Y., Chung, J. & Yang, L. (2014). Using Clickers to Enhance Student Learning in Mathematics. International Education Studies, 7(10), 1-13 https://doi.org/10.5539/ies.v7n10p1

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