

# Using Animation as a Means of Enhancing Learning of Individuals with Special Needs

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**Abstract** – Use of animation in special education has gained great attention recently. Therefore, the use of animation for helping individuals with special needs has become an important research question and this study aims to examine and discuss the role of using animation as a tool to enhance learning of individuals with special needs. This is a qualitative study in which document analysis was used to collect the data. Results revealed the trends in using animation in education and the benefits of animation for enhancing learning of individuals with special needs. This study tried to provide a comprehensive review on the effectiveness of using animation in education and discussed the existing and possible benefits of using animation for individuals with special needs. Results are discussed with relevant literature and recommendations for further research and practices are presented in the study.

**Keywords** – Animation, learning, individuals with special needs, special education.

## 1. Introduction

Technology is developing rapidly in the 21st century and these developments are bringing many innovations in education as well. The use of technology in education also affects learning and teaching environments [3]. It has been suggested that with the use of animation in education, there is a significant increase in the attitudes and academic achievements of the students in a positive way [26, 43, 1]. It has been shown that animations as technological tools used in education have contributed a lot to the students in terms of security, speeding and slowing time, examining very rare events, simplifying complicated systems, being useful and cheap and motivation as well as providing a significant increase in students' attitudes and academic achievements towards the courses in positive manner [4, 21].

Emerging technologies and needs have caused visually to become more prominent over time [10]. The rapid development of the information also results in the failure of a recently produced knowledge to become dysfunctional. This requires timely and effective use of information. In this case, tools were needed to make available information accessible by large masses quickly and effectively without waiting for the existing information to get old. Sharing and using information is as important as producing information. Therefore, there is a need for information dissemination systems that save time and money for sharing and using information produced by the large masses. As a result of this, the work of visualization and visualization systems has become important [20]. Animation as a multimedia tool is at the forefront of the visualization systems [47, 48].

Developments in computer technology contribute to the development of instructional plans to enable students to learn in a variety of ways [42]. In parallel with the increasing advances in computer technology, the use of multimedia technologies such as animation, sound, graphics and text in the

DOI: 10.18421/TEM73-26

<https://dx.doi.org/10.18421/TEM73-26>


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Received: 30 June 2018.

Accepted: 11 August 2018.

Published: 27 August 2018.

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educational environment is also increasing. This allows for the design of education and training by offering a wider variety of learning processes and richer educational environments for students [15]. Developments in computer software play an important role in adding features such as sound, graphics and text to educational tools. Increasingly, educational patterns and developments use multimedia tools that incorporate educational programs and educational courses [25].

Animation is a technical process that, in general, produces motion illusion in the viewer by sequencing the still images produced in the analogue or digital environment in sequence. As a way of producing a film as much as it is technically possible, the development of the animation, which is included in the genre film itself, can now go beyond the judgment that it is mainly an entertainment for the mass audience of children [33]. The realization of 3D animated films appealing to people of all ages has been influential in bringing the concept of animation out of the audience perception of traditional animation films by giving them brand new dimensions [9].

Animations and digital maps make it easier to understand abstract concepts and ensure that learning is permanent. Paintings and cartoons will not be animations if they show no change and are still. This is because animations should not be constantly moving, nor should they stay in motion permanently. Researchers have advocated the idea that animations will be used as a standard in our future education like the alphabet [23]. According to [37], animations are the process of animating graphics in a certain scenario and they should be regarded as alternative teaching ways in order to visualize knowledge.

In the case of animated education, events that occur during a time when a human being can not observe in real time, can easily be presented to students in a more accelerated structure and the student can see a point that he/she does not understand in this structure by stopping the animation and taking it back more effectively and permanently [31].

Furthermore, visual perception happens when people leave five sensory organs (sound, image, etc.) completely open to the stimuli coming from the surroundings and realize the conscious perception by an accumulation of past physiological and psychological experiences. In this perception process, the sensory state of the human body, which occurs kinetically in the nervous system, causes psychological mental loading of the person, leaving permanent or temporary effects in the brain [7]. Mental practices such as collecting, identifying, comparing, establishing similarities, categorizing and interpreting meaningful information on the basis of

the psychological sub-structure of the brain in this kind of perception are also interacting. Not surprisingly, in this perception process, the eye itself is the organ of which the person is most actively concentrating attention with. Depending on the eye, it is also a visual perception that occupies the human mind relatively more than other types of perception. It is a known fact that visual perception intensifies attention to systematically moving objects. This real animation has been an important factor in taking the momentum of motion as a reference to itself [11, 40, 38].

Twelve principles under the title "Basic Principles of Animation" have been identified. These principles, which were determined in the 1980s by the need to determine the rules of a two-dimensional (2D) animation world, are still valid today and must be taken into account in order to obtain realistic motion in a three-dimensional (3D) animation platform [27].

- Squash & Stretch
- Anticipation
- Staging
- Straight Ahead Action & Pose to
- Pose
- Follow Through & Overlapping Action
- Slow In & Slow Out
- Arcs
- Secondary Action
- Timing
- Exaggeration
- Solid Drawing
- Appeal

[50] revealed that relation of education with animation and ways the education reach to individuals are the issues that need to be solved while determining the functions of the animation in education. The idea that animation should be used in the field of education is due its own internal visual arrangements and motion relations. Computer-aided animation systems made for educational purposes simplify the transmission of current, very complex, very fast, very slow, top secret reactions with their analytical fluency as a visual communication medium and concentrate attention on basic movements. The narrative incorporates narrative efficiency into the educational arrangements in it and facilitates the remembrance of the event [46]. Meaningful learning makes it easy to store both information and recall from memory. Animation is the act of moving many pictures and graphics into scenarios. Animations are created by linking consecutive pictures. Animations that are not enough for training alone are technological options used in many different areas of education and animation,

which is used in many areas, especially preferred for describing complex concepts [2].

It is widely known that the use of technology in special education facilitates learning and teaching activities of individuals with special needs and have positive effects on learners' performance and gaining various skills such as reading, writing and mathematical skills [32, 19]. Visuality, moving objects and making visual objects more narrative are the most important benefits of using animations in teaching individuals with special needs. Considering the prevalent and efficient use of animation in education and technology in special education based on its advantages, the use of animation in special education has recently come into prominence. For example, [45] investigated the potential benefit of animated instructional tools for students with dyslexia in higher education and showed that appropriate animated instructional materials facilitate learning more when compared to static materials.

There are various studies examining the role of animation in teaching and learning of individuals with special needs and providing evidence based on various researches [8, 34, 17]. However, when the literature is examined, it is seen that the number of review studies examining the use of animation in special education as a main topic and providing a framework is limited. Therefore, this study aims to provide a comprehensive review on the use of animation in special education and its advantages for individuals with special needs. Since, using animation in special education gained attention recently, it is aimed to introduce the concept of animation as an instructional tool which can be used in special education and make the studies in this field more widely known. It is also aimed to collect and present studies on using animation to enhance learning of individuals with special needs carried out in different countries, settings and participants. Through providing a review on this issue, it is assumed that studies conducted in the past would light the way for studies which will be conducted in the future. Accordingly, it is expected that this study would provide a comprehensive perspective on using animations for enhancing teaching of individuals with special needs.

## 2. Method

Research model, data collection and data analysis of the current study are provided in this section.

### 2.1. Research Model

Document analysis, which is one of the qualitative research methods, was used as the research model in this study. Document analysis is the examination of materials related with a certain research topic [49]. These materials might be written materials involving books, journals, newspapers, archives or diaries and other materials such as films, video or photographs. Document analysis is especially used when it is not possible to carry out interview and observation. It can be also used to make association between the data obtained from interview and observation [5]. When it is used with data collection methods such as interview and observation, it leads to data triangulation and therefore the validity of the research increases. Furthermore, it is indicated that document analyses have positive characteristics such as subjects that can not be accessed easily, lack of responsiveness, long-term duration of analysis, magnitude of sample, individuality and originality, relatively low cost and quality.

### 2.2. Inclusion Criteria

In order to determine the studies to be included in the literature review, the following criteria were considered:

- Open-access full papers published in national or international reviewed journals
- Open-access proceedings published within a symposium or a congress as full papers
- Studies on using animation for teaching concepts or skills to individuals with special needs

### 2.3. Data Collection and Analysis of the Data

Document analysis involves three steps of analysis which includes description, analysis and interpretation. The data collection and analysis process is shown in Figure 1.

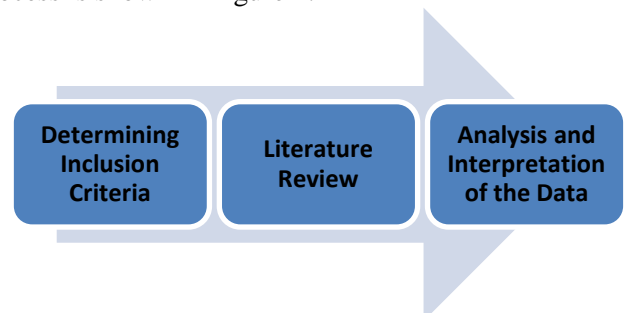


Figure 1. Data collection and analysis process

Firstly, inclusion criteria were determined in order to decide which studies will be included in the study. After a comprehensive literature review, the published materials in academic journals and books were collected from databases, brought together and analyzed by the researchers in the study. Then, all the materials were categorized based on themes. Lastly, these categories were analyzed in detail in order to constitute a framework for important dimensions based on the aim of the study and the results of the study were obtained in this way.

### 3. Results and Discussion

#### 3.1. The Use of Animation Techniques in Computer Aided Education

The most effective learning aspect of computer-assisted education is to locate the animation correctly within the educational process and to handle visual arrangements for communication. Accordingly, [30] stated that the understanding and application of the interaction of movement, sound, time and visual communication within the animation in the education process will give the best results for educational communication.

The conveniences of today's "multimedia" software have made significant structural changes in the field of education. The presentation of an image, voice and motion is transmitted to the viewer more easily. Animation is used in the visual expression of events within the produced education system programs. The message is more attractive when the colors, movements and texts used in the education system are presented in a good composition on the screen [39]. Educational animations contain motivating and entertaining features of computer and education and can be used as an alternative, complement and enrichment of other teaching methods for instructional or educational purposes. Animation-based learning aims at learning of students in educational computer aided animations. The characteristics of learning with animation are as follows [35, 29, 13].

- It is an educational course that students follow visually.
- There can be many kinds of educational animation games and video animation.
- For each content, students can offer a wide range of animation by combining different types of animation with different learning methods.
- Educational animations provide hidden learning.
- The students play with or watch the animation with joy and when it finishes they realize that he /she has learnt something from it.

Educational animations can be combined with other learning methods and provide complete learning.

#### 3.2. Use of Animation in Special Education

Special education can be defined as a specially designed form of education for students with different learning needs. Special education is the form of education in which individuals with special needs receive education based on their competencies, requirements, developmental characteristics and current performance level in order to meet their academic and social needs by professionals through using specially designed educational programs, materials and methods [14].

It is considered that the technologies that will support the independent life of individuals who need special education will be beneficial. These technologies can be used in all areas of life, as well as in the development, maintenance and enhancement of the functional skills of the learners in the classroom environment [12]. For this reason, it is of utmost importance that assistive technologies and computer and animation technologies are included in the education process. According to [44], computer and animation technologies are regarded to support individuals' independent lives and facilitate their lives by supporting individual learning when it is used effectively, providing opportunities for individuals to make their lives easier, improving communication skills and helping to acquire social skills. There is also a very important issue, such as the strengthening of the relationship between private education and technology and the right to equal access to technology for all individuals with the support of the legislation [28].

When the materials are visualized through animation, they become more concrete and narrative and therefore individuals with special needs might easily learn. The ability of computer and animation technologies to create a learning environment according to individual differences and characteristics is seen as one of the most important reasons for using these technologies in education. Effective use of computer and animation technologies in the field of special education, where individual differences are very important, and the dissemination of this usage is a very important point in terms of our education system [22].

Special education research has gained momentum in recent years and parallel to these studies, new approaches have been started to be combined with technology in the field of special education. Technological support and training paths are produced in the 21st century especially in the areas of integration, individualized education programs, special education entry and teaching methods. The

use of computer and animation technology by an effective educator, which has an important potential for facilitating the teaching of specially educated individuals, should be one of the important targets. In addition, these technologies will be effective in solving the problems that will be met in the daily lives of individuals who have special needs [6].

Visual and auditory (by doing - living) training should be considered as one of the most important methods of modern education in special education since individuals with special needs learn more easily when the materials are visualized. The skills gained in this process and the experience gained with these skills play an important role in bringing the existing capacity of the child to the highest level. The child will make sense of what he/she will do. Students with special needs can see themselves as part of an event they watch while watching the animation show. She/He thinks the person or hero who is being described is himself/herself. Through animation, confidence, harmony, ability to act together, trusting and sharing the environment can give them the ability to do a job and finish a job they started. In addition, hand movements, motor skills and hand-eye coordination may be weak for people with mental disabilities [24] and animations can be used to overcome this situation.

The preference for animation in special education will allow children to have fun by learning, allowing them to support their creativity and also allowing them to actively participate in their activities. Children can show everything they have with the help of their infinite imagination and active participation makes active and permanent learning. Active participation can be facilitated if the activities are prepared in accordance with the interests and desires of special needs individuals, attention span and developmental characteristics. In special education, the use of animation events might encourage children who are particularly shy. They learn to speak properly and accurately, to influence what they are saying and others, to be able to manage voice tone and movements while talking, to take initiative, and to manage themselves and others. Individuals with special needs participate in animation events and gain the ability to solve problems with their friends by themselves. These experiences bring children the necessary habits of tolerance, patience, perception, proper and necessary response, adherence to the rules, and prepare them to enjoy group work [18].

Furthermore, [36] examined the effect of animated software named as Team Up With Timo on receptive and expressive language skills of children with language and speech disorders and showed that animated software promoted children's language

skills. In addition, [22] stated that expressing themselves with both verbal and body language is difficult for children with autism spectrum disorder and emphasized that using animated narratives for developing language skills of children with autism spectrum disorder would be beneficial. Besides, they also indicated that since the abilities of the children with autism spectrum disorder on focusing on visual details are at an advanced level, using moving objects such as animation would reduce their anxiety levels and promote explaining, transferring and creating abilities of students with reading and writing difficulties. In another study examining the effectiveness of graphic animation tools for learning verbs among students with autism spectrum disorder, it was found that using graphic animations is more effective on learning verbs when compared to static pictures [34].

According to literature, there are research findings showing the role of animation for enhancing learning of individuals with intellectual disability. For example, [16] examined the effect of animation on learning action symbols among individuals with intellectual disabilities with a single-subject research and figured out that participants benefited from animated symbols in the experimental condition. [41] examined the role of using animated social narratives for teaching social skills to individuals with mild intellectual disability and found that it is effective. Besides, [8] tested whether teaching with animations improve shopping skills of individuals with intellectual disability. They carried out a single subject research with multiple probe design across subjects and showed that animations promoted their shopping skills. In addition, [17] investigated the effect of animation program presented with tablet computer on the effectiveness, permanence and generalization of learning addition skills of students with intellectual disability and showed that using animation program is effective on teaching addition skills to students with intellectual disability and promote permanence and generalization of learning.

#### 4. Conclusion and Recommendations

In the age that we are living in, it is recommended for teachers and other professionals of education to follow the trends in technology and use tools of information technologies in education in an effective way, for example in teaching process and presenting lectures. Use of animation as one of the effective tools of information technology in education has increased recently and it is highly recommended to use animation to enhance learning of individuals with special needs in addition to individuals with typical development. This study provided a review for studies showing the role of animation in special

education. Results primarily showed that based on the increasing use of technology in special education, animations gained great attention recently and found to be an effective instructional tool for enhancing learning of individuals with special needs. Studies discussed in the current study showed that animations are mainly found as beneficial for individuals with dyslexia, autism spectrum disorder and intellectual disability. In addition, language and social skills were the most studied skills in the studies on using animations to enhance learning of individuals with special needs. It was observed that academic skills such as reading, writing and mathematical skills were not frequently studied yet.

In conclusion, this study tried to provide a comprehensive review on the effectiveness of using animation in education and discussed the existing and possible benefits of using animation for individuals with special needs. Based on the results obtained from the present study, following recommendations for further research and practices are provided:

- Experimental researches might be carried out in order to show the effectiveness of animation in enhancing learning performances of individuals with special needs.
- Effectiveness of animations in teaching individuals from different disability groups such as attention deficit hyperactivity disorder, hearing impairment and giftedness might be examined.
- Inservice trainings might be organized in order to increase special education teachers' knowledge and skills on using and integrating animations in teaching.
- Teacher training programs in universities might include more courses on integrating technological tools into special education environments in order to create awareness among preservice special education teachers.
- Academic skills, especially reading, writing and mathematical skills, should be investigated as well whether animations are effective tools for teaching academic skills to individuals with special needs.

## References

- [1]. Akaydin, B. B. & Kaya, S. (2018). Sosyal bilgiler dersinde animasyon iceren ve icermeyen 5E modeli'nin ogrencilerin basari ve tutumuna etkisi. *Kastamonu Egitim Dergisi*, 26(1), 171-179.
- [2]. Akpinar, E. (2014). The use of interactive computer animations based on POE as a presentation tool in primary science teaching. *Journal of Science Education and Technology*, 23(4), 527-537.
- [3]. Bai, H. (2018). Preparing teacher education students to use instructional technology in an asynchronous blended course. In *Innovative Practices in Teacher Preparation and Graduate-Level Teacher Education Programs* (pp. 603-619). IGI Global.
- [4]. Betrancourt, M. & Tversky, B. (2000). Effect of computer animation on users' performance: A review. *Le Travail Humain*, 63(4), 311-329.
- [5]. Bowen, G. A. (2009). Document analysis as a qualitative research method. *Qualitative Research Journal*, 9(2), 27-40.
- [6]. Brodin, J. & Lindstrand, P. (2003). What about ICT in special education? Special educators evaluate information and communication technology as a learning tool. *European Journal of Special Needs Education*, 18(1), 71-87.
- [7]. Caelli, T. (2014). *Visual perception: Theory and practice*. UK: Elsevier.
- [8]. Cakmak, S. & Cakmak, S. (2015). Teaching to intellectual disability individuals the shopping skill through ipad. *European Journal of Educational Research*, 4(4), 177-183.
- [9]. Chen, J. (2017, May). *Construction of animation education system based on interactive teaching pattern*. Paper presented at the 3rd International Conference on Social Science, Management and Economics, Guangzhou, China. Retrieved from: [http://www.dpi-proceedings.com/index.php/dtss\\_ehs/article/view/13025/12555](http://www.dpi-proceedings.com/index.php/dtss_ehs/article/view/13025/12555)
- [10]. Craig, R. J. & Amernic, J. H. (2006). PowerPoint presentation technology and the dynamics of teaching. *Innovative Higher Education*, 31(3), 147-160.
- [11]. Cook, M. P. (2006). Visual representations in science education: The influence of prior knowledge and cognitive load theory on instructional design principles. *Science Education*, 90(6), 1073-1091.
- [12]. Courduff, J., Szapkiw, A. & Wendt, J. L. (2016). Grounded in what works: Exemplary practice in special education teachers' technology integration. *Journal of Special Education Technology*, 31(1), 26-38.
- [13]. Dalgarno, B., & Lee, M. J. (2010). What are the learning affordances of 3-D virtual environments?. *British Journal of Educational Technology*, 41(1), 10-32.
- [14]. Diken, I. H., Rakap, S., Diken, O., Tomris, G. & Celik, S. (2016). Early childhood inclusion in Turkey. *Infants & Young Children*, 29(3), 231-238.
- [15]. Dincer, S. & Doganay, A. (2017). Bilgisayar destekli ogretim yazilimlarinda egitsel arayuz kullaniminin bilgisayar destekli ogretimi degerlendirmeye ve ders ilgisine etkisi. *Amasya Universitesi Egitim Fakultesi Dergisi*, 6(1), 317-366.

- [16]. Fujisawa, K., Inoue, T., Yamana, Y. & Hayashi, H. (2011). The effect of animation on learning action symbols by individuals with intellectual disabilities. *Augmentative and Alternative Communication*, 27(1), 53-60.
- [17]. Gecal, I. & Eldeniz-Cetin, M. (2018). Zihinsel yetersizligi olan ogrencilere eldesiz toplama isleminin ogretiminde tablet bilgisayar araciligi ile sunulan animasyon programinin etkililigi. *Education Sciences*, 13(1), 75-89.
- [18]. Golan, O. & Baron-Cohen, S. (2006). Systemizing empathy: Teaching adults with Asperger syndrome or high-functioning autism to recognize complex emotions using interactive multimedia. *Development and Psychopathology*, 18(2), 591-617.
- [19]. Grynszpan, O., Weiss, P. L., Perez-Diaz, F. & Gal, E. (2014). Innovative technology-based interventions for autism spectrum disorders: A meta-analysis. *Autism*, 18(4), 346-361.
- [20]. Guo, M. L., Wu, M. H. & Luo, L. M. (2017, October). A real-time and multi-dimension data types aware visualization technology in personalized learning system. In *Proceedings of the 2017 International Conference on Wireless Communications, Networking and Applications* (pp. 122-126). ACM.
- [21]. Guvercin, Z. (2010). *Fizik dersinde simulyasyon destekli yazilimin ogrencilerin akademik basarisina, tutumlarina ve kaliciliga olan etkisi* (Unpublished Master Thesis). Graduate School of Social Sciences, Cukurova University, Adana, Turkey.
- [22]. Holmgaard, A., Pedersen, H. & Abbott, C. (2013). Animation: Children, autism and new possibilities for learning. *Journal of Assistive Technologies*, 7(1), 57-62.
- [23]. Johnson, A. M., Ozogul, G. & Reisslein, M. (2015). Supporting multimedia learning with visual signalling and animated pedagogical agent: Moderating effects of prior knowledge. *Journal of Computer Assisted Learning*, 31(2), 97-115.
- [24]. Karal, H., Kokoc, M. & Ayyildiz, U. (2010). Educational computer games for developing psychomotor ability in children with mild mental impairment. *Procedia-Social and Behavioral Sciences*, 9, 996-1000.
- [25]. Kosa, M., Yilmaz, M., O'Connor, R. & Clarke, P. (2016). Software engineering education and games: A systematic literature review. *Journal of Universal Computer Science*, 22(12), 1558-1574.
- [26]. Lai, Y. L., Kuan, K. K., Hui, K. L. & Liu, N. (2009). The effects of moving animation on recall, hedonic and utilitarian perceptions, and attitude. *IEEE Transactions on Engineering Management*, 56(3), 468-477.
- [27]. Lasseter, J. (1987). Principles of traditional animation applied to 3D computer animation. *ACM Siggraph Computer Graphics*, 21(4), 35-44.
- [28]. Lee, H. & Templeton, R. (2008). Ensuring equal access to technology: Providing assistive technology for students with disabilities. *Theory into Practice*, 47(3), 212-219.
- [29]. Lowe, R. K. (2003). Animation and learning: Selective processing of information in dynamic graphics. *Learning and Instruction*, 13(2), 157-176.
- [30]. Lowe, R. & Mason, L. (2017). Self-generated drawing: A help or hindrance to learning from animation?. In *Learning from Dynamic Visualization* (pp. 309-331). US: Springer International Publishing.
- [31]. Luzon, J. M., & Leton, E. (2015). Use of animated text to improve the learning of basic mathematics. *Computers & Education*, 88, 119-128.
- [32]. Maor, D., Currie, J. & Drewry, R. (2011) The effectiveness of assistive technologies for children with special needs: a review of research-based studies. *European Journal of Special Needs Education*, 26(3), 283-298.
- [33]. Martinez, O. O. L. (2015). Criteria for defining animation: A revision of the definition of animation in the advent of digital moving images. *Animation*, 10(1), 42-57.
- [34]. Mat-Rabi, N., Osman, R. & Mat-Rabi, N. (2016). Graphic animation: Innovative language learning for autistic children. *World Academy of Science, Engineering and Technology, International Journal of Social, Behavioral, Educational, Economic, Business and Industrial Engineering*, 10(5), 1614-1621.
- [35]. Mayer, R. E. & Anderson, R. B. (1992). The instructive animation: Helping students build connections between words and pictures in multimedia learning. *Journal of Educational Psychology*, 84(4), 444-452.
- [36]. Mulholland, R., Pete, A. M. & Popeson, J. (2008). Using animated language software with children diagnosed with autism spectrum disorders. *Teaching Exceptional Children Plus*, 4(6), 1-9.
- [37]. Pekdag, B. (2010). Kimya ogreniminde alternatif yollar: Animasyon, simulyasyon, video ve multimedya ile ogrenme. *Turk Fen Egitimi Dergisi*, 7(2), 79-110.
- [38]. Ploetzner, R., & Breyer, B. (2017). Strategies for learning from animation with and without narration. In *Learning from Dynamic Visualization* (pp. 357-378). US: Springer International Publishing.
- [39]. Rosen, Y. (2009). The effects of an animation-based on-line learning environment on transfer of knowledge and on motivation for science and technology learning. *Journal of Educational Computing Research*, 40(4), 451-467.
- [40]. Rusli, M., Ardhana, I. W., Sudana, I. N. D. & Kamdi, W. (2014). The effect of presentation strategy on multimedia learning-animation vs static visualization-and learning style to learning result. *Academic Research International*, 5(1), 216-226.
- [41]. Shepherd, A. (2012). The case of Drew: An animated social narrative intervention to improve the social skills of a student with a mild intellectual disability (MID). *Journal of Student Engagement: Education Matters*, 2(1), 65-77.
- [42]. Shute, V. J. & Rahimi, S. (2017). Review of computer-based assessment for learning in elementary and secondary education. *Journal of Computer Assisted Learning*, 33(1), 1-19.



- [43]. Szabo, M. & Poohkay, B. (1996). An experimental study of animation, mathematics achievement, and attitude toward computer-assisted instruction. *Journal of Research on Computing in Education*, 28(3), 390-402.
- [44]. Takacs, B. (2005). Special education and rehabilitation: Teaching and healing with interactive graphics. *IEEE Computer Graphics and Applications*, 25(5), 40-48.
- [45]. Taylor, M., Duffy, S. & Hughes, G. (2007). The use of animation in higher education teaching to support students with dyslexia. *Education + Training*, 49(1), 25-35.
- [46]. Toroglu, A. & Icingur, Y. (2007). Uc boyutlu bir animasyon sisteminin tasarimi ve teknoloji egitiminde kullanilmasi. *Politeknik Dergisi*, 10(3), 247-252.
- [47]. Tversky, B., Morrison, J. B. & Betrancourt, M. (2002). Animation: Can it facilitate?. *International Journal of Human-Computer Studies*, 57(4), 247-262.
- [48]. Xiao, L. (2013). Animation trends in education. *International Journal of Information and Education Technology*, 3(3), 286-289.
- [49]. Yildirim, A. & Simsek, H. (2006). *Sosyal bilimlerde nitel arastirma yontemleri*. Ankara: Seckin Publishing.
- [50]. Zahra, S. B. (2016). Effect of visual 3d animation in education. *European Journal of Computer Science and Information Technology*, 4(1), 1-9.