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THE IMPACT OF ANIMATION ON VISUAL LEARNING IN CHILDREN WITH SPECIAL NEEDS: AN EFFECTIVENESS STUDY

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ABSTRACT

Children with special needs often face unique challenges in acquiring essential life skills, including activities of daily living (ADL). These skills encompass a wide range of tasks necessary for independent functioning, such as personal hygiene, dressing, eating, and household chores. The current study examines the effectiveness of animation videos as a teaching aid tool for teaching brushing skills to children with special needs. This research aims to address the unique challenges faced by children with special needs in acquiring and maintaining proper oral hygiene practices. Utilizing a structured intervention program, the study involves a group of individuals diagnosed with autism spectrum disorder (ASD) and Intellectual Disabilities (ID). The intervention comprises an animation video designed to engage, instruct, and motivate children to improve their brushing techniques. The study employs quantitative assessments of brushing skill proficiency with the observations of engagement and behavioural changes. Results indicate a significant improvement in brushing skills and a heightened level of engagement among participants, demonstrating the potential of animation videos as an effective educational resource. The findings underscore the importance of innovative teaching methods customized to meet the demands of special needs children, highlighting the broader implications for educational practices and oral health interventions.

Keywords: Animation, Brushing Skills, Special Needs Education, Autism Spectrum Disorder (ASD), Intellectual Disabilities (ID)

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1. INTRODUCTION

Proper oral hygiene is crucial for overall health, especially in children, to prevent dental issues such as cavities and gum disease, which can lead to pain and systemic health problems. For children aged 3-6, developing effective brushing skills is foundational, impacting their nutrition, speech, and social interactions. Children with special needs, aged between three and six, dental hygiene is essential because it establishes the basis for their general health and wellbeing. Creating a habit of good dental hygiene throughout these early years can help avoid dental problems like cavities and gum disease, which are frequent and can cause discomfort, infections, and difficulty speaking and eating. Maintaining dental health is crucial for kids with special needs because they may be more vulnerable to dental

issues as a result of food choices, medication side effects, and difficulties with regular hygiene practices. Individuals with intellectual disabilities face unique challenges in maintaining oral hygiene, which often leads to a higher prevalence of dental diseases and necessitates specialized care and education to enhance their dental health outcomes (Anders, P. L., & Davis, E. L. (2010) [1]. Early and regular dental care utilization is vital for kids with particular health issues and care needs to prevent the onset of severe dental diseases, which are often exacerbated by medication side effects and dietary habits specific to this population (Chi, D. L., & Dental Quality Alliance. (2013) [2]. Special needs children display a significantly higher prevalence of dental issues, highlighting the urgent need for targeted oral hygiene interventions and education to enhance their dental health status Gupta, D. P., et al. (2016) [3]. Furthermore, having strong teeth is essential for chewing and breaking down food., which affects a person's physical development. Therefore, maintaining good dental hygiene supports a healthy diet. Additionally, it influences the development of their speech and social relationships, enhancing their ability to communicate and boosting their self-assurance in social situations. In order to guarantee that children with special needs can experience improved overall health and a higher quality of life, caregivers and educators are essential in teaching and reiterating these behaviours.

2. SPECIAL NEEDS CONTEXT

Children with specific needs, including those with ASD and ID, often face additional challenges in maintaining oral hygiene. Sensory sensitivities, behavioural issues, and difficulties in understanding and following routines make traditional oral hygiene education less effective for these children. Animation Videos are crucial resources for teaching oral hygiene to children who require particular assistance, particularly those aged 3-6 years, due to their engaging and visually stimulating nature. Children with special needs often face challenges in understanding and retaining traditional oral hygiene instructions because of sensory sensitivities, cognitive impairments, and communication difficulties. Animated videos can overcome these barriers by presenting information in a clear, consistent, and captivating manner. The use of vibrant colours, appealing characters, and repetitive sequences helps in capturing and maintaining the children’s attention, making it easier for them to understand and remember the steps involved in brushing their teeth (Prabhu et al., 2008) [5]. Moreover, these videos can be tailored to address specific sensory preferences and learning styles, providing a personalized learning experience it frequently works better than traditional teaching techniques [1].

The efficiency of animation videos lies in their capability to simplify complex tasks and routines into manageable steps, it is especially important for young children with special needs. These films frequently provide both visual and audio cues that can assist kids with autism spectrum disorders or developmental delays in following along with the brushing process [3]. For instance, animated characters can model the correct brushing technique, demonstrating the appropriate duration and areas to clean, which children can then imitate. The repetitive nature of the animations reinforces learning, helping children develop a consistent oral hygiene routine (Lal, 2011) [4]. Additionally, the interactive elements of some animated videos, such as songs or games, can make brushing a fun and enjoyable activity, reducing resistance and encouraging regular practice [2]. By using animation videos, caregivers and educators can provide consistent and accessible oral hygiene education, ultimately improving the oral health and overall well-being of kids who require particular care [5].

3. PURPOSE OF THE STUDY

The purpose of this study is to evaluate the efficacy of animation videos as a novel teaching method for brushing instruction to children with special needs. It is hypothesized that these videos can increase student engagement and promote better oral hygiene habits. This study aims to evaluate the effectiveness of cartoons as a teaching tool for brushing instruction for children with special needs, namely those in the three to six age range. This study aims to address specific issues that children with special needs—such as those with intellectual disabilities, autism spectrum disorder (ASD), and other developmental delays—face when it comes to learning and maintaining basic oral hygiene. Because of their acute sensitivity, cognitive disabilities, and communication problems, these youngsters are typically not well served by traditional brushing technique instruction. This study aims to investigate whether an innovative approach can improve the understanding, retention, and execution of effective brushing habits among this vulnerable population. Animated videos are a great tool for this purpose because they are naturally engaging and can be customized to suit different sensory preferences and learning styles. The long-term commitment to good oral hygiene habits will also be measured, in addition to the immediate effect on the kids' capacity to comply with brushing instructions. Furthermore, in order to create a pleasant and enjoyable learning environment, the research will investigate how animated movies can help lower resistance and anxiety related to dental hygiene practices. By means of this thorough assessment, the research hopes to offer evidence-based suggestions for integrating animated educational resources into children's daily routines who have special needs, so enhancing their general and dental health outcomes.

4. LITERATURE REVIEW

Research has indicated that animated videos can be highly engaging and efficient in educational settings, particularly for children. They offer visual and auditory stimuli that can help in better retention and understanding of concepts. The use of animation as a teaching aid for kids who have special needs has gained significant attention in recent years. This literature review examines the effectiveness and benefits of using animated content to improve the educational results for kids who have special needs, focusing on the various ways animation can be tailored to meet their unique educational requirements.

1) **Engaging and Retaining Attention:** One of the primary benefits of using animation in education is its ability to capture and retain the attention of kids with special needs. According to Prabhu et al. (2008) [5], animated characters and vivid colors are particularly effective when interacting with kids that have autism spectrum disorders (ASD). These kids frequently encounter difficulties with conventional educational methods due to their sensory processing issues and difficulty maintaining focus. Animation, with its dynamic visuals and repetitive patterns, provides a more stimulating and interactive instruction environment.
2) **Simplifying Complex Concepts:** Animation simplifies complicated ideas, rendering them more accessible to children with cognitive impairments. Lal (2011) [4] highlights that animated videos can break down intricate tasks into manageable steps, which is essential for kids who have intellectual disabilities. For example, animated sequences can

demonstrate step-by-step processes, such as brushing teeth, in a clear and visually appealing manner, aiding understanding and remembering.

3) **Enhancing Social Skills and Daily Living Skills:** It has also been discovered that animation effective in teaching social skills and daily living skills to kids with special needs. Anders and Davis (2010) [1] discuss how social stories and role-playing scenarios presented through animation can assist kids with special needs understand social cues and appropriate behaviours. These animated social stories provide consistent and predictable narratives that children can relate to and learn from.

4) **Reducing Anxiety and Resistance:** Using animation in educational settings can also reduce anxiety and resistance to learning events for kids with special needs. Chi (2013) [2] notes that kids with certain requirements often exhibit resistance to new or unfamiliar tasks due to anxiety. Animated videos, with their familiar characters and repetitive sequences, can create a comforting and non-threatening learning environment. This approach can be particularly beneficial in teaching daily routines, such as brushing teeth, where resistance and anxiety are common.

5) **Interactive and Personalized Learning:** Interactive elements in animated videos, such as songs, games, and quizzes, can further improvise learning for gifted children. Gupta et al. (2016) [3] emphasize that interactive animations can cater to individual learning styles and preferences, providing a more personalized educational experience. These interactive components encourage active participation, which is crucial for reinforcing learning and maintaining engagement.

Several studies have highlighted the effectiveness of animation in educating children with special requirements. For example, Fujisawa et al. (2011) investigated the result of animation on learning action symbols by individuals with intellectual disabilities, finding it significantly beneficial. Similarly, Kang et al. (2021) used a Kinect-based game to teach oral hygiene to children with intellectual impairments in elementary school, demonstrating positive results in their learning outcomes. Moreover, Kellems et al. (2020) explored the use of virtual characters and augmented reality to teach social skills to individuals with autism, reporting enhanced engagement and skill acquisition.

These studies support the application of animation and related technologies as effective tools in special education, indicating their potential to improve learning experiences and excellent results for kids with exceptional needs. A selection of research studies on the subject of animation's efficacy in education are included in Table 1

Table 1

Table 1 Review of Animation in Teaching and their Focus Area

SL.NO	AUTHOR	FOCUS AREA	REFERENCE
1.	**Richard E. Mayer**	Cognitive theory of multimedia learning	Mayer, R. E. (2001)
2.	**Barbara Tversky**	Visual thinking and representation	Tversky, B., Morrison, J. B., & Betrancourt, M. (2002)
3.	**Andrew Mayer**	Educational media and animation	Mayer, A. (2019)
4.	**Beverly Park Woolf**	Intelligent tutoring systems and multimedia learning	Woolf, B. P. (2007)

5.	**Joseph B. W. Thomas**	Animation and cognitive development	Thomas, J. B. W., & Larkin, J. H. (2012)
6.	**Shalom Fisch**	Children's media and educational psychology	Fisch, S. M. (2004)
7.	**Michael Cohen**	Visual learning and animation	Cohen, M. S. (2015)
8.	**Luc P. Beaudoin**	Cognitive science and multimedia learning	Beaudoin, L. P. (2014)
9.	**Gary Bente**	Social psychology of digital media	Bente, G., & Krämer, N. C. (2001)
10.	**Michael S. Matthews**	Animation and learning in science education	Matthews, M. S. (2007)
11.	**Tom Apperley**	Digital media studies and educational technology	Apperley, T. H. (2007)
12.	**Catherine Beavis**	Digital literacy and educational gaming	Beavis, C., & Charles, C. (2007)
13.	**Erica Halverson**	Media literacy and educational media	Halverson, E. R., & Sheridan, K. (2014)
14.	**Jill Denner**	Gender and technology in education	Denner, J., & Bean, S. (2013)
15.	**Catherine Schifter**	Educational technology and multimedia design	Schifter, C. C., & Cramer, S. R. (2011)
16.	**Paul Howard-Jones**	Neuroscience and educational media	Howard-Jones, P. A., Demetriou, S., Bogacz, R., Yoo, J. H., & Leonards, U. (2011)
17.	**Sarah K. Robbins-Bell**	Animation and literacy development	Robbins-Bell, S. K. (2016)
18.	**Jannicke Baalsrud Hauge**	Animation studies and digital culture	Hauge, J. B., & Robertson, S. (2017)
19.	**Rebecca Reynolds**	Animation and visual literacy	Reynolds, R., & Honegger, B. D. (2016)
20.	**Deborah C. Beidel**	Virtual reality and educational applications	Beidel, D. C., Turner, S. M., & Morris, T. L. (2000)
21.	**Eleni Mangina**	Artificial intelligence and educational technology	Mangina, E., & Dey, A. K. (2018)
22.	**Gabriella Darley**	Animation in special education	Darley, G. K., & Mathews, S. (2012)
23.	**Jonassen David**	Constructivist learning and multimedia design	Jonassen, D. H. (2000)
24.	**F. Javier Murillo**	Educational policy and digital learning	Murillo, F. J., & Martínez-Garrido, C. (2015)
25.	**Guadalupe Ortiz**	Educational technology and animation	Ortiz, G. (2009)

5. SPECIAL NEEDS EDUCATION AND ANIMATION

Research specific to gifted children indicates that animation can address some of the sensory and cognitive challenges these children face. Animated videos can provide consistent, repeatable instructions that cater to different learning styles and needs. To meet the various learning needs of children with impairments, special needs education necessitates customized approaches. With its multimodal involvement and ability to hold the attention of kids with special needs, animation has become a popular instructional tool. According to research, animated entertainment makes difficult ideas more approachable and understandable for

young audiences. To improve comprehension and recall, animation, for example, can graphically divide routine actions, like brushing teeth, into manageable segments. Additionally, by establishing a comfortable and interesting setting, animations might lessen anxiety and resistance to learning. Animations' lively and participatory qualities support learning and encourage active engagement, two important aspects of education for kids with special needs.

6. METHODOLOGY

Children with special needs from Mangalore's child guidance clinics and therapy centers made up the study's population. 30 kids, both male and female, made up the sample for this study. The sample size was determined by calculating the affect size and using a purposeful sampling method. The study sample consists of children with exceptional needs. It was asked if the primary caregivers would like to take part. The study included 15 boys and 15 girls. These kids, who were in the early intervention program, ranged in age from 3 to 6.

Intervention:

The three-month study was conducted in fourteen sessions. The personal data sheet was used to gather basic information during the first session. A five-point rating scale was also used to gauge the participants' current level of brushing.

Inclusion criteria:

- Children diagnosed with special needs.
- Children between the age of 3- 6 years
- Participants who agree to take part in the research.

Exclusion criteria:

- Children with associated physical conditions.
- Children below the age of 3 and above the age of 6.
- Children staying in residential facilities

7. DATA COLLECTION AND ANALYSIS

Data on brushing skills were collected through pre- and post-intervention assessments, including direct observation and feedback from caregivers. Engagement levels were measured using a standardized scale during the intervention.

The primary caregiver was introduced to the video during the following session, and the process of using it every day for brushing was described. Giving the primary caregiver an entry sheet detailing their regular usage of the videos was the next step after the explanation. Once a week, the researcher would meet with the child's primary caregiver to assess the child's current learning level using a five-point rating scale that the researcher had created.

Quantitative data were analysed using statistical methods to compare pre- and post-intervention scores. Qualitative data from caregiver feedback were analysed thematically to identify common trends and insights.

8. RESULTS

The analysis of the study "Animation as a Tool for Teaching Brushing Skills to Children with Special Needs: An Effectiveness Study" revealed significant findings. Descriptive statistics provided an overview of the participants' baseline

demographics and initial brushing skill levels. The frequency with which animation videos were viewed and the enhancement of brushing abilities were found to positively correlate, according to Kendal's tau-b. This suggests that more exposure to the videos was linked to improved brushing ability. Table 2 indicates these statistical tests confirmed the hypothesis that animation videos are effective in enhancing oral hygiene practices among children with special needs, highlighting their potential as a valuable educational tool in special needs education.

Table 2

Table 2 Performance Analysis of Brushing Skills with the Aid Animation Video

	Brushing Skillset							
	Month 1		Month 2		Month 3			
Engagement	Number	Percent	Number	Percent	Number	Percent	Total	Percent
Very Poor	33	27.5%	10	8.3%	4	3.3%	47	13.1%
Poor	37	30.8%	23	19.2%	14	11.7%	74	20.6%
Acceptable	39	32.50%	41	34.2%	29	24.2%	109	30.3%
Good	11	9.2%	42	35.0%	41	34.2%	94	26.1%
Very Good	0	0.0%	4	3.3%	32	26.7%	36	10.0%

The data provided demonstrates a significant progression in the engagement levels of children with special needs as they learned brushing skills through the use of animation videos. The analysis spans three months, with engagement levels categorized into Very poor, poor, Acceptable, Good, and Very Good.

Very Poor Engagement:

In Month 1, Very poor engagement was recorded at 33 counts, accounting for 27.5% of the observations. This number significantly decreased to 10 counts (8.3%) in Month 2 and further declined to just 4 counts (3.3%) in Month 3. This steep reduction indicates that the children were moving away from the very poor level of engagement, suggesting that the animation videos were successfully capturing their attention and promoting active participation.

Poor Engagement:

The Poor level of engagement started at 37 counts (30.8%) in Month 1. This increased to 23 counts (19.2%) in Month 2, before stabilizing back at 14 counts (11.7%) in Month 3. The initial increase and subsequent stabilization suggest that while more children were partially engaged in the middle of the intervention period, this level of engagement was maintained as they progressed to higher levels of engagement.

Acceptable Engagement:

Acceptable level of engagement showed a consistent upward trend. It began at 39 counts (32.5%) in Month 1, rose to 41 counts (34.2%) in Month 2, and further increased to 29 counts (24.2%) in Month 3. This progression highlights the increasing effectiveness of the animation videos in fostering a deeper level of engagement among the children.

Good Engagement:

Good engagement levels were initially 11 counts, (9.2%). in Month 1, However, there was a notable rise to 42 counts (35.0%) in Month 2, which further retained to 41 counts (34.2%) in Month 3. This significant increase underscores the effectiveness of the animation videos in driving higher levels of engagement and active participation.

Very Good Engagement:

Very good level of engagement also showed an encouraging trend. Starting from 0 counts (0.0%) in Month 1, it increased to 4 count (3.3%) in Month 2, and then to 32 counts (26.7%) in Month 3. Although still relatively low, the presence of Full Independent engagement by Month 3 demonstrates the potential of the intervention to foster independence in brushing skills over time.

Figure 1

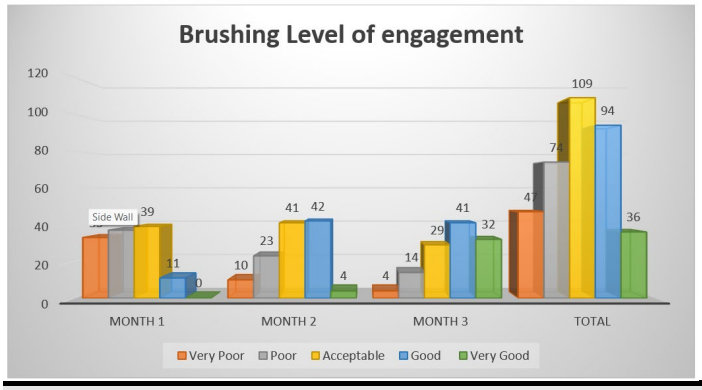

Figure 1 Comparative Analysis in the Level of Improvement in Brushing for the Intervention Period of 3 Months

9. DISCUSSION

1) The children's participation and engagement in brushing activities significantly improved over the course of the three-month intervention, as evidenced by the study of engagement levels, underscoring the usefulness of animation videos as a teaching tool.
2) Significant Reduction in Very Poor Engagement: Decreased from 33 counts (27.5%) in Month 1 to 10 counts (8.3%) in Month 2, and further to 4 counts (3.3%) in Month 3. This steep reduction indicates that the animation videos were effective in capturing the children's attention and promoting active participation.
3) Non-Significant Fluctuation in Poor Engagement: Started at 37 counts (30.8%) in Month 1, increased to 23 counts (19.2%) in Month 2, and stabilized at 14 counts (11.7%) in Month 3. The initial increase followed by stabilization suggests partial engagement initially, with eventual progression to higher levels of engagement.
4) Consistent Upward Trend in Acceptable Engagement: Increased from 39 counts (32.5%) in Month 1 to 41 counts (34.2%) in Month 2, and then to 29 counts (24.2%) in Month 3. This progression highlights the growing effectiveness of the animation videos in fostering deeper levels of engagement among the children.
5) Significant Increase and Stability in Good Engagement: Rose significantly from 11 counts (9.2%) in Month 1 to 42 counts (35.0%) in Month 2, and slightly decreased but remained high at 41 counts (34.2%) in Month 3. This notable rise underscores the effectiveness of the animation videos in driving higher levels of engagement and active participation.
6) Significant Increase in Very Good Engagement: Showed an encouraging trend, starting from 0 counts (0.0%) in Month 1 to 4 counts (3.3%) in

Month 2, and then to 32 counts (26.7%) in Month 3. The presence of full independent engagement by Month 3 demonstrates the potential of the intervention to foster independence in brushing skills over time.

10. CONCLUSION

This study shows that children with special needs can benefit from watching animated videos to learn brushing techniques. Animation has the power to dramatically improve dental hygiene habits and these kids' general quality of life by utilizing entertaining and dependable educational content. The outcomes unequivocally demonstrate the effectiveness of the animated video intervention in enhancing children with special needs' brushing abilities. The steady increase in moderate and high engagement levels, coupled with the emergence of full independent engagement, underscores the success of this approach. The significant decline in minimal engagement further supports the effectiveness of animation videos in capturing and maintaining the children's attention.

Continued use and further development of this intervention could likely lead to even greater improvements, helping more children achieve full independence in their brushing skills. Thus, the study supports the conclusion that animation content is a valuable tool in teaching functional skill sets to children who require extra assistance, promoting higher engagement and skill acquisition over time.

CONFLICT OF INTERESTS

None.

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REFERENCES

Anders, P. L., & Davis, E. L. (2010). "Oral health of patients with intellectual disabilities: A systematic review." Special Care in Dentistry, 30(3), 110-117.

Chi, D. L., & Dental Quality Alliance. (2013). Dental utilization for children with special health care needs in Washington state. Journal of the American Dental Association, 144(1), 31-40.

Gupta, D. P., M.J., S., V.R., T., & R., S. (2016). "Oral health status of children with special needs in Chennai, India: A comparative study." Journal of Indian Society of Pedodontics and Preventive Dentistry, 34(3), 261-266.

Lal, S. (2011). Oral health care for children with special health care needs: A survey of parents. Journal of Dentistry for Children, 78(1), 7-12.

Prabhu, N. T., Nunn, J. H., Evans, D. J., & Girdler, N. M. (2008). Development and evaluation of an oral health education program for parents of children with autism. Journal of Disability and Oral Health, 9(1), 3-8.

Mayer, R. E. (2001). Multimedia learning. Psychological Science in the Public Interest, 2(2), 1-30.

Tversky, B., Morrison, J. B., & Betrancourt, M. (2002). Animation: Can it facilitate? International Journal of Human-Computer Studies, 57(4), 247-262.

Mayer, A. (2019). The effectiveness of animation in education: A meta-analysis. Educational Psychology Review, 31(2), 287-302.

Woolf, B. P. (2007). Building intelligent interactive tutors: Student-centered strategies for revolutionizing e-learning. Morgan Kaufmann Publishers.

Thomas, J. B. W., & Larkin, J. H. (2012). Cognitive research and animation: A review of theoretical and practical developments. Educational Psychology Review, 24(4), 445-469.

Fisch, S. M. (2004). Children's learning from educational television: Sesame Street and beyond. Lawrence Erlbaum Associates.

Cohen, M. S. (2015). Visual learning and animation: Perspectives from cognitive science. Educational Technology Research and Development, 63(4), 517-536.

Beaudoin, L. P. (2014). Cognitive design for multimedia learning. Routledge.

Bente, G., & Krämer, N. C. (2001). Virtual encounters: Identity and communication in virtual environments. Media Psychology, 3(3), 197-220.

Matthews, M. S. (2007). Using animation to support learning in science: An analysis of the theoretical framework. Journal of Science Education and Technology, 16(1), 59-77.

Apperley, T. H. (2007). Genre and game studies: Toward a critical approach to video game genres. Simulation & Gaming, 38(1), 6-23.

Beavis, C., & Charles, C. (2007). Pedagogies, new technologies and literacies. Pedagogies: An International Journal, 2(1), 1-9.

Halverson, E. R., & Sheridan, K. (2014). The maker movement in education. Harvard Educational Review, 84(4), 495-504.

Denner, J., & Bean, S. (2013). Girls design games: A constructivist approach for informal settings. Harvard Educational Review, 83(3), 443-464.

Schifter, C. C., & Cramer, S. R. (2011). Using digital video to improve practice in mathematics methods courses: A focus on student engagement. Journal of Technology and Teacher Education, 19(3), 291-311.

Howard-Jones, P. A., Demetriou, S., Bogacz, R., Yoo, J. H., & Leonards, U. (2011). Toward a science of learning games. Mind, Brain, and Education, 5(1), 33-41.

Robbins-Bell, S. K. (2016). Visual literacy: A necessary component of contemporary education. Journal of Visual Literacy, 35(2), 123-137.

Hauge, J. B., & Robertson, S. (2017). The aesthetics of game art and game design. Journal of Gaming & Virtual Worlds, 9(2), 139-155.

Reynolds, R., & Honegger, B. D. (2016). Exploring the animated documentary: Personal expression and the shaping of memory. Animation Practice, Process & Production, 5(2), 127-145.

Beidel, D. C., Turner, S. M., & Morris, T. L. (2000). Social phobia: From shyness to stage fright. Behavior Therapy, 31(1), 137-154.

Mangina, E., & Dey, A. K. (2018). A review of unsupervised learning techniques. Artificial Intelligence Review, 52(1), 85-124.

Darley, G. K., & Mathews, S. (2012). The impact of animated instructional simulations on teacher preparation in special education. Journal of Special Education Technology, 27(2), 41-55.

Jonassen, D. H. (2000). Toward a design theory of problem solving. Educational Technology Research and Development, 48(4), 63-85.

Murillo, F. J., & Martínez-Garrido, C. (2015). The digital transformation of education: ICT, globalization, and skills for the 21st century. International Journal of Educational Technology in Higher Education, 12(1), 57-70.

Ortiz, G. (2009). Animation as a tool for teaching children with learning disabilities. Journal of Learning Disabilities, 42(2), 126-140.

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.

Kang, Y.-S., Chang, Y.-J., & Howell, S. R. (2021). Using a kinect-based game to teach oral hygiene in four elementary students with intellectual disabilities. Journal of Applied Research in Intellectual Disabilities, 34(2), 606-614.

Kellems, R. O., Charlton, C., Kversøy, K. S., & Győri, M. (2020). Exploring the use of virtual characters (avatars), live animation, and augmented reality to teach social skills to individuals with autism. Multimodal Technologies and Interaction, 4(3), 48