

1. Introduction

According to Article 12 of the *Law on Education of the Republic of Azerbaijan*, three main forms of education are recognized in the country:

1. formal,
2. non-formal,
3. informal [Law on Education of the Republic of Azerbaijan].

Formal education refers to learning processes that result in a state-recognized education certificate. This includes general education, primary vocational education, secondary vocational education, higher education, retraining, and repeated higher or secondary vocational education. Informal education, by contrast, refers to self-education through independent study, while non-formal education encompasses learning acquired through courses, clubs, and individual lessons that are not accompanied by a state-recognized diploma.

Globally, non-formal forms of education increasingly include the use of **3D animation technologies**. The concept of 3D refers to the process of creating three-dimensional moving images. These three dimensions represent the width, length, and height of an object or scene [Journal of Educational Psychology, 83(3), 318–328]. In the educational context, 3D animation provides learners with a three-dimensional visualization of topics. Moreover, applications have diversified across disciplines, resulting in field-specific concepts such as *3D mathematics*, *3D biology*, and *3D history*.

Although extensive international research has been conducted on the application of 3D animation in education, this issue has not been systematically studied in Azerbaijan. Therefore, the present research constitutes one of the first attempts to evaluate its significance in the local context. Insights were obtained through structured conversations with education experts, teachers, and a psychologist, enabling the formulation of a contextual understanding of the benefits of 3D animation for Azerbaijani schools. The overarching aim of this study was to examine the potential effects of 3D animation on the quality of education in general education institutions of Azerbaijan.

The study employed a qualitative research design and was limited to interviews with experts and practitioners from general education schools in Baku. The research group included specialists with more than five years of professional experience. Participants voluntarily joined the study, providing sincere and accurate responses without external psychological or political pressure. The questions posed were tailored to the aims of the research, and the participants did not perceive the study as a threat to their personal or professional status. It is anticipated that the findings of this research will be considered valuable by the educational community, particularly by the Ministry of Education of the Republic of Azerbaijan.

It is acknowledged that the opinions of participants may reflect subjective judgments and thus introduce potential biases [Creswell, 2016]; [Yıldırım & Şimşek, 2008]. Nevertheless, the study highlights critical dimensions of the use of 3D animation in education.

Existing literature confirms that 3D animation enables the detailed explanation of abstract and complex concepts, making them more accessible, accelerating comprehension, differentiation, and memory retention. As multiple sensory channels are engaged in the learning process, knowledge is stored more effectively and retained over time. 3D animation thus allows learners to penetrate deeper into phenomena while simultaneously creating personalized learning experiences. It also fosters curiosity and motivation, enhancing the enjoyment of learning and improving overall academic outcomes [Catenazzi & Sommaruga, 1999]; [Mayer, 2001]; [Journal of Educational Psychology, 83(3), 318–328]; [Winn, Li, & Schill, 1991].

According to Zahra [2016], 3D animation transforms the educational process into an enjoyable environment. It enhances teachers' capacity to diversify their instructional strategies while also stimulating students' imagination and creativity. Observations further indicate that children often identify with 3D animation characters, adopting them as role models. Consequently, 3D animation functions not only as a formal learning tool but also as an informal educational influence that shapes children's worldview, lifestyle, and behavior.

It is noteworthy that powerful states and corporations also use 3D animation strategically to transmit cultural values and ideologies to children, which may expose them to manipulative influences. This phenomenon is compounded by the fact that most animations are produced in foreign languages, contributing to the infiltration of loanwords into the Azerbaijani language. Therefore, careful pedagogical oversight is necessary when integrating 3D animation into classrooms.

In the contemporary era, communication is undergoing a transition from verbal to visual forms, with the importance of visual communication growing significantly. As Winn [1989] stated, “a picture is worth a thousand words.” Similarly, Mengüç [2017] argued that in human communication, words account for only 7% of meaning, tone of voice for 38%, and body language or visual cues for 55%. Given that visuality is central to 3D animation, the effectiveness of information delivery is significantly enhanced, thereby improving the overall quality of learning.

Yusifova [2019] noted that **Generation Z** (born after 2000) represents the first generation of digital natives for whom digital technology is an integral part of life. They are also referred to as the “iGen” or “instant online” generation. According to generational theory developed by Strauss and Howe, this cohort values individualism and tends to live in relative isolation. This perspective reinforces the importance of incorporating 3D animation into education, as it aligns with the interests and learning preferences of modern students.

Supporting evidence is provided by Bamford [2011], who conducted a study across 15 schools involving 740 students (aged 10–13) and 15 teachers. The findings revealed that 90% of students watched 3D films with enthusiasm and interest. Moreover, 86% of students who engaged with 3D animations performed better academically compared to their peers who did not. These students also demonstrated stronger knowledge retention, increased motivation, and a greater propensity for creative thinking and exploration.

2. Limitations and Challenges of 3D Animation in Education

Despite the numerous advantages outlined in the previous section, several challenges and limitations associated with the use of 3D animations in education have also been identified. According to research conducted by the *Progressive Institute of Education and Learning*, the following drawbacks may arise:

- The pace of information delivered through 3D animation may not correspond to the individual learner’s rate of comprehension.
- Poorly designed animations may diminish the pedagogical value of critical information.
- Learners may overlook or miss important details embedded within the animation.
- The animated content may not align with, or sufficiently reinforce, learners’ prior knowledge and existing information base.

To mitigate these challenges, recommendations include allowing users to control the playback of 3D animations, introducing adjustable video speeds, and ensuring that professional educators manage the presentation and integration of such materials.

3. Existing Problems in the Educational Context

Traditional teaching methods are increasingly being replaced by modern, interactive instructional practices. As noted in the *State Strategy for the Development of Education in the Republic of Azerbaijan*, one of the strategic directions of national education policy is the creation and expansion of an infrastructure that meets modern demands and supports lifelong learning. A crucial component of this direction is the establishment of information and communication technology (ICT)-based infrastructures in educational institutions, aligned with contemporary teaching methodologies.

Although substantial progress has been made in modernizing educational infrastructure under various state programs, analyses show that the use of modern technologies in the teaching process remains limited. In many cases, the systems that have been developed are underutilized. Consequently, the teaching methods employed by most educators do not fully correspond to contemporary educational requirements. A key problem identified is the lack of applied educational content available in the Azerbaijani language.

Given the rapid global diffusion of technological innovations, it is imperative that Azerbaijan leverages international best practices to accelerate the integration of ICT into education. Addressing these issues requires the development of progressive teaching methods and the enhancement of teachers' professional competencies.

4. Research Model

The study was based on a **qualitative phenomenological research design**, which seeks to examine phenomena that are recognized but insufficiently understood in depth, relying on the insights of individuals with relevant expertise [Creswell, 2016]; [Merriam, 2015]; [Patton, 2014]; [Yıldırım & Şimşek, 2008].

In phenomenological research, **interviews** serve as the primary data collection tool. Participants are selected from individuals representing the focus of the study [Yıldırım & Şimşek, 2008]. The aim is not to generalize findings but to capture **diverse perspectives**; therefore, maximum variation sampling was employed [Merriam, 2015]; [Patton, 2014].

Typically, phenomenological studies involve approximately ten participants [Creswell, 2016]; [Yıldırım & Şimşek, 2008]. For the purposes of this research, five individuals were included in the study group: two education experts, two teachers, and one psychologist. The exact number of participants was not predetermined; instead, recruitment continued until new interviews no longer generated novel insights. Data collection was concluded once saturation was reached [Merriam, 2015]; [Patton, 2014].

5. Research Group Composition

The composition of the research group is shown in **Table 1**. Participants were selected based on professional experience (minimum of 5 years), academic standing, and relevance to the subject matter.

Table 1. Research group composition

Participant type	ID codes	Gender (M/F)	Years of experience	Academic status	Number
Education experts	T1, T2	1 M / 1 F	20	Professor, Dr.	2
Psychologist	P	1 F	7	–	1
Teachers	M1, M2	1 M / 1 F	6–7	–	2
Total	–	2 M / 3 F	–	–	5

5.1. Additional description of the research group

As shown in Table 1, **two education experts** participated in the study; **both are male**. One participant has **20 years** of professional experience, and the other has **7 years**. One holds the title of **Professor**, while the other is a **Doctor of Philosophy in Pedagogy**. The study also included **one female psychologist** with **6 years** of experience.

Of the **two teachers** in the research group, **one is male** and **one is female**. They have **6** and **7 years** of teaching experience, respectively. One teacher specializes in **biology**, and the other teaches **Azerbaijani language and literature**.

6. Data collection instruments

Flexible interviewing techniques were employed to probe more deeply whenever responses were unclear or insufficient for the purposes of the study. To this end, **conversation format** and **semi-structured interview questions** were used [Patton M., 2014]. During the interviews, participants were asked **additional, emergent questions** that were **not pre-formulated**, arising naturally in the course of discussion. To gain deeper insight, the interviewer also used **probing prompts** such as: “*What else can you say?*”, “*Why do you think so?*”, “*What else could be added?*” With the participants' permission, all responses were **audio-recorded** to ensure that no information was overlooked.

A **pilot interview** was conducted with one participant to evaluate the adequacy of the questions vis-à-vis the topic; however, these pilot data were **not included** in the results [Creswell J.V, 2016].

Interview questions:

1. How do you evaluate the use of 3D animations in general secondary schools? Why?
2. In your opinion, how might the application of 3D animations in secondary schools affect the **quality of education**? Why do you think so?
3. As a teacher, do you use 3D animations in explaining topics? Why?
4. When using 3D animations in the teaching process, what **new aspects** do you observe in students' behavior?
5. At which **educational levels** should 3D animations be used more frequently? Which **subjects** support 3D animations most strongly? Why?

7. Data analysis

The collected data were analyzed using **internal content analysis methods**. Categories, themes, and codes were identified; findings are presented with explanatory commentary. Specifically, the data were **coded, carefully read, synthesized, and interpreted**; they were then organized in alignment with the **research questions**, accompanied by the relevant **citations**. Participant **code names and roles** are reported, while personal identities were kept **anonymous** [Creswell J.V, 2016]; [Merriam S. B, 2015]; [Yıldırım A., Şimşek H, 2008].

8. Validity (credibility)

In qualitative research, **validity** refers to an impartial and unbiased investigation. For this study, both **internal** and **external** validity were addressed [Lincoln Y.S., Guba E, 1985].

8.1. Internal validity (member checking). During and after the interviews, **member checking** was conducted. In the interview phase, the interviewer verified understandings with prompts such as *“Is this what you meant?”* and *“Did I understand correctly?”* After the interviews, participants were provided with summaries of their statements and asked to **confirm** their accuracy.

8.2. External validity and transferability. Since the aim of qualitative research is **in-depth exploration** rather than statistical generalization, generalization is not intrinsic to its nature. Instead, the concept of **transferability** applies [Lincoln Y.S., Guba E, 1985]. Because this study includes the views of **education experts, a psychologist, and teachers** with a **minimum of 5 years** of professional experience, the findings are **transferable** to individuals within these groups in **Azerbaijan** and may inform **future studies** on related topics.

9. Reliability (dependability)

No **leading questions** were used in the interviews; data are reported **impartially**. No identifying information that could reveal participants' identities is disclosed [Creswell J.W. 2007]. As noted, **participation was voluntary**.

Time was dedicated to engaging with respondents **before, during, and after** the interviews, including both **phone** and **face-to-face** conversations. Because the researcher already knew the respondents, **rapport** was readily established. Interviews were conducted in a comfortable environment, adhering to agreed-upon procedures. Each interview lasted **1–1.5 hours**. With participants' consent, the audio was recorded and later **transcribed**, then **archived** for potential future reference [Lincoln Y.S., Guba E, 1985].

At the outset, participants received an **information sheet** detailing the study's aims, and they were informed of their right to **withdraw at any time**. In qualitative studies, the **researcher's identity, worldview, and experience** shape the inquiry; thus, the researcher should be specially trained to understand the nature of qualitative work. Interview experience, in particular, enables **deeper exploration** of data [Lincoln Y.S., Guba E, 1985].

10. Consistency (coherence)

To verify the **consistency** of the study, an expert evaluated the **alignment** between the **research questions** and the **themes**, as well as the alignment between the **results** and the **research questions** [Yıldırım A., Şimşek H, 2008].

11. Analyses

Participants—including **education experts**, **teachers**, and the **psychologist**—evaluated the application of **3D animations** in education and their effect on **educational quality** in terms of **visual memory**, **comprehension**, **motivation**, and the **enrichment of methods**.

Theme 1. Visual memory

Subtheme 1.1. Retention. Respondents believe that 3D animations **serve visual memory**, since people remember information **better** when they both **hear** and **see** it. As the psychologist noted, if approximately **50%** of the learning process is **visual**, then increasing visuality through 3D animations **supports retention**, thereby enhancing **efficiency** and promoting **effective learning**.

- **Education Expert 1:** “Just as we increase visuality in explaining topics by using pictures, videos, and teaching aids, **3D animations also serve to increase visuality**. Why is it necessary to increase visuality? Humans comprehend better when **more senses** are engaged in the process of acquisition. For example, as a biologist, I am certain that if there are **animated versions** of topics like **chromosomes** and **DNA**, this will deepen not only **learning** but also **retention** and **understanding**. Isn't that the aim of education? We cannot go against **world science**.”
- **Teacher 2:** “If I convey any fact **only verbally**, the likelihood of forgetting is higher. But if I **both say it and show it visually**, **retention** becomes more achievable. For instance, when a topic explanation is accompanied by a **visual aid** or **video**, I observe that it attracts students' attention much more. In this respect, because **3D animation is a visual medium**, it positively influences **memory**. Therefore, it helps us achieve our goals and **positively affects quality**.”
- **Psychologist:** “Learning methods are divided into three types: **visual**, **auditory**, and **tactile**. If humans learn approximately **20%** of what they know by **touch**, **30%** by **hearing**, then the remaining **50%** is learned **visually**. Information acquired visually is remembered better; that is why we often hear statements like, *‘I don't remember the topic, but I recall where it was written on the page.’* In **visual learning**, a person retains **more material**. **3D animation** of curricular topics can be beneficial in this regard. Reading something from a book alone does not always yield efficient results. Moreover, **today's children** show special interest in **new technologies**.”

Theme 2. Comprehension

Subtheme 2.1. Explaining abstract concepts. All respondents indicated that using **3D animation** has a **positive effect on comprehension**. In their view, 3D animations are particularly valuable in **conveying abstract concepts** to students, as they help when **detailed explanation** and **mental visualization** are challenging. In this way, the **comprehension process** is supported, enabling **deeper exploration** of the subject matter.

- **Teacher 1 (Biology):** “Because my specialty is **biology**, let me give an example from my field. Visuality is essential in biology; many topics that must be studied at a **microscopic level** cannot be explained adequately **in words**. For example, with **verbal explanation alone**, we cannot help students visualize the **structure of the cell**. In such cases, **3D animations** are very effective.”
- **Education Expert 1:** “The main point is being able to **see** what is explained. I can tell you **thousands of stories**, but do my words **come to life** in your imagination? I'm not entirely sure. If I **show** you what I want to convey **visually**, you will comprehend it better. Explaining the structures of **glucose** and **sucrose** in words is as different from **tasting** them as verbal explanation differs from **3D animation**—it's a very apt comparison.”

Theme 3. Motivation

Subtheme 3.1. Learning through enjoyment. Respondents consider 3D animations to be significant in terms of **motivation** and **drawing students' attention** to the topic. They believe that **student interest** directly influences **educational quality** and that learners are **more eager** when their interests are **taken into account**. Given that the **modern generation** places special emphasis on **digital media** and **moving images**, 3D animations are deemed valuable for **motivating students** and **meeting their interests**. This also **transforms the educational process** into an

enjoyable environment, enabling learning through enjoyment. Topics supported by 3D animations become more engaging and novel for students.

- **Education Expert 2:** “Modern children show a great interest in new technologies. Rather than listening to someone or reading something, they prefer to watch. We must cater to their interests. When we do so, we can attract their attention to learning. If we create the conditions for students to learn while having fun, they will show greater interest in education. Children are always open to novelties, and repeating the same things in education—or even in games—bores them. 3D animations will bring a breath of fresh air to their educational experience.”

Theme 4. Enrichment of Teaching Methods

Subtheme 4.1. Teachers’ professional development. Education experts, teachers, and the psychologist involved in the study also emphasized that the integration of 3D animations enriches teaching methods. Overreliance on the same instructional approach can render lessons monotonous. From this perspective, 3D animation provides teachers with opportunities to diversify their methodologies, stimulate professional growth, and remind them of the importance of introducing periodic methodological changes. The purposeful enrichment of teaching strategies is one of the key factors contributing to improved educational quality.

- **Psychologist:** “We must remember that children quickly grow tired of sameness and repetition. Explaining topics through 3D animations is a different method, but we should not forget that even the best method can become boring if overused—just like eating your favorite food every day until you lose your appetite. Teachers, as the creators of their lessons, should know which method to use, where, and how, and must be able to make changes when necessary.”
- **Teacher 2:** “I always try to introduce innovations in my lessons. For this reason, I frequently conduct research. Children love new things. Gathering information about innovations and preparing to apply them in class takes a great deal of time. If ready-to-use 3D animations were provided for teaching, instructional methods would be greatly enriched.”

Table 2

Themes, subthemes, and representative participant quotes on the use of 3D animations in education

Theme	Subtheme	Key insights	Representative quotes
Visual memory	Retention	3D animations strengthen visual memory; learners retain more when they both hear and see content.	<i>Education Expert 1:</i> “3D animations deepen not only learning but also retention and understanding.” <i>Teacher 2:</i> “If I say it and also show it visually, memory retention becomes more achievable.” <i>Psychologist:</i> “50% of learning occurs visually; thus, 3D animations support retention.”
Comprehension	Explaining abstract concepts	Animations make abstract or microscopic concepts tangible; they support deeper comprehension.	<i>Teacher 1 (Biology):</i> “With words alone we cannot help students visualize the cell’s structure. In such cases, 3D animations are very effective.” <i>Education Expert 1:</i> “Verbal explanation alone is limited; visual demonstration ensures better comprehension.”
Motivation	Learning through enjoyment	Students are more engaged when lessons are interactive and visual; interest directly	<i>Education Expert 2:</i> “Modern children prefer to watch rather than listen. If we create conditions for learning while having fun, students will show greater interest.”

		affects quality.	<i>Psychologist</i> : “Visuality directs learners’ attention to the topic and sustains motivation.”
Enrichment of methods	Teachers’ professional development	Animations diversify instructional strategies, prevent monotony, and encourage teacher innovation.	<i>Psychologist</i> : “Even the best method becomes boring if overused; teachers must know when and how to vary methods.” <i>Teacher 2</i> : “If ready-to-use 3D animations were provided, teaching methods would be greatly enriched.”

12. Recommendations

Based on the findings, the following recommendations are proposed:

1. **Pilot projects**: Implement 3D animations in several schools as pilot projects. Schools should be equipped with the necessary technology, and animations should be prepared by specialists in collaboration with teachers.
2. **Interactivity**: When designing 3D animations, interactivity should be prioritized. For example, animations may include embedded questions directed at students or knowledge delivered through educational games.
3. **Corporate social responsibility**: Private companies may develop 3D educational materials as part of their social responsibility initiatives. Since 3D animations can also serve as informal learning tools, partnerships with companies should be established to raise their awareness and encourage their participation in educational innovation.
4. **Teacher involvement**: According to one expert, the creation of 3D animations should not be considered a teacher’s duty. Instead, teachers should be provided with ready-made materials and trained in how to integrate them into their lessons—similar to how textbooks are delivered to them in complete form.

14. Findings

The qualitative analysis revealed four central themes regarding the application of **3D animations in Azerbaijani schools: visual memory, comprehension, motivation, and enrichment of teaching methods**. Each theme was supported by subthemes and validated through participant narratives. The results are summarized in **Table 2**.

14.1. Visual memory

Participants consistently emphasized that 3D animations strengthen **visual memory** by engaging multiple senses in the learning process. Respondents noted that students remember more effectively when information is **both heard and seen**. According to the psychologist, since **50% of learning occurs visually**, animations significantly enhance retention. Teachers and experts highlighted that animations make complex subjects—such as chromosomes or DNA—easier to remember and internalize.

14.2. Comprehension

The second major theme was **enhanced comprehension**, particularly of **abstract or microscopic concepts**. Teachers explained that in disciplines such as biology, it is difficult to convey cellular structures or biochemical processes through verbal explanation alone. In such cases, 3D animations provide clear visualizations, making abstract ideas **concrete and accessible**. Education experts stressed that animations serve as effective mediators between verbal explanation and student understanding, allowing learners to visualize what is otherwise difficult to imagine.

14.3. Motivation

Respondents also emphasized the role of 3D animations in fostering **motivation and engagement**. Students’ interest was described as directly linked to educational quality, with modern learners displaying a strong preference for **visual and digital content** over traditional lectures or textbooks. Experts and the psychologist noted that animations can

transform the classroom into an **enjoyable environment**, where students learn while being entertained. This aligns with global findings that motivation is a critical determinant of educational success.

14.4. Enrichment of teaching methods

Finally, participants viewed 3D animations as a means of **enriching teaching strategies** and supporting **teachers' professional development**. Over-reliance on a single method was described as monotonous and ineffective. Teachers reported that animations could diversify instruction, introduce variety into lessons, and remind educators of the need for **methodological flexibility**. The psychologist warned, however, that even effective methods may become dull if overused; thus, teachers must exercise **pedagogical creativity** in determining when and how to apply animations.

13. Conclusion

The rapid development of modern technologies requires educational institutions to continuously adapt, respond to new needs and expectations, and engage in ongoing renewal. In this context, the integration of **3D animations** into teaching is of particular significance.

The findings of this study indicate that the use of 3D animations in teaching has a **positive impact on educational quality**. Experts, teachers, and the psychologist linked their impact to improvements in **visual memory**, **comprehension**, **student motivation**, and the **enrichment of teaching methods**. Respondents agreed that 3D animations support **visual memory**. As noted by the psychologist, approximately **50% of learning and knowledge acquisition occurs through visual means**. Therefore, ensuring long-term retention requires methods that strengthen visual engagement, and 3D animations fulfill this role by enhancing efficiency and facilitating effective learning.

Another factor positively influenced by 3D animations is **comprehension**. Respondents observed that animations are particularly effective in conveying **abstract concepts**, as they allow learners to see and explore what is otherwise difficult to imagine. In this way, comprehension is reinforced, and opportunities for deeper investigation arise.

The results also demonstrate that the use of 3D animations is crucial for **stimulating student interest**, which directly influences learning quality. When student curiosity is met, learning becomes more effective and enjoyable. In fact, 3D animations transform the classroom into an **engaging and entertaining learning environment**, enabling students to **learn through enjoyment**.

Finally, the introduction of 3D animations contributes to the **enrichment of teaching methods** and supports **teachers' professional development**. All members of the research group viewed 3D animation as a means of diversifying instructional strategies, thereby enhancing teaching quality.

In conclusion, the adoption of 3D animations in Azerbaijan's general education schools has the potential to significantly improve the quality of learning by strengthening visual memory, supporting comprehension, enhancing motivation, and enriching pedagogical methods. However, for successful implementation, **pilot projects**, **teacher training**, **infrastructural investments**, and **inter-institutional cooperation** are essential.

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Conflict of Interest

The author declares **no conflict of interest** related to this research.

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