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PERSPECTIVES
OF USING 3D TECHNOLOGIES IN TEACHING BIOLOGY

PERSPECTIVAS DEL USO DE TECNOLOGÍAS 3D EN LA ENSEÑANZA DE BIOLOGÍA

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ABSTRACT

The objective of this article is to analyze the perspectives of the application of 3D technologies in the teaching of biology, discussing the work done in this direction and the gained achievements. Since the use of technologies in the field of education is considered a priority, attention is drawn to the changes occurring in the fields of biology and medicine. The article underscores a critical realization that basic education alone will not propel us far enough to compete in our rapidly evolving world. Addressing these challenges is not only the responsibility of educators but is also a collective effort that necessitates a synergy between evolving global educational reforms and the dynamic application of ever-changing teaching technologies. Then, given the experimental nature of biology, traditional teaching approaches, such as lectures, visual aids, and multimedia presentations, are no longer sufficient. In the work it is contended that, in today's landscape, numerous scientific hypotheses once considered validated are losing significance due to the continual application of cutting-edge technologies. This dynamic evolution in scientific understanding results in the creation of new fields of science and professions. Therefore, the 21st century education requires to educate the founders of tomorrow, young people who can create radical changes in the society and solve the problems that will be faced flexibly.

Keywords: 3D technologies, biological education, e-resources, STEAM, inclusive education

RESUMEN

El objetivo de este artículo es analizar las perspectivas de la aplicación de las tecnologías 3D en la enseñanza de la biología, discutiendo el trabajo realizado en esta dirección y los logros obtenidos. Dado que el uso de tecnologías en el campo de la educación se considera prioritario, se llama la atención sobre los cambios que se están produciendo en los campos de la biología y la medicina. El artículo subraya la comprensión crítica de que la educación básica por sí sola no nos impulsará lo suficientemente lejos como para competir en nuestro mundo en rápida evolución. Abordar estos desafíos no es sólo responsabilidad de los educadores, sino también un esfuerzo colectivo que requiere una sinergia entre las reformas educativas globales en evolución y la aplicación dinámica de tecnologías de enseñanza en constante cambio. Entonces, dada la naturaleza experimental de la biología, los enfoques tradicionales de enseñanza, como conferencias, ayudas visuales y presentaciones multimedia, ya no son suficientes. En el trabajo se sostiene que, en el panorama actual, numerosas hipótesis científicas que alguna vez se consideraron validadas están perdiendo importancia debido a la aplicación continua de tecnologías de vanguardia. Esta evolución dinámica en la comprensión científica da como resultado la creación de nuevos campos de ciencia y profesiones. Por lo tanto, la educación del siglo XXI requiere educar a los fundadores del mañana, jóvenes que puedan crear cambios radicales en la sociedad y resolver los problemas que se enfrentarán con flexibilidad.

Palabras clave: Tecnologías 3D, educación biológica, recursos electrónicos, STEAM, educación inclusiva

INTRODUCTION

There are several methods of using digital technologies in education include robotics, continuous learning, ICT, STEAM learning, and lately the application of 3D technologies in education is already in the spotlight, too. Digitalization, digital transformation and the use of Internet resources in education have become relevant day by day, and this development is not limited to computers, but requires integrated learning in all areas. The concept of virtual reality and augmented reality can also be viewed as extended reality (Scavarelli et al., 2021). In the conditions of augmented reality, it is possible for students to freely carry out learning activities in educational environments and obtain virtual learning experience (Oyelude, 2017). Several studiees have considered these educational tools, and how they improve students' performance and analytical skills (Damar, 2021; Damar et al., 2018). Then, we can see that augmented reality applications increase student motivation, engagement levels, and interest in research.

The positive impact and contribution of 3D technologies to educational processes is an undeniable fact. For example, in the teaching of chemistry, learning in a virtual laboratory environment develops analytical, logical-critical thinking (Babayeva, 2023). It is considered effective to give virtual lessons in chemistry lessons, as well as other subjects (Fernandez, 2011; Karayilan et al., 2022). Folliwing this reasining in biology classes, many different topics can also be taught through the virtual environment (Chuang et al., 2023).

For example, dynamic simulation of biological processes, learning supported by system models, interactive educational environment can be taught with virtual and augmented reality. The use of various 3D technology courses created for this purpose helps students and those interested in this field. In the current period, the field of educational opportunities has expanded, institutions with the mission of creating conditions for high-tech production, creativity with modern quality standards, and the development of business areas have started to operate. The goal of these courses is to develop technologies as a state strategy and educate the society with technological innovations. In this regard, the 3D technology company in Azerbaijan is known for the use of new technologies in its activity since its establishment in 2013, and continues online and offline courses. Thanks to these technologies, such qualitative changes are taking place in the field of science and education that it is impossible to predict what the world will be like in 2050, what new science and education opportunities will be created. For this reason, avoiding changes go in hands with the risk of falling behind the times.

The better we understand the biochemical mechanisms underlying human emotions, desires, and preferences, the more successful computers will be in analyzing human behavior, predicting, and replacing human preferences (Harari, 2018). Even if we do not know exactly the problems that people will face in the future, we should work so that our children can cope with the problems that they will face. If the progressive scientists of the world put all their efforts in this direction, we think that we will prepare the future generations to protect themselves from a desperate situation. For this reason, raising a new generation in the rapidly digitalizing world is more responsible than in previous times. The last thing a teacher can do in the audience is to give information. The current generation has enough information and information base compared to the period 50-100 years ago (Karashay, 2018). That's why we have a mission to turn knowledge into skills and achieve its application, to train human potential with creative, different thinking. It should be noted that if there is one thing that is constant in the 21st century, it is a change. In today's society,we need to update our education as individuals in a society that is changing, renewing and digitalizing in seconds.

In the forums organized in Azerbaijan in recent years, "Azerbaijan 2030: on socio-economic development" and "Education according to the requirements of the 21st century" are aimed at discussing new challenges in education and achieving further improvement of the quality of education and training of personnel who have mastered the skills of the 21st century. Benefiting from discussions at the international level will also affect the quality of our work. For example, Michael Fullan, Philip Koestler, Andreas Schleicher, Azra Cohen, Anant Agarwal, and Sal Khan discussed virtual education, international assessment, leadership, the 21st century skills, and sustainable development in a forum on "from Initiation to Implementation" (Fullan, 2021). The exchange of ideas and experiences of educators and Methodists at international level events serves to minimize the potential difference between them.

The changes and reforms that have taken place in the field of education in recent years, new learning technologies that have proven themselves in the teaching process, modern training, methods and tools can only be effective if they are applied in place and correctly. Especially in the teaching of biology, we consider it useful to teach and compare local fauna and flora first. It should be noted that any methods and opportunities used in the teaching process should not be taken as standards, the age and knowledge level of the audience should be taken into account, adapted to local conditions, and further improved. Learning the secrets of the planet we live in should always

be our goal, and we should inspire the younger generation in this direction. For this, it is necessary to implement various reforms, projects and ideas. Although the goal of the reforms is to change the lives of young people, and although these reforms claim to be fundamental in the life of the society, in the end, achieving success is not as simple as it seems. Of course, here the main responsibility rests on the educators to properly choose the methods of their work. Since the 21st century is the age of speed, technology, and new discoveries, educational institutions and educators should pay attention to these points in all their activities, give priority to the exchange of experience, and interdisciplinary integration.

Considering the above, the objective of this work is to analyze the importance of the use of 3D technologies in teaching, specifically biology. To this end, the work discusses the necessary changes in educational systems demanded by contemporary society, and how these new technologies have broken into all spheres of life, education not being an exception. Some advances that have been made in Azerbaijan for the introduction of these technologies are also highlighted, while software that is currently used in the teaching process is mentioned.

DEVELOPMENT

The socio-economic development and ideological views in the society in all periods have caused quantitative and qualitative changes in the field of education as well as in other fields. STEAM education, which we can consider as the total and peak level of educational reforms of the 21st century, is not limited to increasing the quality of education, but plays an important role in turning the learned knowledge into a product. This requires creative thinking, imagination and a different approach. Unbelievable achievements are being made with large investments in education and other fields of developed countries. For this, special importance is given to providing the learners and teachers with the necessary conditions and freedom of thought (Babayeva, 2022).

In recent years, education experts have noticed that education does not meet modern needs. For this reason, it is important for the field of education to approach modern challenges and to look for solutions to the problems encountered. The main goal of education, which is one of the urgent problems of today, is the preparation of the young generation that meets modern requirements and new world standards. The thought "Life for learners begins after school" is wrong. In fact, they should live their lives comprehensively in school, they should be given freedom to think and work for their comprehensive development. At this time, the formation of competent, creative, knowledgeable, logical-critical thinking students will take place.

Biological science, as one of the fundamental sciences, is experiencing continuous development with ongoing complex experiments. This progress is paving the way for innovations in the field of medicine. An illustrative example of this advancement is the 3D Organon VR Anatomy, an interactive human anatomy app that comprehensively covers the entire body. With over 12,000 realistic anatomical models/structures, high-quality definitions of body structure, and detailed micro-anatomical structures, there is now an opportunity to learn and teach anatomy effectively. To establish a foundation for this progress, it is crucial to adapt the organization of biological education to contemporary requirements (Figure 1). This involves modernizing the material and technical infrastructure of educational institutions and elevating the level of teaching and learning to meet global standards. In the realm of biology education, it is recognized that biological concepts are foundational to the learning process. Consequently, the three primary objectives of education – teaching, educating, and developing – are realized.

Figure 1: Use of 3D in biology teaching.

Source: Own elaboration-

The transfer of concepts into skills is applicable across all biology courses, and the development of skills is intricately connected to the evolution of concepts. To foster knowledge, skills, and habits, it is imperative to initially develop their content. This involves the sequential development of simple skills followed by more sophisticated and complex skills. Currently, there are qualitative and quantitative changes underway in the teaching process, driven by curriculum reforms in the education sector. The science-oriented curriculum encompasses the field of science and its comprehensive system of concepts, aiming at the assimilation of these concepts. The overarching purpose of practicing practical skills is to enhance the strength and durability of knowledge.

3D Organon has been established in more than 70 countries and was accepted by prestigious universities, hospitals, etc. worldwide. It has also been recommended by leading publications reporting on the future of science, education and medicine, such as Huffington Post, Scimex, SBS, Futurism and others. The virtual reality version of the 3D Organon was presented at the MWC19 conference by HTC president Cher Wang and Zuckerberg's keynote speakers at the OC3 conference. 3D Organon is also the first software platform in the world to integrate an ultrasound simulator for virtual reality that does not require a mannequin or other special equipment. The latest 2022 release provides a fully immersive virtual reality training solution for medical and healthcare students with real-time volumetric scanning and detailed anatomical views. For the first time, VR controllers simulate curved, linear and cardiac probes all in one solution. In-app 3D models can add important cognitive inputs that improve in-depth understanding of key anatomical concepts and information retention. Reflecting on my role as a trainer in the Grand project on the "Prospects of application of 3D technologies in the teaching of biology" (Babayeva, 2023), it became evident that there is a pressing need for fundamental development and improvement in this field.

These innovations make it possible to study the human body in a comprehensive way, and to minimize the mistakes that medical students and doctors can make when making a diagnosis. The developed 3D human model and the application of VR glasses to teaching also make it possible to achieve great success in the field of biology and medicine. In general, those who study or teach biology should follow the innovations in this field in the country and the world, should be able to discuss educational reforms, modern technological possibilities, different software and choose the most effective ones for teaching. Also, any knowledge, skill and method learned should not be considered as a standard, the ability to critically approach what we have learned should enable both in-depth study of information and creative application. Since training is an activity process, special communication models should be created between the teacher and the learner in this process. 3 techniques can be attributed here: To understand; To explain; To agree. In other words, in order to understand each activity process, it is a basic condition that we understand what we want to convey. That is - training - education - upbringing -> development.

"Study, study and repeat studying without hesitation" was considered by Confucius the more effective training, but now we consider it effective training when in the training process, together with scientific knowledge, the training is transformed into a skill, a project, and creative application is carried out. The modern era demands to "take students out of the folder format where knowledge is stored and turn them into active participants of the educational process", to direct knowledge application skills to promising projects. In particular, "From live observation to abstract thinking, then application in practice" is of special importance in teaching biology. The study of living organisms, the development of medicine depends very much on the level of biological education.

The New World Order of the 21st century requires a new format, new methods and tools. Like any development in the already globalized world, the problems also require cooperation covering the whole world quickly. The field of education has to respond effectively to the changes taking place in the world. Because schools and teachers train potential personnel to manage the society. For this, in order to integrate the innovations going on in the world, the field of education should also enrich the personnel potential in the field of educational format and technologies. This also includes the enrichment of the material and technical base of educational institutions. Currently, the methods and techniques we use in teaching biology continue to affect the efficiency of teaching. However, the search for different, new opportunities must continue. The application of the STEAM method in education, which has gained relevance in recent years, the increasing interest of educational institutions in this method, and the concern for the creation of STEAM centers in schools have already shown their results. Support for this field at the state strategy level in Azerbaijan has achieved great success thanks to the skills of teachers and students.

In this regard, increasing the interest of learners is a factor that increases the quality of teaching by bringing new pedagogical and technical tools used in the field of education, different methods of using ICT, etc. For this, biology teachers, in particular, need to update technology, programs, etc., that can be used for teaching, and their

skills to use maximum visualization. "Professional development is a must" (Yilmaz, 2020). If earlier we could surprise students with ICT in class, today's students prefer to watch movies and games in 3D. For this purpose, the 3D glasses, are being started using in teaching; they attract the interest of the class and the audience and increase the interest in learning subjects.

According to many methodists, the education system is like architecture. Looking at this system from the inside, we need to properly assess what we will change. In fact, the architecture in the field of education is a social architecture: there is a need for qualitative changes in the culture of learning, teacher-student interaction, and the relationship between teachers. In addition, the heads of educational institutions should reform their work. They should try to achieve high efficiency in the field of education by mutual appreciation of the work of educators, studying and meeting their needs in teaching, and exchanging experience. The teacher's character plays an important role in the education system: it mainly depends on their principles, self-confidence in the teaching process, their relationship with teachers at school, etc.

For example, the assessment of natural sciences by the European Economic Cooperation Organization mainly evaluates the performance of teachers. Here, their work schedule, preparation for the lesson, and job satisfaction are investigated. It is decided that teachers' psychological condition, conditions, salary, motivation, professional potential of teachers, etc. should be taken into account, because these factors directly affects the quality of teaching. Social well-being of the teacher is one of the main factors affecting the improvement of the level of education. At this time, both parties are satisfied with each other, and the quality of the process and activity increases, and in this case, it is society that wins again. In educational institutions organization, unanimity, mobilization, mutual support, and cooperation of teachers should be considered indispensable.

We think that by restructuring the structure of the educational system, we can increase the work ability, interest, and motivation of the teachers and learners through the proper organization of the competencies, capabilities, and physical environment of the learners. Calculations show that some of the problems that have arisen make students want to leave the educational process for two reasons but the most important is that students' interest in the process fades since 75% of the educational process is not attractive. It is a monotonous process.

Then, the attention and care given to increasing the professionalism of teachers can make the educational environment even more favorable. Because the teacher is also a social being, if they are satisfied with their social and personal life, this has a positive effect on their work and the learner. Both the teacher and the student should be satisfied with the educational process so that the quality of the work increases. In addition to the development in the field of education, effective use of technologies, educational innovations and shortcomings, there are also problems of the 21st century Education Industry:

- Radical changes are required in the current education system, which cannot reach the speed of the Fourth Industrial Revolution.
- Although the world's rapid digitalization and technological development bring new opportunities to teaching, the current education system cannot get out of the old method and educational content format.
- According to experts in the field of technologies, we should focus on three main directions - Education, Entrepreneurship and Employment.

Although the current development of the Fourth Industrial Revolution actually benefits from the existing education system, it stems from the skills gained from the integration of the broad technologies and sciences that have been mastered in recent years. This development has spurred the creation of many e-resources, innovative learning platforms and resources, such as: Massive Open Online Courses (MOOCs) such as Coursera and Edx, Google, Podcasts, YouTube Videos, etc. This shift in learning is happening because the emergence of hybrid learning resources can help young professionals acquire multidisciplinary skills. All these will be useful in various fields of activity and labor management. This change will also enable them to use technology to make everyday tasks easier, more streamlined and valuable. However, it will take a long time for such learning resources to be adopted and used on a large scale, and we must also seriously consider the problems we may face in using this development for the benefit of humanity in the near future (Lee, 2012).

As in all fields, there is competition in the field of education. In fact, it will lead to rapid development of the society if it is directed to the benefit of the educated. It is known that 65% of teachers who support innovations and love their profession are looking for effective ways to use modern digital solutions in classes to make the teaching process more attractive and teach comprehensively, to form 21st century skills. The main goal is to serve the society as a teacher who provides the best educational services, wins the competition among the best teachers, and trains researchers with the most modern skills and abilities. For this reason, we need to increase the ability of both teachers and students to use new learning technologies.

The recent COVID-19 crisis has shown us that it is of strategic importance to review the problems we have to face in education systems to meet the needs of students in any pandemic in the coming years or natural disaster (Masters et al., 2020). Thanks to technologies alone, we cannot always get out of the situation. After that, we should also bring to the agenda the solution of problems such as the lack of modern teachers, the availability of technology and resources, and digital literacy. At the same time, we should take care of equipping the teachers in higher and secondary schools with the necessary material and technical base to form their modern skills and habits. Even in universities that have an electronic university system, the way of working that requires effort, funds, and paper should be abandoned, and the use of electronic resources in cooperation should be preferred.

As a result of the creation of modern teaching environments and the hard work of innovative teachers, we are already witnessing the implementation of various ideas and projects by the students using the STEAM method and 3D technologies. For example, the "EcoTech" team, with the participation of Ulvi Ismayilli, a 4th-year student in biology teaching speciality at the Faculty of Natural Sciences of Nakhchivan State University, together with 4 students from other faculties, participated in the "Recyclaton" hackathon on waste reduction for the first time in Azerbaijan within the framework of the "World Without Waste" program and took the 2nd place.

The main goal of the hackathon is the search for innovative proposals and solutions to reduce plastic waste. Hundreds of young people participated in the month-long hackathon, and in applications covering 197 ideas, the teams made proposals for the development of solutions with the participation of artificial intelligence, blockchain, complex sensors for waste reduction, the introduction of new chemical processes for recycling, and the creation of mobile applications for information and promotion. Among the applications, 60 teams distinguished by the creativity, originality, and applicability of their ideas won the right to participate in the semi-finals (2022).

All these achievements are based on raising the young generation in the right direction, starting from a young age, who can be creative, dream freely, give ideas, create a new product, show it and accept it. Of course, a lot depends on the direction, but the potential of the other party is also an important condition. Because a young person who creates his idea and project to meet the needs of society (construction), to make some existing products more advanced, to be efficient, should be interested in innovation, have creative thinking, critical and logical thinking, and sharp intelligence.

The field of the 21st century education is faced with new technologies every day, soon these technologies become teaching tools and serve to increase the quality of teaching. One of them is the Mosaic 3D application. As one of the most modern fields of modern technology, Augmented Reality and Virtual reality technologies are more closely encountered recently. As we have mentioned, when using AR/VR applications in education, it creates a special interest and enthusiasm in the students for the subject studied. There are also some applications that combine several topics and subjects, creating a wide opportunity for integration. But what is the benefit of the Mosaic 3D application, what makes it different from other applications? In this application, more than 1200 useful 3D AR examples have been created for teachers of all subjects (elementary, mathematics, physics, chemistry, history, geography, biology, music, visual arts, technology teachers) to use in the teaching process. The difference from other applications not only that it covers different fields of science, but at the same time, the application contains books for various images, videos, animations, sounds, games, tests and smart boards. The convenient aspect is that with the help of the Mosaic 3D application, it is possible to watch 5 samples and play games per week, which makes it possible to use this application effectively every week.

In general, globalization and digitalization in the world make the use of technologies necessary, but this may not be accessible to everyone. It is known that all countries and societies can benefit from these innovations according to their financial capabilities. But some difficulties exist even in developed societies. These difficulties also include discrimination among all people in the world. Currently, there are many people who are discriminated due to physical disabilities, race, financial means, religion, nationality, etc. and are excluded from educational institutions and careers for these reasons. This discrimination between people deprives every child from participating in social and cultural activities, where they want to study, along with others. It is "Inclusive education" that has undertaken the mission of creating equal opportunities for all children to prevent these sad situations, and created a chance to achieve democracy and humanity in education and career thanks to the approach aimed at their development. Over the years, the scope of this concept has developed and expanded to include all discriminated people (disabled, low-income, etc.). Inclusive education currently includes all children with limited educational opportunities, who do not have access to social and cultural activities, and who have physical and mental disabilities, and it is possible to see that important tasks and successful steps have been taken in this area.

It should be taken into account that when it comes to inclusive education and efforts, this process period is not easy for children, teachers and parents and today it faces several challenges (Figure 2). Not every teacher is ready to teach in an inclusive class. Because children with physical and mental disabilities are unable to adapt to the environment after a while, as they fall into crowded environments, and they cause physical strain on teachers by demanding more attention. Also, it takes a lot of time for the other students in the class to adjust to each other. At this time, more responsibilities fall on parents, which is very important for them to help their children's studies. Thus, every child, every individual can receive inclusive education. All educational institutions should think about solving the problems facing inclusive education, which is a successful step towards bringing children into society and raising useful young peopl

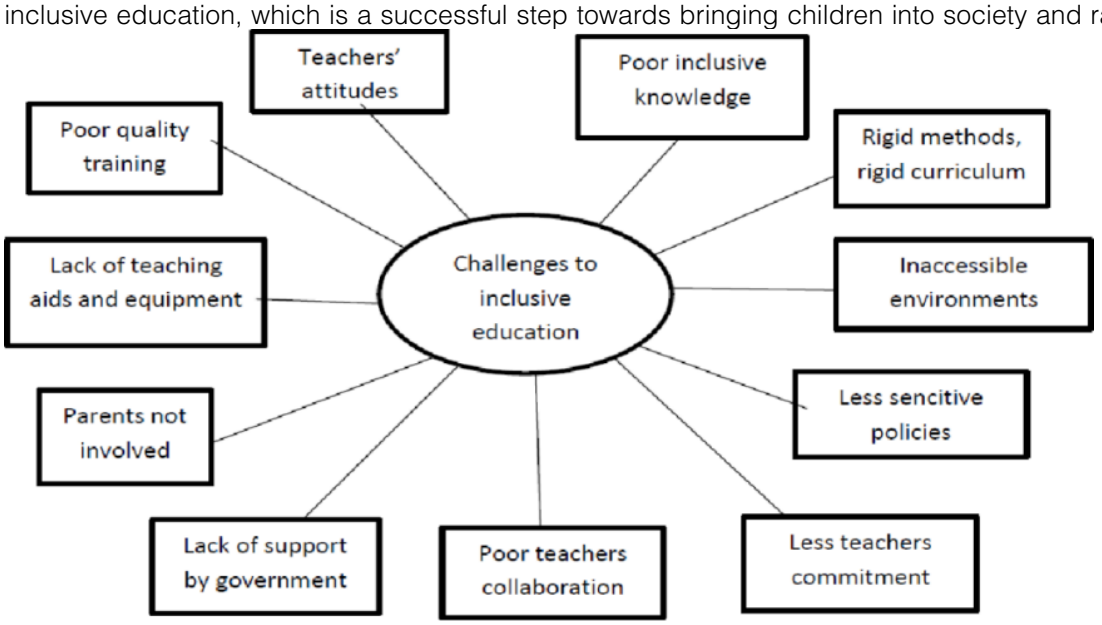

Figure 2: Challenges to inclusive education.

Source: Own Elaboration

UNESCO (United Nations Educational, Scientific and Cultural Organization) supports the goals of inclusive education. According to UNESCO, the main responsibility of the state in this process is to develop and implement the right educational strategies to include all children of school age, and at the same time to check whether these strategies are effective. Thanks to these strategies, the state should create appropriate conditions and take necessary measures for the education of all children. But what are the benefits of inclusive education to society? It should be considered that the main goal of this education is not only to restore the right of children to education, but also to integrate them into the society, to increase their chances of finding a job in the future, to make their own free decisions, to manage and provide for their lives. The application of technologies in all areas of our lives is of great importance, both in inclusive education and in the later life activities and careers of those people. The use of these technologies enables large-scale research that can lead to scientific discoveries, allowing many scientists to participate in large projects remotely. It is high time to move towards integrated cooperation instead of individual activity. Through ICT tools, internet, various platforms, we have the opportunity to participate in lectures from any school, any country. Thanks to these opportunities, we can discuss various problems and make common decisions through the exchange of experience.

In environments characterized by innovation and hard work, a notable observation is that individuals in such settings may, at times, prefer independent activities and refrain from sharing their experiences. This tendency can be attributed to various factors, including the organization's neglect of its personnel or the presence of jealousy among the staff. Despite the advancement and education levels in modern society, misunderstandings and conflicting opinions persist among individuals, nations, and races. This issue is not confined to everyday interactions but extends to the realm of education as well. It is emphasized that discrimination has no place in society, and principles like "fairness" and "effort" are crucial. However, it is acknowledged that "equality" does not always equate to justice, and ensuring equality can be a challenging endeavor. The concept of justice is subjective and varies for each individual. Consequently, the idea is

put forth that each person should be "treated differently," and the pursuit of justice should involve open discussions to accommodate diverse perspectives.

Ensuring equity in educational practices is a significant responsibility for educators, particularly teachers, who play a crucial role in shaping the learning experiences of students. To achieve this, teachers must adopt a proactive and continuously evolving approach. First and foremost, teachers should prioritize ongoing professional development, updating their knowledge base and adapting their teaching methods. This involves embracing flexibility and regularly reassessing and changing teaching formats to meet the diverse needs of students. Critical and logical thinking skills should be actively cultivated among students, fostering an environment that encourages questioning and exploration. The adage, "If you stop learning from teaching, you become a blackboard," underscores the importance of educators staying engaged in their own learning processes. Stagnation in learning can hinder educational development. Over the past two decades, significant innovations have emerged in the realm of biology classes, encompassing higher and secondary education. These innovations include the integration of new technologies, diverse training methods, technical tools, and the STEAM (Science, Technology, Engineering, Arts, and Mathematics) method.

Various tools and methods, such as ICT (Information and Communication Technology), electronic microscopes, electronic boards, VR glasses, and interactive and constructive training, have become integral components of modern teaching. The Bologna education system is also among the innovations introduced. It's essential to note that the effectiveness of these tools and methods relies on the pedagogical and methodical expertise of the teachers. In addition to traditional teaching methods like verbal, visual, and practical approaches, educators are now incorporating new methods to enhance the learning experience. For instance, the use of a fishbone diagram is interesting in visualizing specific topics, showcasing a commitment to diverse instructional approaches. In general, the success of these methods lies in the ability of teachers to adapt them effectively within their pedagogical frameworks.

But what are the factors that make technology necessary in teaching biology? Computer technologies play an indispensable role in showing some objects and events that cannot be observed for various reasons. For example: if they are not large (core structure); if it is fast-conducting (the process of transmitting a nerve impulse from neuron to neuron); if the observation is impossible (embryo development); if it is complicated to explain, or rather to understand (protein synthesis); if it is impossible to demonstrate (deep water animals, alpine meadows), etc.

In the process of teaching biology, pedagogical principles should be taken as a basis for forming a comprehensive outlook, turning biological knowledge into skills and habits. The 21st century skills of modern students, free thinking, creative creativity, training of a new generation that tries to fill the gaps in the society and is inclined to make new discoveries are among the main tasks facing us. Basically, in the teaching of biology, the worldview is based on three directions: the materiality and uniformity of the worldview, the general nature of the laws of dialectics. Worldview fulfills the task of training and education, and therefore serves the formation, development, self-education, and self-confidence of the personality. In the school biology course, living organisms should be viewed as constantly moving, developing matter: That is, the development principle - from primitive to advanced, from simple to complex, is the main principle.

If the teaching of biology as a science is a goal, the formation of biological knowledge, skills, and habits, and the transformation of the taught knowledge into skills, application, projects, and new products, is now a necessity. Education and training is a process in which several components must be involved: knowledge, skills, habits. Their relationship with each other forms the desired education as a result. There is also a special point that the teacher should know his specialty well, love the audience, give students the opportunity to think freely, be open to innovations, and create a favorable environment for turning knowledge into biological skills. We should take what we learn as clues with critical and logical thinking, and try to create more advanced, gap-filling ideas and products. Real development happens when new ideas and skills are acquired without repetition and copying.

CONCLUSIONS

The efficacy of any educational reform, technological advancement, or innovative methodology hinges significantly on the teacher's profound familiarity with the methodologies employed. Genuine educational transformation goes beyond superficial, visually appealing changes; it demands a deep understanding and mastery of the applied methodologies. We extend the exploration of these conclusions to our esteemed colleagues, presenting them not as conclusive statements but rather as open questions, sparking discussions that warrant a broad audience. These themes, when deliberated upon in educational conferences, will undoubtedly remain pertinent and thought-provoking.

Certain studies transcend the realms of individual endeavors. Collaborative efforts, such as the involvement of scientists from diverse fields like chemistry, physics, mathematics, engineering, and design in the research endeavors of a biologist, amplify the scope of the research, transforming it into a significant project. The world's current influx of new discoveries, innovative ideas, and products of creative thinking owes its existence to these collaborative endeavors.

In the realm of virtual and augmented reality, the development of topics or projects necessitates a nuanced consideration of factors such as the age and knowledge level of the audience, as well as the feasibility of implementing such software in educational institutions. Additionally, the demand-supply dynamic and the necessity for consultations between programmers and users become crucial aspects to be addressed. The practicality of introducing innovations like virtual glasses in schools also demands careful consideration; if the existing computer infrastructure does not support such equipment, it introduces additional financial challenges. Therefore, fostering mutual discussions between technology companies and educational institutions becomes imperative in navigating these considerations effectively. Our work underscores the importance of merging theoretical exploration with practical implementation, creating a holistic approach that optimizes the benefits of technological advancements in education.

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