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The effectiveness of a proposed program based on smart applications to develop deep understanding of the nanotechnology and future thinking skills of tenth grade students in Palestine

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ABSTRACT

Background: Nanotechnology and its biological applications is considered a scientific wealth and a vivid example of a great development at a very precise level, which proved how successful it was in entering into the smallest details of living organisms at a very small level with all boldness and speed to impress us with what it can do with minimal time and effort and rebel against the familiar reality, adding everything that is new, renewed, great and amazing results in various fields of life, it has risen in the life of society and organized its priorities with extreme accuracy. Being the result of the Fourth Industrial Revolution in the history of mankind, it has become one of its most important technologies and has dominated it with all its might and provided innovative solutions to the problems of the upcoming era, as it is nanotechnology that works on the design and production of vehicles and systems by controlling shape and size to show the nature of integration between science and society and technological innovations in solving the water crisis, energy resources, health, poverty, unemployment, providing jobs, reducing the cost of some products, developing energy resources, discovering new methods of medical treatment and water purification, so this study aimed to find out the effectiveness of a proposed program based on smart applications to develop a deep understanding of nanotechnology applications and future thinking skills About of tenth grade students in Palestine.

Materials and Methods: The study adopted a semi-experimental design based on the design of the two groups. Students used a smart application consisting of information to develop a deep understanding of nanotechnology and identifismart application study from the tenth grade students in the Gaza Strip, and all participants were over the age of 15.

Results: The study showed that there is a statistically significant difference at the level of 50.0 between the average scores of the experimental group and the control group in the remote application of the deep understanding test with nanotechnology applications, and it turns out that these differences were in favor of the experimental group, where the arithmetic average of the experimental group scores in the remote application of the deep understanding test with nanotechnology applications was 26.458 while the arithmetic average of the control group Students was 14.958, and the difference between them was 11.50 degrees. The presence of a significant statistical difference at the level of 50.0 between the average scores of the experimental group and the control group in the remote application of the future thinking skills scale, and it turns out that these differences were in favor of the experimental group, as the arithmetic average of the experimental group's scores in the remote application of measuring future thinking skills was 110.125, while the arithmetic average of the control group's students was 82.50, with a difference of 27.625 degrees, and the percentage of the average total score of the test is 1.393, all of which is more than the limit set by Black, which is 1.2, meaning that the proposed program based on smart applications is effective in developing deep understanding The percentage of the adjusted gain for the total score of the scale was 1.313, all of which exceeds the previously stated limit of 1.2 set by Black.

Conclusion: This means that the proposed program based on smart applications is effective in developing future thinking skills and these results show that students are willing to develop their knowledge and knowledge of what's new.

Keywords: proposed program, nanotechnology applications, smart applications, 10-grade students, deep understanding, future thinking skills

INTRODUCTION

Many international expectations pointed out that in light of such human acceleration, it is not difficult to believe that all forms of life will look different soon. Looking at all the changes that have taken place in education over the past three decades, it has been proven that nanotechnology has a wide range of applications. This makes it a very significant technology for the future. Because of its scope, nanotechnology is multidisciplinary, requires specialized personnel, and is highly capital intensive. Thus, many nations are increasing their respective activities in fundamental research in nanotechnology intending to develop products and/or processes based on their respective strategies, as shown in more than 60 countries globally (Muhammad, 2022).

It seems to us that trying to think ahead and predicting what will change over the next 30 years is important, especially at this moment in the history of our nation and the impact of the global pandemic that affects us all (Affouneh et al., 2020). Changes in how we use technology, how students engage in technology in both methodological activities and curricula and providing radical alternatives to the traditional school model. Major shifts emphasize the importance of employing smart phone applications in developing a deep understanding of nanotechnology and its biological applications, which is considered a sophisticated science that relies heavily on the mixing of technology with other sciences and represents a common ground for engineering, biology, physics, medicine and chemistry. Technology, which has begun to be employed in developing this refined and applied science and making it a new vision, as a qualitative shift that will transform the balance of life in all fields and encourage self-learning and interactive for students (Affouneh et al., 2020).

The development in the field of biotechnology has led to the emergence of several applications of it in different fields. These applications have become a major basis in the scientific development programs and different research, especially in the field of food, pharmaceutical and environmental industries (Abu Amra, 2021a, 2021b).

MATERIALS AND METHODS

This experimental study was conducted by 10th grade students in the public schools of the Ministry of Education/Gaza for the year 2022-2023 on his eye is made up of (48) female students divided into two groups, an experimental group of (24) female students, and the other is an officer of (24) female students.

Study Design: This study is based on the experimental approach and data collection.

Study Location: This study was in the public schools of the Ministry of Education/Gaza (Rafah).

Study Duration: In the first semester of the academic year for the year 2022-2023.

Sample size: 48 tenth grader.

Sample size Calculation: The sample was selected randomly as the sample size actually obtained for this study was 48 Grade 10 students.

Subjects & selection Method: The study community was taken from the 10th grade students in the government schools affiliated to the Ministry of Education/Gaza according to the following random distribution, Rafah area (48).

Inclusion criteria:

1- Tenth graders,

2- Studies in the State schools of the Ministry of Education.

Exclusion criteria:

- Basic 10 students.

Procedure Methodology

The researcher followed the experimental approach, which is appropriate to the nature of the study, in order to examine theories or answer questions. One common type of study in such studies is that related to deep understanding or future thinking toward different issues," where the study community consists of tenth-grade students at government schools under the Ministry of Education in the first semester of the academic year in (2022-2023). Test the deep understanding dimensions of nanotechnology applications and this test is used to give a deep understanding indicator of nanotechnology applications, a measure of future thinking skills toward nanotechnology applications according to skills (future planning, problem solving, future imagination, and future prediction).

To prepare the test, a list of nanotechnology applications was established through the review of specialized journals, studies and educational research in the field of nanotechnology, and an "interview" was conducted with a number of specialized professors It is also the first time in the world to be able to use the technology to develop the technology. Considering the above, the test was prepared in its initial form and included (30) paragraphs according to the dimensions of a question distributed on (6) basic dimensions of deep understanding of nanotechnology applications. The arbitrators pointed out that some paragraphs were amended, considering which some appropriate amendments were made, in terms of drafting and amending some alternatives so that they may be more suitable for the subject, according to the recommendations of the arbitrators. It was applied to a sample survey to calculate the validity of the internal consistency by calculating the Pearson correlation coefficient between the scores of each dimension paragraph in the total degree of distance and the correlation coefficient D statistically in each paragraph and in

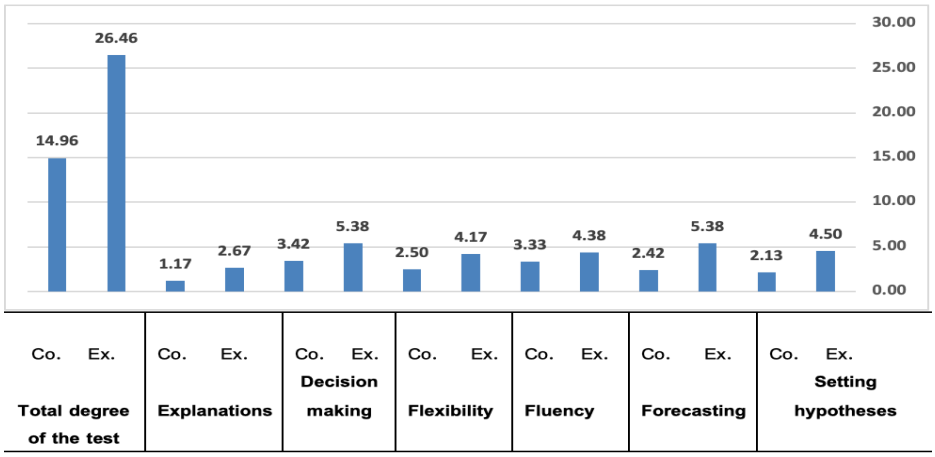

Figure 1. The arithmetic averages of the experimental and control groups in the dimensional application to test deep understanding of nanotechnology applications (Source: Author's own elaboration)

all areas) All correlation coefficients between each test field and the overall score for the test are statistically a function at a significance level (0.01), indicating consistency between the test fields and the overall score for the test.

The correlation coefficients between the degree of each dimension of the test were also calculated to the total degree of the test all that the elements of the deep understanding test with nanotechnology applications are statistically related at the significance levels (0.05-10.0) with the overall grade of the field and the overall grade of the test. This indicates that there is internal consistency between the test elements, the overall grade of the field, and the overall grade of the test. The results of the students' answers to the test questions were then analyzed to identify the coefficient of difficulty and the differentiation factor for each of the test items and found that the difficulty parameters for the DIA paragraphs range from 0.27 to 0.80, all of which are morally acceptable. Also, all cognitive testing discrimination parameters are accepted, since all transactions exceed the minimum acceptable paragraph marking factor (0.30), and thus the test of deep understanding of nanotechnology applications is characterized by a level of difficulty and an objectionable distinction. The Coder-Richardson equation's stability coefficient was 20 (0.938), a high-level indication of the test's consistency. The final image of the test was then confirmed to be (30) paragraphs distributed on the dimensions of deep understanding (hypotheses-prediction fluency-flexibility-decision-making-explanations), and the researcher created the second tool, the standard of future thinking skills, which dealt with future thinking, which are the essential skills of future thinking (Future planning - future prediction - future imagination - future problem resolution) the validity of a tool was confirmed in a way that the arbitrators were honest, and some paragraphs were excluded and modified, and the internal consistency of the scale was calculated, as the scale was applied to a sample of 30 students outside the sample of the study, which is from The study community to measure the validity of internal consistency by calculating Pearson's correlation coefficient as all items of the future thinking skill scale are statistically related at the significance level (0.01) to the overall skill score and the overall score of the scale. This shows internal consistency between the scale elements, the overall skill grade, and the overall scale. The scale, in its final form, now contains 25 paragraphs, and after that it was confirmed that the alpha-based scale is stable, that the alpha-chromabach parameters range from the half-titration parameters of the scale ranges between 0.937 and 0.987. This indicates that the standard has an acceptable degree of stability that the researchers are reassured of its application to the study sample in its final form.

STATISTICAL ANALYSIS

H1. There is a statistically significant difference (α 0.05) between the average score of the experimental group studied using augmented reality and the control group that studied in the normal way the deep understanding (testing) of nanotechnology applications in favor of the experimental group.

To verify **H1**, arithmetic averages are calculated, and are shown in **Figure 1**.

Figure 1 notes that there are apparent differences between the arithmetic averages of the experimental and control groups in the dimensional application of testing awareness of nanotechnology applications, and to detect statistically significant differences between these averages.

To answer the question, is there a statistically significant difference (0.05 Pinterest a) between the average scores of the experimental group and the control group in the dimensional application to test the deep understanding of nanotechnology applications for the experimental group? To verify the hypothesis, there is a statistically significant difference (0.05 Ph. a) between the average scores of the experimental group and the control group in the dimensional application to test the deep understanding of nanotechnology applications. At the indication level (α 0.05) the T. Test Independent Sample was used to calculate the differences between the median grades of students from both the experimental group and the control group in the post-test test to test the deep understanding of nanotechnology applications as shown in **Table 1.**

Table 1. The T-test has the average scores of the experimental group and the control group in the post application of the deep understanding of nanotechnology applications test

value Sig	Calculated "T"	Degree of freedom	Total degree	Standard deviation	Arithmetic mean	Number	Test fields	
0.001	8.547	46	5	1.251	4.500	24	Experimental	Setting hypotheses
				0.537	2.125	24	Control	
0.001	8.866	46	6	0.770	5.375	24	Experimental	Forecasting
				1.442	2.417	24	Control	
0.005	2.947	46	5	1.013	4.375	24	Experimental	Fluency
				1.404	3.333	24	Control	
0.001	4.772	46	5	1.129	4.167	24	Experimental	Flexibility
				1.285	2.500	24	Control	
0.001	4.614	46	6	1.765	5.375	24	Experimental	Decision making
				1.100	3.417	24	Control	
0.001	6.166	46	3	0.917	2.667	24	Experimental	Explanations
				0.761	1.167	24	Control	
0.001	10.077	46	30	4.809	26.458	24	Experimental	Total degree of the test
				2.851	14.958	24	Control	

Table 2. ETA squared effect size to see if the differences are real and attributable to the use of smart applications to develop a deep understanding of nanotechnology applications among 10th grade students

Effect size	value η 2	df	value "T"	Test fields
Big	0.614	46	8.547	Setting hypotheses
Big	0.631	46	8.866	Forecasting
Big	0.159	46	2.947	Fluency
Big	0.331	46	4.772	Flexibility
Big	0.316	46	4.614	Decision making
Big	0.453	46	6.166	Explanations
Big	0.688	46	10.077	Total degree of the test

Table 1 shows that for the total score for the test: The calculated "C" value (10.077) is greater than the tabular "C" value (2.013) at the indication level (0.05) and the degree of freedom (46), and the value (SIG) The probability (0.001), which is less than the semantic level (0.05), which indicates a statistically significant difference between the average scores of the experimental group and the control group in the dimensional application of the nanotechnology awareness test. The average score for the experimental group in the dimensional application of the nanotechnology awareness test was 26.458, while the average score for the control group was 14.958, with a difference of 11.50 points.

For dimensions of deep understanding of nanotechnology applications: The calculated "C" value for all areas of testing (hypotheses, prediction, fluency, flexibility, decision-making, explanations) was greater than the tabular "C" value (2.013) at the indication level (0.05) and degree of freedom (46), and the SIG. All domains are below the semantic level (0.05), which indicates a statistically significant difference of (0.05) between experimental and control group averages in the dimensional application of nanotechnology awareness areas. Arithmetic averages show that those differences were in favor of the experimental group in all areas of testing.

H2. The proposed program based on smart applications will achieve a magnitude of impact on the development of awareness of nanotechnology applications at least (0.14), according to ETA box.

In order to ascertain the magnitude of the impact to see whether the differences are real and attributable to the use of smart applications to develop a deep understanding of nanotechnology applications in tenth grade students, the magnitude of the effect is the one that most clearly confirms the effect, the "ETA" box is calculated as shown in **Table 2**.

This means that the values of the magnitude of the effect (η 2) for the test fields ranged from (0.159 - 0.631), to (η 2) for the total score of the test (0.688), all of which are greater than the limit (0.14), thereby accepting the hypothesis that: The proposed program based on smart applications will achieve a magnitude of impact on the development of awareness of nanotechnology applications at least (0.14) according to ETA box.

This result indicates that 68.8% of the variation in the overall score of the dependent variable (awareness of nanotechnology applications) is because of the independent variable (the proposed program based on smart applications), while the rest is due to experimental errors or other factors.

H3. The effectiveness of the proposed program based on smart applications in developing awareness of nanotechnology applications is higher than (1.2) gain based on the rate of gain adjusted for Black.

To validate this hypothesis, the researcher used Black modified gain ratio to reveal the proposed smart application-based program to raise awareness of nanotechnology applications.

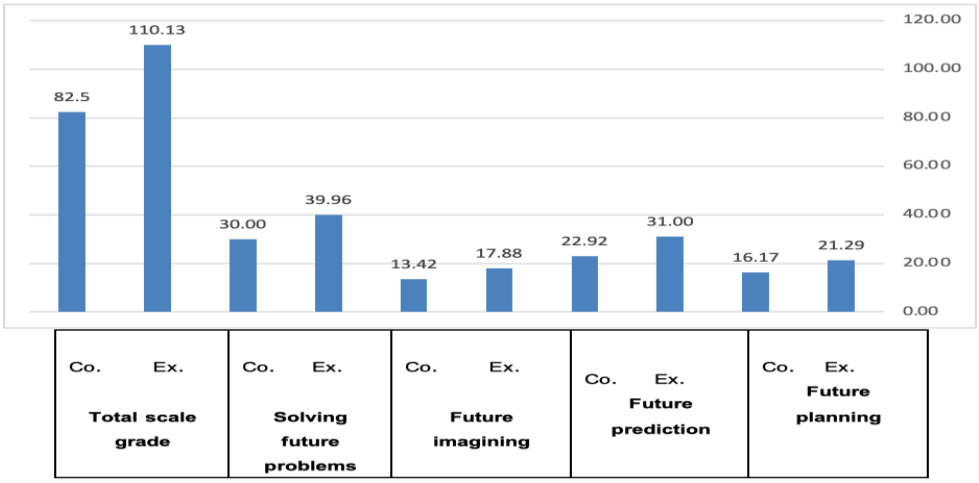

Figure 2. The mathematical averages of the experimental and control groups in the dimensional application of the scale of future thinking skills (Source: Author's own elaboration)

Table 3. The effectiveness of the proposed smart applications-based program in developing awareness of nanotechnology applications using Black's modified gain ratio

MG value	Total degree	Post average	The pre- average	Test fields
1.427	5	4.500	1.625	Setting hypotheses
1.363	6	5.375	2.208	Forecasting
1.499	5	4.375	1.083	Fluency
1.393	5	4.167	1.125	Flexibility
1.319	6	5.375	2.417	Decision making
1.371	3	2.667	1.042	Explanations
1.393	30	26.458	9.500	The overall score of the test

Table 4. C-Test for differences between the experimental group's average scores and the control group's average scores in the dimensional application of the future thinking skills scale

value Sig	calculated value of "t	degree of freedom	Total degree	Standard deviation	Arithmetic average	Number	Scale areas	
0.001	6.880	46	25	2.032	21.292	24	Experimental	Future planning
				3.031	16.167	24	Control	
0.001	7.382	46	35	2.432	31.000	24	Experimental	Future prediction
				4.781	22.917	24	Control	
0.001	8.023	46	20	1.227	17.875	24	Experimental	Future imagining
				2.430	13.417	24	Control	
0.001	10.251	46	45	2.032	39.958	24	Experimental	Solving future problems
				4.304	30.000	24	Control	
0.001	9.321	46	125	4.830	110.125	24	Experimental	Total scale grade

To verify this hypothesis, arithmetic averages are calculated, and are shown in **Figure 2**.

Figure 2 shows apparent differences between the arithmetic mean of the experimental and control groups in the dimensional application of a future-thinking skill scale, and to reveal statistically significant differences between these averages.

Table 3 shows that values MG for all areas of the nanotechnology application awareness test ranged from (1.319 - 1.499), while the total score adjusted gain was (1.393), all higher than Black's 1.2 threshold. This means that the proposed application-based program is effective in developing awareness of nanotechnology applications, thereby accepting the hypothesis that: The effectiveness of the proposed smart application-based program in developing awareness of nanotechnology applications is raised to a gain of at least (1.2) based on black's adjusted gain.

H4. What is the effectiveness of a proposed program based on smart applications to develop the skills of future thinking among students of the tenth basic grade in Palestine?

To answer this question, the following hypotheses have been tested:

H5. There is a statistically significant difference (0.05 Pinterest a) between the experimental and control averages in the dimensional application of the future-thinking skills scale in favor of the experimental group.

The researcher used the test (T) of two independent forms, the results as shown in **Table 4**.

The calculated value of "t" reached (9.321), which is greater than the tabular value of "T" (2.013) at the level of a function (0.05) and a degree of freedom (46), and the value of (Sig) probability reached(0.001), which is lower than the level of significance (0.05), which indicates a statistically significant difference at the level of (0.05) between the average scores of the experimental group

Table 5. The magnitude of the impact of the proposed program based on smart applications in the development of future thinking skills using the ETA Squared

Effect size	value η 2	df	value "T"	Future mindset areas
Big	0.507	46	6.880	Future planning
Big	0.542	46	7.382	Future prediction
Big	0.583	46	8.023	Future imagining
Big	0.696	46	10.251	Solving future problems
Big	0.654	46	9.321	Total degree of thought metric

Table 6. (MG) Prospective thinking skills scale

MG value	Total degree	Post average	The pre- average	Future mindset areas
1.294	25	21.292	8.375	Future planning
1.379	35	31.000	11.708	Future prediction
1.276	20	17.875	8.625	Future imagining
1.288	45	39.958	18.458	Solving future problems
1.313	125	110.125	47.167	Total degree of thought metric

and the control group in the 110.125), while the arithmetic average of the control group Students was (82.50), with a difference of (27.625) points.

The value of "T" calculated for all areas of the scale (hypothesis setting, prediction, fluency, flexibility, decision-making, explanations) was greater than the tabular value of "T" (2.013) at the level of significance (0.05) and the degree of freedom (46) and the value of (sig) for all areas came less than the level of significance(0.05), which indicates a statistically significant difference at the level of (0.05) between the average scores of the experimental group and the control group. It is clear from the arithmetic averages that, these differences were in favor of the experimental group in all areas of the scale. Thus, the imposition is accepted.

H6. The proposed program based on smart applications achieves an impact on the development of future thinking skills of at least (0.14) according to the ETA Squared.

To verify the correctness of this hypothesis, the researcher used the ETA equation (Eta Squared) (see **Table 5**).

For the areas of the scale ranged between (0.507-0.696), while the value of η 2 for the total index of the scale reached (0.654), and all these values are greater than the limit (0.14), and thus the assumption is accepted that the proposed program based on smart applications achieves the impact size in the development of future thinking skills not less than (0.14) according to the ETA box. This result indicates that (65.4%) of the robots in the total score of the dependent variable (future thinking skills) is due to the influence of the independent variable (the proposed program based on smart applications), while the rest of the percentage is due to experimental errors or other factors. 6-the effectiveness of the proposed program based on smart applications in the development of future thinking skills is raised to a gain ratio of not less than (1.2) based on the adjusted gain ratio for black. To verify the validity of this hypothesis, the researcher used the black Modified Gain Ratio to reveal the revised program based on smart applications in the development of future thinking skills through the equation.

Table 6 shows that the (MG) values for all areas of the future thinking skills scale ranged from (1.276-1.379), while the adjusted gain ratio for the total score of the scale was (1.313), all of which exceed the limit set by Black, which is (1.2). This means that the proposed program based on smart applications in the development of future thinking skills to the gain ratio is not less than (1.2) based on Black's adjusted gain ratio.

DISCUSSION

Our world today is facing rapid and successive changes in aspects of life, as a result of significant scientific and technological developments in all fields, and witnessing great and rapid cognitive and Information Development at all levels, and the cognitive aspect is flourishing significantly and rapidly, which in turn is reflected on life in general, and on the educational system in particular, education with its curricula, philosophy and tools cannot remain isolated from this great knowledge shift that the world is witnessing today (Murphy, 2020).

In addition, authors find that there is a global interest in researching nanotechnology, emphasizing the importance of following up on recent developments in the field of gene therapy using nanoscales (Tinkle et al., 2014) and highlighting the importance of exchanging information on ethical and scientific issues and developing awareness of them.

Most of the specialized professors who reviewed the results of the current study agreed on the need for sustainable development of the curricula for students, and their inclusion of nanotechnology concepts in the curricula and teaching plans, to ensure that students graduate ready for the next stage of future professions (Jian, 2015), and some of the current Palestinian and Arab curricula need deep knowledge enrichment, As the knowledge structure of our curricula is not ready and it needs a lot of effort to accommodate these new developments, this is why most studies recommended the need for a complete review. To the content of the current curricula (especially at the secondary and university levels), its evaluation and development (Abu Amra, 2021a, 2021b).

In view of the previous studies that have dealt with Nanotechnology, it is crystal clear that these studies were carried out at different scientific fields and a few numbers of these studies were concerned with the development of Deep understanding of the

nanotechnology of High school students. On the other hand, there are studies that have been concerned with measuring the Developing future thinking skills towards nanotechnology, and there was a diversity in the use of tools such as testing, attitude measuring, an interview and a questionnaire, so the researcher stresses we still need further development, and it has become necessary that educational initiatives coincide with financial support and mechanisms that are still absent from our Arab world in preparation for the next generation and providing schools with the capabilities and various learning resources that allow teachers to develop their expertise and implement their various activities related to this technology. Encourage and motivate students to conduct research and scientific activities in the field of nanotechnology, and work to include some related topics in the curricula (biology, chemistry, physics, technology).

CONCLUSION

Needless to say, there is an urgent necessity for education to be accompanied by more interest in following up with the scientific change that has occurred (Abu Amra, 2021a, 2021b). Nanotechnology and materials science played important roles in everyday life of people. As the size of a material was reduced to nanometer range, the chemical, physical and biological properties of the material changed, it is important to use nanotechnology in biology, chemistry, physics, and Geosciences. as an important branch to understand and study the science of the fourth industrial revolutions. This section can be divided into the following sections (Biosensors, Nanosensors, Nanomedicines) (Nikalje, 2015)- Spacecraft, Magnetic Nanowires, solar cell, photovoltaic cell, nano-mechanical energy, Agro ecosystems) (Pektas et al., 2015; Sharma et al., 2021). However, teaching nanotechnology for students at high school level was difficult because of the limitation of science laboratory instruments. So, students could not clearly see how small the size of a nanoparticle was. Moreover, the property of nanoparticle was not a discrete knowledge. It was described by an integration of many disciplines. Consequently, learning and teaching methods suitable for nanotechnology should be a technique that integrated disciplines and helped to promote students' creativity (Khamhaengpol et al., 2021). This study explains the contribution of 3D computer modeling and augmented reality to the twenty-first century's common competencies was evaluated from the perspective of secondary school students.

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Ethical statement: The author stated that all participants were over the age of 15 and that their participation was entirely voluntary. The author also stated that since no personal data was analyzed and figures were used in this article. No ethics committee approval was required.

Declaration of interest: No conflict of interest is declared by the author.

Data sharing statement: Data supporting the findings and conclusions are available upon request from the author.

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APPENDIX

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SCAN ME

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