The Effectiveness of Students' Use of Computer Modeling in Learning Engineering Mathematics

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Abstract—The aim of this study is to explore the effectiveness of teaching mathematics using computer modeling. It was conducted for a five-grade engineering unit by modeling concepts, terminology, and issues related to engineering in collaboration between groups of students and teachers from several primary schools in Amman, Jordan, in the academic year 2021/2022. The working group consisted of thirty students. An action research model was used to conduct this study. Photographs, videos, teacher records, graded grading model, focus group discussions, and researcher's record were used to collect data. Through percentage statistics and content analysis, the obtained qualitative data were analyzed. And concluded that the positive impact of students' use of computer modeling in learning aeronautical engineering mathematics and motivating students towards studying mathematics and increasing study skills and the ability to represent and model to clarify any issue in mathematics in space engineering.

Keywords—computer modeling, Jordanian students, engineering mathematics

1 Introduction

Modeling is the most prominent results of the revolution in social networks and technology, which produced a development and a qualitative leap in education and the presentation of knowledge in an understandable manner and the simplified visualization of the complex issues in engineering in the mathematics curricula in a modern, sophisticated, and technological manner that relies mainly on modeling concepts and terminology using computer software.

[17] He stressed that technology provides people with the opportunity to make useful and developed products through the exchange of experiences and the leakage of knowledge from a place and the exchange of experiences between people in their areas of interest and study through social networking sites and displaying products and ideas in a variety of different and innovative ways. The makers of these products express the ideas inside them In an easy and simplified way, without any complications or temporal or spatial limitations, through Internet communication. As for developing content, it is to attract the attention of learners to achieve goals and for permanent education. Information technology created what is called "digital students".

According to [3] "digital students" rely on the Internet for daily study and homework, and exchange experiences among themselves in a voracious and accelerated manner, and in another creative aspect that is completely different from the previous traditional methods that depend on rote memorization and are marked by boredom.

[4] Description of "digital students" They are interested and interested in using modeling through games, pictures, and videos instead of abstract written text to explore and acquire knowledge faster, simpler and with high professionalism in achievement instead of blind memorization and rigid understanding that cannot be linked or applied.

[10] Define the criteria for the digital student, as he is characterized by: (specialized, original, collaborative, entertaining, fast, independent, honest, accurate and innovative).

Modeling is a way to facilitate the teaching of mathematics and is also believed to be effective in providing students with skills that prepare them for life. This research is an example of what has been implemented through modeling and in a platform for production and project implementation in the eTwinning project, where eTwinning has worked to provide a platform for participating school teachers in different countries to communicate, collaborate, develop projects and participate [6].

[19], [23], [24], eTwinning adopts a face-to-face method using social networking technology and the Internet, which makes the world a small, continuous village that exchanges knowledge among itself, shares ideas, presents solutions to similar problems, and exchanges experiences in dealing with developments instantly, which facilitates the task of effective, flexible, applicable and productive continuing education at the lowest costs, easiest ways, and available to all.

eTwinning promotes diverse and interdisciplinary learning. Jordan participated in the 2018 eTwinning year through the European Union Commission (EC).

The Grade 10 Mathematics curriculum includes the skills defined by the European Commission which include Creativity, Responsibility, Citizenship and Entrepreneurship [27]. Modeling is implemented in the Grade 10 Mathematics curriculum for the Aero engineering unit through the eTwinning platform.

Studies on modeling are associated with their effects [28], [9], [26], [27], [1], [4] and are publications related to technology-assisted teaching and modeling, however current research is believed to contribute significantly to the literature on modeling mathematics teaching. On the other hand, this research is characterized as practice research and depends on the opinions of practitioners from teachers, students and educational supervisors specializing in mathematics.

To reveal the role of modeling in mathematics, this article focused on two main aspects that were formulated through two questions:

The first question of the study is about the contribution of modeling in increasing students' skills in mathematics

As for the second question about the contribution of modeling in increasing the participation and interest of students.

The aim of this study is to explore the effect of modeling on Jordanian students' learning in aerospace engineering. An action research model was used. The researcher

chose this method to be a practitioner. [25] So that he is an observer and evaluator who additionally conducts the experiment personally. The study group consisted of 30 male and female students in primary schools in Amman. The researcher worked, and through the data obtained from the pre-process questionnaire, which was applied to identify the students who are able to participate in the work group in the implementation of the project, in addition to determining their attitudes towards the use of Internet In the study, 26 of the students had a computer, tablet or smartphone that was in their home and 21 of the students had the Internet. It was found that 29 of the parents are positive towards their children's participation in modeling, and 28 of the parents believe that modeling improves students' academic achievement. For the sake of morality, blurring of faces and names has been shortened.

To ensure reliability, data collection was diversified. To determine students' academic achievement in mathematics skills, a scoring key was developed in three dimensions with full, partial, or extreme criteria [15], [16], [5].

Through three different experts the tool was prepared, and the researcher was the other data collection tool used in the research. During the process, [18], [13] photo and video recording was determined as the most appropriate data source for the student's presentation of knowledge, skills, and attitudes were recorded by the researcher.

To analyze the results descriptively, after the implementation process, focus group interviews were conducted with the students.

Use descriptive frequency and percentage statistics related to the first question. From the graduated keys, data on students' skills were obtained, which were conducted practically one by one, to answer the second question through pictures and video recordings. Students' experiences during the class were described and analyzed, which is the students' participation in the class. The obtained data were analyzed and analyze the content according to [21] by coding the data and organizing, identifying and interpreting those codes.

For the application of action research, the literature on the topic has been pre-screened, and implementation is planned by obtaining research-related permissions. In 2021/2022 in Madras in Amman, heterogeneous groups were created and modeling started. The teachers did the following

Statement of objectives and methods that were used.

– A group of female students were trained in modeling personally in a computer lab and explained the main idea of the project.

Create a WhatsApp group to receive posts. Divide the students into two working groups, each group includes a teacher and a supervisor.

– Students were encouraged to make modeling through drawings from the students' surroundings.

After completing the process procedures, the students were interviewed in groups. Through the analysis of the data, the results obtained, teachers need to use modeling to encourage students to study aero engineering in mathematics.

Fig. 1.

The students participated in a creative modeling of aero engineering in mathematics to express their understanding of it. Each teacher is responsible for a discussion with the students about the modeling conditions in his/her week (online meetings) https://twinspace.etwinning.net/166724/pages/page/1640073

Weekly dialogues were organized to suggest modeling topics (WhatsApp)

The students collected information for each modeling topic in collaboration with their teacher. A journal was created: containing all the topics covered throughout the year to develop content using modeling. In this study, modeling in mathematics from the five grade was examined. The series of applications was composed during the academic year 2021/2022.

2 Findings

The contribution of modeling practices to students' development of mathematics skills In the first question, the contribution of modeling to students' development of mathematics skills was studied. The level of achievement in the mathematics skill acquired from the scaled scoring key is shown in Table 1.

Table 1. The level of achievement of modeling skill goals

The Level of Attaining the Objectives		Completely Achieved		Partly Achieved		Low Achieved	
Objectives		f	%	f	%	f	%
1	He will be able to know the engineering concept	10	33.3	4	13.3	16	53.3
2	He will be able to determine the angle	21	70	–	–	9	30
3	He will be able to locate the inscribed angle in the circle	17	56.6	13	43.3	–	–
4	When he doesn't know the answer, he will be able to model that he doesn't know the answer	19	63.3	9	30	2	6.6
5	Will be able to produce modeling, when necessary, around the assigned material	17	56.6	13	43.3	–	–
6	He will be able to respond appropriately to questions regarding the modeling he has drawn.	18	60	–	–	12	40

The findings were commented on in accordance with the data presented in Table 1:

Target 1: 24 (80%) were observed to be positive.

The second objective: 70% of the students achieve the behavior using modeling. This was considered an indicator of the students' comprehension.

Objective 3: It was observed that 24 (80%) of the 30 students were able to achieve Objective 5 in the activities of the third week. 56.6% of students demonstrated behavior using modeling in the fourth week.

Objective 4: 63.3% said "I'm sorry. I don't know", while 30% used modeling with minor errors (93.3%) that they have modeling they use.

Objective 5: 56.6% of the students answered the whole question according to the modeling scale key.

Goal 6: 60% of students have fully achieved Goal 9.

As a result, significant progress has been made in the field of modeling and skill development in mathematics. Results on listening skills were evaluated in line with the data acquired.

From the scaling scale key, we note that most of the students (90%) achieved Target 1. 10% of the students

Has partial knowledge of Objective 2. related topics (cognitive, social and emotional) as demonstrated through analysis of data and symbols.

The level of students' participation in the modeling is cognitive, emotional, and social (Figure 2).
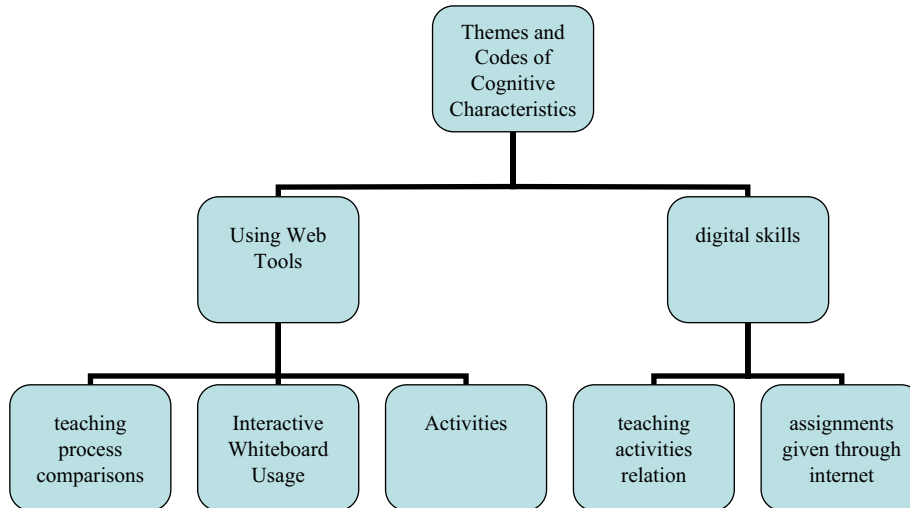
Fig. 2. Themes and codes of cognitive characteristics

It contains icons "The use of modeling and its impact on student learning. As for the focused interviews, it was noted that the students enjoyed the interaction over the web, and the emotional area was evident. When the students were asked about the project, the responses to some of them were as follows, K." For study only, I prefer a board Clever." Here are a selection of sentences from the interviews:

Teacher: What is your idea of the project?

D.D.: We expressed ourselves through drawing.

EZ: We enjoyed learning about modeling.

Ek: We study anywhere.

Teacher: Do you like math?

EK: Her clever questions.

The activities varied in the teacher's record "Pie Model" and the application of the corners game. "The students are not interested in the theory of circumferential angles, but they are interested in modeling with active participation interest. The shy students actively participated in the activity." It was noted in the videos recorded by the researcher: "They were happy." He was asked about the comparison between traditional teaching and modeling teaching. The dialogue as in the video was: "Teacher: What are the advantages of modeling? What do you think about that? NN: Traditional learning is boring, and I like modeling."

A: I prefer modeling on icons. D.D.: Gentle use of modeling contributes to enhancing cognitive orientation and has emotional effects.

As for the emotional characteristics (motives and attitudes, achievement, right of expression), they were taken into account through active participation (Figure 3).
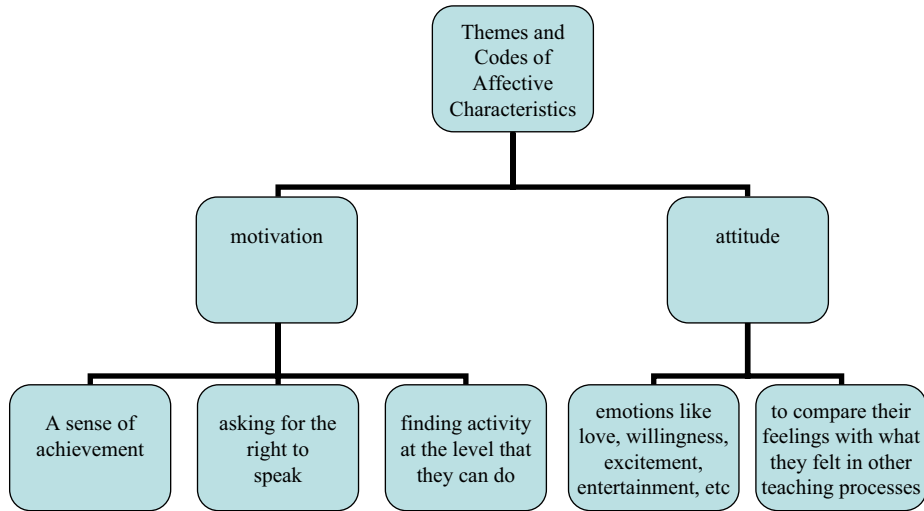
Fig. 3. Themes and codes of affective characteristics

Week 1: The video was shown to be effective, the answer to the students' questions, and the notes on the researcher's record were: "The participation and interest is very high. The students were attentive and observant."

In the second week: the use of modeling in mathematics, it was noted that it can attract the attention of E.K. and B.A., and lose interest easily as it is mentioned on the record that students M. and T.K. Those whose academic level was low also watched the video with interest.

In recent interviews, it has been noted that students believe they are getting more learning through modeling. Here are some quotes: When I model, I memorize it and understand it. Yes: modeling is helpful. Makes. Remind the students that they had difficulty in the beginning and yet continued: CT: Things started to be difficult. Teacher: What were the difficulties?

CT: Doing homework and learning to draw Teacher: Which is better, not doing modeling or doing it? CT: I love doing modeling said the participating students. We can communicate with people from different regions," said T.U. I am interested in discussing with others," said M., "I like to learn with pleasure," regarding social characteristics (Figure 4).
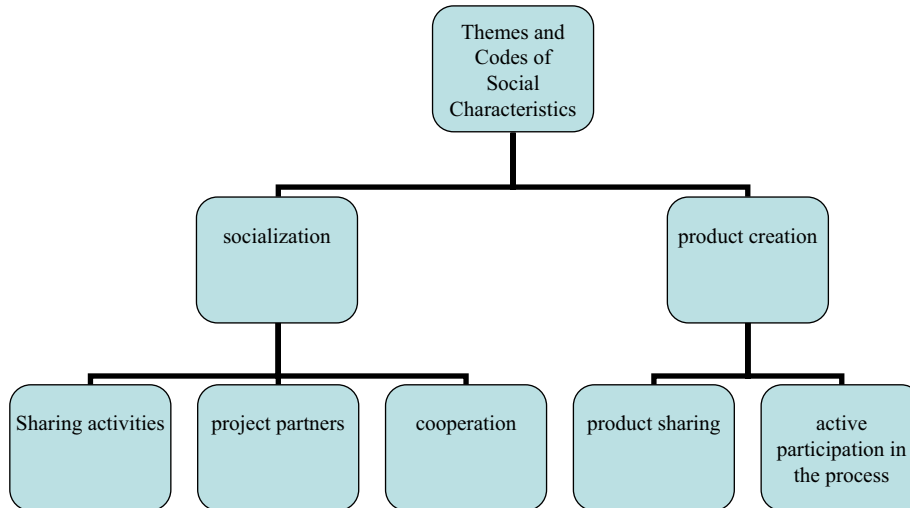
Fig. 4. Themes and codes of social characteristics

Through social work, achieving the social dimension, videos and images of students' drawings in mathematics were recorded, and meetings took place between the participants through the platform, and students exchanged what they produced between them, and they produced an electronic modeling magazine. The social character dominated the work of the students, who displayed their drawings on the work platform, and divided the students into groups to do the modeling and make the drawings collectively. The researcher mentioned that the students were cooperative and positive.

The students were successful in achieving the goals, and they enjoyed teamwork. Presentations, models and drawings made by students were also shared on the platform. EC said, "There were assignments. We put our experiences on stage," and R.A. One of the best parts of the project was making the models. K "Sharing products and active learning makes me happy" after the modeling works prepared by the students in the field of engineering were collected and their concepts and terminology were presented through an electronic modeling magazine on the project platform and shared with other works from the participating schools.

3   Result and discussion

The result of the research, which aims to determine the effect of modeling on engineering skills in mathematics and motivation for students. When students' skills in mathematics were examined, the first result in the research was that students acquired skills in geometry in mathematics through modeling. Evaluation between the improvement in the expression of engineering concepts and their terminology in mathematics through modeling among the participating students. Records, videos, graphics, photos, and meetings demonstrated that collaboration and communication across the project platform enhanced the knowledge domain. Through modeling and this is consistent

with the results [12], [7] Collaborative work increases using modeling and the Internet. The modeling educated the participants (teachers, students and administrators) about the use of collaborative work and the Web, and this supports the results of [14], [4] in the use of Web tools. Increasing communication between the participants because of the method of working in modeling collectively, collaboratively spreading the spirit of cooperation and exchanging experiences, keen to produce what is better, students who have enthusiasm, self-confidence, and openness to acquiring skill and will get successful results [8], [11], [21] in modeling applications, which increase students' attention and motivate them In teaching and increase their participation, so that they feel successful and increase their self-confidence. As for the second study question, which is the contribution of modeling applications to student interaction in the classroom. When examining the results, the interaction of the students in the category of "cognitive, emotional and social" dimensions was positive. Students' activities increased students' interest and motivation, and this was positively reflected in the students' skill in engineering and mathematics. This is consistent with the results of studies [18], [2], [22], [20], which confirms the need to establish a collaborative network for different levels in schools through the Internet. Students made significant progress in Internet skills. Students dealt tolerantly with different cultures and social skills, in the field of teamwork acquired communication skills.

4   Conclusion

The use of modeling increases the interaction between teachers, students and geometry in mathematics, organizes students in the classroom, and leads to an increase in the effectiveness of the teaching and learning process. The use of modeling aims to increase the knowledge of students who use the platform daily. Teachers should receive appropriate training in the effective use of modeling through e-learning and by encouraging them to use modeling.

 Schools should obtain the resources necessary to use the modeling. And it must provide appropriate training for the cadres associated with the education process through modeling, on a regular and continuous basis, so that modeling becomes an essential part of an effective curriculum capable of preparing individuals who are able to work effectively in the future and apply what they have learned correctly.

As for the learning environment, the use of modeling stimulated students and increased their interest in mathematics, by increasing the opportunity for students to share their products with all participants, and their products and models appeared through their electronic magazine at the end of the work, which had a great impact on the development of students' skill in engineering In mathematics. It is hoped that this research will shed light on the use of modeling and the use of similar technological applications, experimental design and may be useful for comparing the results of using modeling with traditional techniques. Finally, the current research was conducted with a limited number of schools. It is believed that research with a larger number of schools could be beneficial.

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