Presentation date: February, 2023, **Date of acceptance**: April, 2023 , **Publication date**: June, 2023

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MODERN TECHNOLOGY INTEGRATION IN MATHEMATIC EDUCATION

INTEGRACIÓN DE TECNOLOGÍA MODERNA EN LA EDUCACIÓN MATEMÁTICA

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Suggested citation (APA, seventh edition)

Hasanov, R. (2023). Modern technology integration in Mathematic education. *Revista Conrado, 19(S1)*, 212-218.

ABSTRACT

The aim of the research is to reveal the integration of technology into education within the framework of mathematics education in secondary education. The research is a case study by its nature. The participant of the research is the teacher selected by the critical situation sampling method. The participant of the research was selected by the critical situation sampling method. Data were collected with a semi-structured interview form and observation tools. The data obtained with thematic analysis method and Maxqda software were analyzed. According to the findings obtained from the research, two main themes and twelve sub-themes were formed. According to the findings, the process that focuses on technology integration in mathematics lessons is the process of using stimulating materials in Gagné's Teaching Situations Model. In this process, technology integration is implemented to validate and increase understanding. However, it has been concluded that there are difficulties in the use of applications such as Geogebra and Kahoot. Lack of technological equipment and planning is the main reason for this difficulty. It is recommended to include technology-based materials in order to integrate technology into every stage of education and to make lessons more efficient. When the questions about the process of technology integration into mathematics education are examined, it can be said that it is more important to focus on the mathematics teacher's decision to use technology in the process of integrating technology and at what stage it will use it.

Keywords:

Mathematics education, technology integration, Gagné's instruction model

RESUMEN

El objetivo de la investigación es revelar la integración de la tecnología en la educación en el marco de la educación matemática en la educación secundaria. La investigación es un estudio de caso por su naturaleza. El participante de la investigación es el profesor seleccionado por el método de muestreo de situaciones críticas. El participante de la investigación fue seleccionado por el método de muestreo de situaciones críticas. Los datos se recogieron con un formulario de entrevista semi-estructurado y herramientas de observación. Se analizaron los datos obtenidos con el método de análisis temático y el software Maxqda. Según los resultados de la investigación, se formaron dos temas principales y doce subtemas. Según los resultados, el proceso que se centra en la integración de la tecnología en las lecciones de matemáticas es el proceso de uso de materiales estimulantes en el modelo de situaciones de enseñanza de Gagné. En este proceso, la integración tecnológica se implementa para validar y aumentar la comprensión. Sin embargo, se ha llegado a la conclusión de que hay dificultades en el uso de aplicaciones como Geogebra y Kahoot. La falta de equipo tecnológico y de planificación es la razón principal de esta dificultad. Se recomienda incluir materiales basados en tecnología para integrar la tecnología en cada etapa de la educación y hacer que las lecciones sean más eficientes. Cuando se examinan las preguntas sobre el proceso de integración de la tecnología en la educación matemática, se puede decir que es más importante centrarse en la decisión del profesor de matemáticas de utilizar la tecnología en el proceso de integración de la tecnología y en qué etapa la utilizará.

Palabras clave:

Educación matemática, integración de tecnología, modelo de instrucción de Gagné

INTRODUCTION

The "Information Age" we are in; It has introduced new concepts such as changing and developing science and technology and computers and Internet technologies. These new concepts have also caused serious changes in teaching needs. The concept of "lifelong learning" is becoming more and more widespread not only in professional but also in personal development, thus increasing the demand for "continuous education". With the increase in the number of students who want to receive education, technological modern teaching becomes widespread. Today, the understanding of teaching has shifted from classical teaching to technology-supported modern teaching (Alakoc, 2003). One of the concepts that express the process of using technology in education encountered in the literature in recent years is technology integration.

There are two approaches to the use of technology in schools. These can be stated as 'learning from technology' and 'learning with technology'. In the technology learning approach, the content is presented through technology and it is assumed that this will result in learning. On the other hand, in the technology-learning approach, technology is used as a tool to help critical thinking and higher-level learning, and in this approach, it is aimed that technology functions as a mental partner for the student (Jonassen et al., 1999). According to Wachira and Keengwe (2011), "technology integration" is to include technology and technology-based applications in learning and teaching perspectives, to evaluate learning outcomes, and to combine appropriate technologies in lessons.

Many studies conducted today show a tendency towards the selection of appropriate technologies, how to use these technologies and how to integrate them into lessons (National Council of Teachers of Mathematics [NCTM], 2008). In this sense, many models for technology integration are suggested in the literature. The most indispensable element in technological modern teaching is multimedia. Multimedia; It consists of using audio, video, images and written texts together to explain a topic. Multimedia applications are the use of different types of data in a computer environment to explain an idea, an event, a place or a subject. One of the biggest application areas of multimedia elements is teaching. It enables students to learn information through auditory and visual means, as well as enabling them to access information actively, allowing them to learn in the freedom of trial and error, making mistakes and correcting (Alakoc, 2003). It offers students simulations of the natural applications of complex concepts, allowing people to learn with their own skills and knowledge.

According to Heddens and Speer (1997), today's technology has begun to change the teaching and learning processes related to mathematics, as in all areas. It is now accepted that teachers should use technological tools to increase students' interest and facilitate their understanding of mathematics. According to NCTM (2008), one of the six principles of mathematics education is technology, and the use of appropriate technology allows students to develop deep meanings and focus on problem solving and reasoning. Technology has a positive effect on students' learning as listed below (Wachira & Keengwe, 2011; Buteau & Muller, 2006; Keong et al., 2005):

- students' ways of mathematical thinking,
- develop their mathematical ideas,
- to motivate students and take responsibility for their own mathematics learning.

According to Jinich (1986), software programs are the most important factor in enabling students to achieve success in mathematics using computers. However, most of these programs can pacify the student in front of the screen. However, computers can affect students by using sound and visual effects as well as their graphic capacity. The user can frequently answer multiple-choice questions on the subject and receive instant feedback on these answers. After these stages, computer algebra systems-CAS, as well as Dynamic Geometry Systems-DGS, modern graphing calculators-TI89, as well as Cabri, are effective tools to increase the accuracy and speed of calculations (Artigue, 2002; Straesser, 2002). Geogebra were used in mathematics education and studies in this field accelerated (Hohenwarter, 2006).

The technology integration process in the research was designed with Gagné's Model of Teaching Situations. Gagné (1985) teaching process is a 9-stage model of teaching situations. Attracting attention, informing about the target, reminding preliminary information, using stimulating materials, guiding the student, revealing the behavior, feedback, evaluation, ensuring its permanence and transfer are the stages of the model. The model is presented in Table 1.

Table 1. Stages of Gagné's (1985) model of instructional situations

1. Attention	Since student-centered education is in question, different attention-grabbing methods should be used in order to attract the attention of each student.
2. Informing the Target	Knowing what the student will learn before the learning-teaching process prepares him for learning. It enables him to act selectively among the stimuli he will be exposed to in the learning-teaching process. For this, at the beginning of the lesson, the students should be told what will be taught in that lesson.
3. Reminding the preliminary information	According to information processing theory, information must be encoded into long-term memory in order to be learned permanently. For this, the information in the short-term memory must be associated with the foreknowledge in the long-term memory. For this reason, before presenting new information, it is necessary to remind the student's foreknowledge about the new subject to be learned. Thus, by associating the new information with the existing information, the student can code it in his long-term memory in a meaningful and organized way.
4. Using stimulating material	After the student's attention is drawn and his prior knowledge is reminded, the stimuli related to the achievements are presented to the teaching environment. Depending on the nature of the subject, information is transferred to the students by using various teaching methods. At this stage, what should be considered is that it is presented to the students by making use of various teaching methods, techniques and materials. According to Gagne, content should be presented in accordance with each learning area. If verbal information is to be taught, books, notes, auditory messages can be used. Symbols, objects, models, real entities or events, which represent concepts or 46 principles, can be shown in subjects where mental skills will be taught.
5. Guiding the Student	In order to ensure that students do not acquire undesirable behaviors and be successful, they should be guided in the learning environment. For this purpose, the student is guided on the source to study. If the information to be learned is verbal information, the student is taught the ways and tools that will make the content understandable. If a concept or rule is to be learned, schemas and verbal expressions showing the relationship between the concept and the sub-concepts and rules covered by the rule are used.
6. Revealing Behavior	In the learning-teaching process, students should be given the opportunity to practice new skills or behaviors. Exercises should be done in order to provide students with the opportunity to demonstrate what they have learned. These exercises can be performed with written or verbal questions. Thus, in the stage of revealing the behavior, students have the opportunity to exhibit the information they have learned. At the end of each subject, it is necessary to examine how much the achievements to be achieved have been achieved.
7. Feedback	Learning is assumed to have taken place when desired behaviors occur. However, the student should be informed about the correctness of his behavior. By asking different questions, special exercises, dialogues can be used for feedback. The extra guidance and answers provided in this area are also called feedback formats.
8. Evaluation	The teacher may conclude that learning has taken place after observing a few behaviors in informal ways. Evaluation can take place more systematically with formal follow-up tests. These tests are called final assessment or post-test. Unlike feedback, this assessment is completed without hinting or implying. However, the tests used in the evaluation must be reliable and valid. In order to prevent the student from memorizing new learners, care is taken to ensure that the materials used in the assessment are different from those used in the presentation.
9. Ensuring Permanence and Transfer of Learned:	It needs to be repeated at regular intervals in order to remember the information in long-term memory and use it in new situations. This may be intensive or intermittent, depending on the characteristics of the relearned information. It should also be used in new situations so that information can be well organized in long-term memory.

Source: Gündüz (2010, p. 43-49).

With the teaching model developed by Gagné, it is thought that the student's abilities can be improved and that he can answer the question of 'where to start' in order to achieve the gains. According to this teaching model, new learning is built on previously learned knowledge and skills (Gündüz, 2010). Since the science of mathematics is also an agglomerated science, technology integration in the mathematics teaching process can be realized with this teaching model. It is thought that Gagné's nine teaching steps will serve in the formation of the framework of the course as well as being a basic tool in the educational processes (Gagné, 2000). In this direction, when the teaching models that teachers can use while designing the lesson process are examined, Gagné's Teaching Situations Model was preferred in this study. Based on the Gagne model presented in Table 1, it is seen that teachers have great difficulties regarding the ICT applications of their teachers. This is also true in the field of mathematics (Sivakova et al., 2017). Apart from the application of ICT technologies, it is known that they also have difficulties in incorporating this technology into the education process. Such uncertainties bring great difficulties in incorporating technology into the teaching process.

This study, which evaluates the technology integration process from the beginning to the end, based on what has been said, is important. As a matter of fact, the teacher who is able to use technology in the research is important in terms of revealing technology integration in mathematics education. As a matter of fact, the results obtained will contribute to the literature as they will both guide teachers and inspire future studies. Considering the originality and contribution of the research, the aim is to determine the technology integration of the mathematics teacher with technology knowledge into education and to reveal the process. In accordance with the purpose, the question of the research is "How does a

mathematics teacher with technology knowledge integrate technology into education?" designed as. The answer to this question also addresses the integration process.

METHOD

The research was designed as a case study. Case studies are a method that answers the why and how questions by examining in detail the situations of an event, training, activity and one or more participants (Yin, 2018). The research was selected by the critical situation sampling method, which is sampling purposeful sampling. The critical situation sampling method advocates the logic of choosing the region or individual that can give the most information and make the greatest impact on knowledge production (Patton, 2014). The real name of the participant was not used in the study. The data collection tools of the research are a semi-structured interview form, which was prepared by scanning the literature and taking the opinion of 1 expert, and a semi-structured interview form with 3 mathematics teachers, and an observation form, which was prepared by reviewing the literature and taking the opinion of 1 expert, and the pilot application was realized with 6 lesson hours. In the middle of the observations, which totaled 30 lesson hours, the teacher was interviewed with a semi-structured interview form. Interview 20 min. it took. The data obtained from the interviews; It was transcribed, coded event by event, then coding was done using Maxqda.

Data analysis was based on Gagné's (1985) 9-stage teaching model. Thematic analysis is a method used to identify, analyze and analyze themes in data. It enables the researcher to best organize and describe the data set in depth (Braun & Clarke, 2019). The validity of the findings was ensured by the diversification of data collection tools and data diversity. After data collection and analysis, interviews were held with the participant for member control. As suggested by Creswell (2016), time was spent in the environment with the participant outside the observation to ensure validity. The reliability of the findings was tried to be ensured by coding the data line by line, event by event and using Maxqda software, keeping the coding process under constant control and writing short notes about the codes and the definitions of the codes (Gibbs, 2007). Although there is no generalization concern in the study, it is widely believed that specialization rather than generalization is the distinguishing feature of a good qualitative research (Grene & Caracelli, 1997).

FINDINGS

After the research data were coded using Maxqda, 245 initial codes were created. The codes were created according to the personal information of the teacher, the problems experienced while using the technology, the purpose of using the technology and Gagné's teaching situations model (See Figure 1).

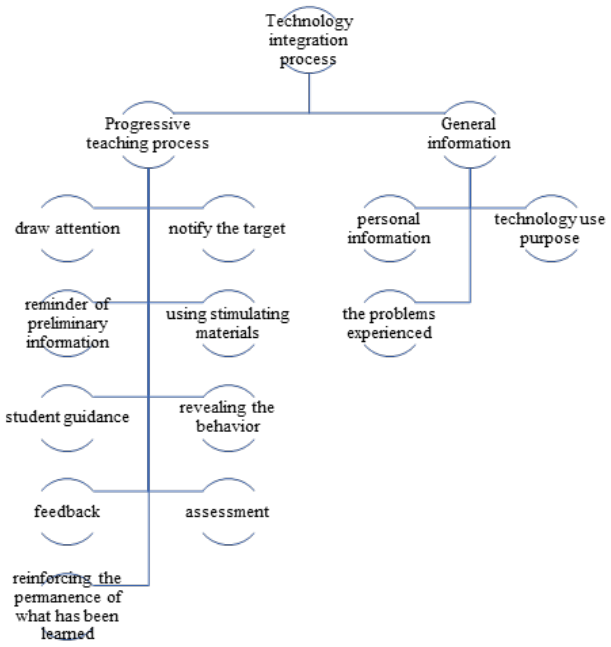

Figure 1. 12 sub-themes formed by data analysis

The personal information obtained in the research, the purpose of using technology and the problems experienced were gathered under the theme of "general information". On the other hand, the stages of "attracting attention and informing about the target", "presenting preliminary information and content", "guiding and practicing the student", "giving feedback and correction", "evaluation" and "ensuring the permanence of what has been learned" are called "progressive teaching process". gathered under the theme.

Technology Integration to the Attention and Target Stage

During the observations, the teacher had the students read the definitions of some mathematical concepts in the math book. In addition to this, students have never used Kahoot! They managed to attract students' attention by opening the Web 2.0 tool when they first entered the class. In some of their lessons, it was determined that they informed the lesson verbally. "*I use a number of activities or videos that are relevant to the topic. Before I start the lesson, I repeat the last week and specify the rules to be used for this lesson*".

Technology Integration to the Stage of Presenting Background and Content

In the observations, the teacher generally asked "What was the area in the drawing?", "Why was it like this?" It was seen that this process was carried out with the question-answer technique using questions such as: The only example encountered in the observations is a brief summary of the concept of drawing, showing its features through Geogebra and repeating it.

According to the data obtained from the observations, Mouse application, Starboard and e-books were used at this stage. There is evidence of using Geogebra software and toolbars. Geogebra software was used for concept creation, interpretation and validation. For example; They drew a question they opened from the z-book in Geogebra to help students understand the question and facilitate its solution. "*Since mathematics is an abstract lesson, if there are some deficiencies in the readiness of the child in their pre-learning, you cannot create some things in the child's mind by writing them on the board. In that sense, technology helps like a lifebuoy*."

Technology Integration into the Guidance and Practice Phase

In the observations, it was seen that the teacher showed some mathematical expressions with the students by using Geogebra, and in this sense, he allowed the students to use Geogebra and guided them on the board. For example; They put a student on the board to use Geogebra in order to comprehend triangle inequality. By guiding and directing the student, he helped the student discover step by step. At the same time, in almost all of the observed lessons, the teacher used technology to reveal the behavior. Reflecting a question from the Z-book and waiting for its solution from the students is an example of its use as an exercise to reveal the behavior.

Technology Integration into the Feedback Stage

In the observations, it was seen that they made the feedback and corrections verbally without using technology. While using technology on the smart board, the student gave feedback such as "That's right, well done... Nice, nice logic...". At the same time, it was observed that the students smiled when they answered the questions correctly and expressed their thoughts with their facial expressions. It was observed that he did not provide any feedback and corrections using technology.

Technology Integration into Assessment Phase

In the observations, it was seen that the teacher used the Kahoot application in four lessons, different classes. It was obtained from the field notes that he performed the application using his personal phone, since the interactive board did not have an internet connection. It was observed that the teacher had many problems during the use of Kahoot. One of the most important is that during the implementation of Kahoot in two separate classes for four lessons, the teacher does not remind students to bring mobile phones. Another problem is that the questions on the smart board are too small for students and they try to show the questions or answers one by one.

Technology Integration to the Stage of Ensuring the Permanence of Information

In the observation lessons, it was seen that the teacher recommended the students to use technology and emphasized that when they learned what came from with technology, it would be more memorable. In addition, it was seen that the teacher associated the side and angle relationship of the triangle with the conjunction "if" and transferred the student's knowledge.

CONCLUSION

The aim of the study is to examine the relationship between technology integration in mathematics education and teaching of teachers with technology knowledge. Gagne's model was preferred to investigate integration. The research was designed in accordance with this model. With the research, coding was done in accordance with the model and themes were obtained from the codes.

The findings are that the mathematics teacher who is self-confident and has technology knowledge has not been successful in the integration of technology into education.

It can be stated that the teacher uses technology especially in the stage of presenting the content of the Gagne model and this is the classical approach. Indeed, such a configuration demonstrates the logic of presentation rather than the inclusion of innovative technologies. As a matter of fact, it was found in the findings that applications such as Kahoot were not used efficiently. With this approach, instead of including the students as active participants in the technology integration process, the teacher included the students in the audience. In other words, a collaborative learning environment has not been achieved with the integration of teacher and students technology.

On the other hand, the findings show that the teacher applies the course materials during the processing of the course rather than planning it before the course. This situation may show that the teacher with technology knowledge is not sufficient in material.

In summary, with this research, it is aimed to determine the result of technology integration at every stage of the education-teaching process. As a matter of fact, the Gagne model expresses this in 9 stages. At the same time, it is important to plan the technological materials in advance, not at the stage of the lesson. With this research, it is aimed to contribute to this process.

DISCUSSION AND SUGGESTION

When the process of technology integration into mathematics education is examined, first of all, a mathematics teacher should focus on deciding to use technology in the process of integrating technology and determining at which stage it will be used. This situation also supports the views that teacher decisions are effective in technology integration (Li & Ma, 2010; McCulloch et al., 2018). On the other hand, it is important to focus on technological material development. The main reason for the difficulties experienced by a well-equipped teacher is seen to be that the teacher does not prepare technological materials and enters the lesson unprepared without planning. As a matter of fact, it is stated that lesson planning plays an important role in making and applying technology decisions in technology-supported teaching (Canbazoğlu-Bilici eta la., 2016).

On the other hand, it is a challenge to use the classical method instead of learning in cooperation with technology integration. As a matter of fact, Ertmer and Ottenbreit-Leftwich, (2010) and Voogt and Pelgrum (2005) state that the positive effects of technology are strengthened when combined with a constructivist approach, teamwork, project work and non-standard evaluation methods.

Moreover, the availability of materials in the process of technological integration is an important part of the modern technology integration process. However, the findings do not indicate this. On this subject, Ljajko and Ibro (2013) also mentioned the importance of dynamic geometry software and the importance of teachers choosing and using the materials they will use correctly. On the other hand, considering the integration and use of technology in mathematics education, McCulloch et al. (2018) advocate the importance of material preparation and material.

In line with the data obtained from the research, some suggestions are presented for future studies. First of all, it is suggested that teachers should be evaluated according to their seniority, gender and age. It is recommended to research technology integration in mathematics teaching with different models and methods. The findings also offer recommendations to practitioners. The main suggestion is that teachers need hands-on training in the technology integration process. Because the obtained finding is seen as the visualization of technology integration only in classical education. For this reason, it is recommended to provide support to teachers in order to make an approach that will involve students in the process.

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