journal of
Adolescent and Youth Psychological Studies
www.jayps.iranmehr.ac.ir

Fall and Winter 2022, Volume 3, Issue 3 (6, Special issue on education), 81-86

Designing an Internet of Things-Based Learning Management Model to Improve the Math Problem Solving Ability of High School Students in Mashhad

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ARTICLE INFORMATION

Article type
Original research
Pages: 81-86

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Article history:
Received: 2022/08/10
Revised: 2023/01/19
Accepted: 2023/01/30
Published online: 2023/03/18

Keywords:
Learning management, Internet of things, improving the ability to solve mathematical problems

ABSTRACT

Background and Aim: The Internet of Things has many uses in education. However, one of the most important subjects in all educational levels is mathematics, which was specifically addressed in this research. Therefore, the purpose of this research was to design a learning management model based on the Internet of Things to improve the mathematical problem-solving ability of secondary school students in Mashhad. **Methods:** The current research is applied in terms of its purpose, which was carried out with an approach mixed with an exploratory design and by combining qualitative and quantitative methods. In order to deeply investigate and understand more about the subject and the factors affecting them, in addition to theoretical foundations, interviews were used for better understanding and the grounded theory approach. Then a quantitative approach was used to confirm the qualitative results. In the qualitative part, in order to identify the components of the model, 12 experts from the scientific community and academic experts were interviewed in the field of research. **Results:** The results of the qualitative part showed that the model includes 75 major categories (resulting from open coding), 10 core categories (resulting from axial coding) and two main categories (resulting from selective coding). In the quantitative section, a questionnaire containing 51 items was prepared and given to 384 secondary school students in Mashhad. The results of this section showed that there is a significant relationship between learning management based on the Internet of Things and the ability to solve mathematical problems. **Conclusion:** The results showed that the effectiveness of the variable components of learning management based on the Internet of Things (in order of technical and systemic infrastructures, measurement and evaluation, educational content, support (technical, financial and legal) and educational method) and the variable components of solving ability It is a mathematical problem (in the order of testing hypotheses, making hypotheses, gathering information, defining the problem and drawing conclusions).

How to Cite This Article:
Fatehi, R., Cherabin, M., Karimi, M., & Zendedel, A. (2022). Designing an Internet of Things-Based Learning Management Model to Improve the Math Problem Solving Ability of High School Students in Mashhad. *Jayps*, 3(3): 81-86.

Introduction

The Internet of Things is one of the technologies that can play an important role in education and not only change traditional methods, but also create significant changes in the infrastructure of educational institutions (Gol et al., 2009). Kevin Ashton first proposed the concept of Internet of Things in 1999. Since then, many researchers have tried to define it in different ways, including the Internet of Everything, the Internet of Everything, the Internet of People, the Internet of Signs, the Internet of Services, the Internet of Data, and the Internet of Processes. Accordingly, the Internet of Things is to show everything everywhere, depending on the need (Goll et al., 2009). The wide range of applications of the Internet of Things has made it possible for educational environments at all educational levels to benefit from it. (Bagheri and Mohed, 2016). The Internet and electronic education have been present in schools in countries like the United States since the past. However, the Internet of Things is relatively new in educational topics and has many applications. Also, with the help of this technology, access to educational information will increase. Smart technologies affect education in two ways: 1) Faster learning of students: Children and teenagers are educated better with the help of smart tools and more interaction. 2) Teachers also perform their duties more effectively. For example, a teacher has to spend 12 to 14 hours a day teaching, designing questions or preparing new teaching methods for future lessons. However, with the help of the Internet of Things and smart tools, this time is reduced and the quality of the content is increased. Digital content is shared more easily among teachers; they can exchange information and display their knowledge and experiences to others. Also, the speed of training increases; Because there is no need to write word by word on the class board. Also, they can easily deliver the presented materials to students through smart tools (Khakpour, 2017). In general, the Internet of Things has many roles in education and learning, including:

The role of Internet of Things in planning for teaching and learning: In planning, there are three components: teacher, learner and planner. Since all three components are equipped with the Internet of Things, they exchange essential data. Therefore, accurate and appropriate planning is provided for the planner component by sharing data between these three components and taking into account the conditions and the situation of the two components of the learner and the teacher (Esmaeili, 2015).

The role of the Internet of Things in implementing education: In traditional teaching methods, the centrality of education is the professor (teacher), but the Internet of Things has destroyed this centrality, and students (students) also participate in education along with the teacher. In education based on the Internet of Things, there is no longer a border for the classroom, and all universities (schools), professors (teachers) and students (students) related to the subject are in communication with each other and share the relevant data. Through this technology, instead of using outdated textbooks, real-time information can be obtained from multiple sources and presented to students. In fact, this issue is considered a kind of cultural change for teachers (Brown, 2017).

The role of the Internet of Things in evaluation: education based on the Internet of Things becomes more integrated and less manual and time-intensive. Teachers no longer need to conduct exams on paper and grade all exams manually. Instead, they can focus on learning activities that impact students most (Zebra Technology, 2015).

The current research will be conducted to design a learning management model based on the Internet of Things to improve the mathematical problem-solving ability of high school students. Mashhad schools have also been considered as a study.

Method

The current research is applied in terms of its purpose, which was carried out with an approach mixed with an exploratory design and by combining qualitative and quantitative methods. In order to deeply investigate and understand more about the subject and the factors affecting them, in addition to theoretical foundations, interviews were used for better understanding and the grounded theory approach. Then a quantitative approach was used to confirm the qualitative results. In the qualitative part, in order to identify the components of the model, 12 experts from the scientific community and academic experts were interviewed in the field of research.

Results

The results of the qualitative part showed that the model includes 75 major categories (resulting from open coding), 10 core categories (resulting from

axial coding) and two main categories (resulting from selective coding). In the quantitative section, a questionnaire containing 51 items was prepared and given to 384 secondary school students in Mashhad. The results of this section showed that there is a significant relationship between learning management based on the Internet of Things and the ability to solve mathematical problems.

Conclusion

This research aimed to design a learning management model based on the Internet of Things to improve the mathematical problem-solving ability of middle school students of Mashhad schools, which was done by applying a mixed approach and exploratory design and was realized in three stages. In the first stage, the theoretical foundations, studies and background related to the subject were examined, analyzed and compiled systematically. In the second stage, after reviewing and evaluating the internal and external studies conducted in the field of learning management, learning management based on the Internet of Things and students' ability to solve mathematical problems, a semi-structured in-depth interview was conducted with 12 experts active in this field. After implementing the interviews, the qualitative grounded theory method was used to analyze the interviews. In this method, in the open coding stage, the text of each interview was examined word by word and concepts were extracted from the words and phrases of the interviews. In the central coding stage of each interview, by placing similar categories in the general levels of features, components and indicators of learning management based on the Internet of Things and students' ability to solve mathematical problems were identified. Then, a suitable learning management model based on Internet of Things was designed to improve the mathematical problem-solving ability of high school students in Mashhad. This model includes two main categories (resulting from selective coding), including 1) learning management based on the Internet of Things and 2) students' ability to solve mathematical problems; 10 core categories (resulting from axial coding), including 1) educational content, 2) educational method, 3) technical and system infrastructure, 4) support (technical, financial and legal), 5) measurement and evaluation, 6) identifying the problem, 7) gathering information, 8) creating hypotheses, 9) testing hypotheses and 10) concluding and also includes 75 major categories (resulting from open coding).

The results of the T-value related to the relationship between the main components of educational content, educational method, technical and systemic infrastructure, support (technical, financial and legal) and measurement and evaluation with the learning management variable based on the Internet of Things showed that. At the confidence level of 95, the main components of educational content, educational method, technical and systemic infrastructure, support (technical, financial and legal) and measurement and evaluation significantly impact the learning management variable based on the Internet of Things. Also, the results of comparing the factors of the variable components of learning management based on the Internet of Things showed that the priority of these components is based on the degree of their influence on the variable of learning management based on the Internet of Things in the following order: 1) technical and systemic infrastructure components, 2) measurement and evaluation 3) educational content, 4) support (technical, financial and legal), 5) educational method.

The results of the T-value related to the relationship between the main components of identifying the problem, gathering information, making hypotheses, testing hypotheses and concluding with the variable of mathematical problem-solving ability showed that. At the confidence level of 95, the main components of educational content, educational method, technical and systemic infrastructure, support (technical, financial and legal) and measurement and evaluation significantly affect mathematical problem-solving ability. Also, the results of the factorial comparison of the components of the mathematical problem-solving ability variable showed that the priority of these components is based on the degree of influence on the mathematical problem-solving ability variable in the following order: 1) hypothesis testing, 2) hypothesis generation, 3) information gathering, 4) Specifying the problem, 5) Conclusion.

The results of the T-value of the relationship between the learning management variables based on the Internet of Things and the ability to solve mathematical problems at the 95% confidence level is equal to 8.887, which is higher than 1.96. This case indicates the significance of the relationship between learning management based on the Internet of Things

and the ability to solve mathematical problems. On the other hand, according to the path coefficient related to the relationship between Internet of Things-based learning management and mathematical problem-solving ability, it can be concluded that Internet of Things-based learning management has an effect of 0.665 on mathematical problem-solving ability. That is, if the learning management based on the Internet of Things increases by 1 unit, there is a 95% probability that the value of mathematical problem-solving ability will increase by 0.665 units. Factor loads are also very good in explaining their structure because they have more than 50%.

Conflict of Interest

According to the authors, this article has no financial sponsor or conflict of interest.

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