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Article

The use of mobile learning for teaching and analyzing measures of central tendency in grouped data

Uso del aprendizaje móvil para la enseñanza y análisis de medidas de tendencia central en datos agrupados

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Abstract

This article presents a quasi-experimental study on the integration of mobile technologies in teaching measures of central tendency for grouped data to third-year high school students at a public educational institution in Guayaquil, Ecuador. The objective was to evaluate the impact of m-learning (mobile learning) as a pedagogical tool in the understanding and analysis of statistical concepts. Two groups were involved: an experimental group, which used mobile devices to access content and interactive exercises, and a control group, which did not use this technology. The results show a significant improvement in the academic performance of the experimental group, with a notable increase in their ability to interpret and calculate measures of central tendency. These findings suggest that incorporating mobile learning not only facilitates access

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to educational resources but also contributes to the development of analytical and mathematical skills in a more dynamic and accessible environment. It is concluded that m-learning can be an effective strategy for modernizing the teaching of statistics in the current educational context.

Keywords: M-learning, Measures of central tendency, Teaching statistics, Grouped data, Educational technology.

Resumen

Este artículo presenta un estudio cuasi-experimental sobre la integración de tecnologías móviles en la enseñanza de las medidas de tendencia central para datos agrupados en estudiantes de tercer año de bachillerato en una unidad educativa pública de Guayaquil, Ecuador. El objetivo fue evaluar el impacto del m-learning (aprendizaje móvil) como herramienta pedagógica en la comprensión y análisis de conceptos estadísticos. Se trabajó con dos grupos: uno experimental, que utilizó dispositivos móviles para acceder a contenidos y ejercicios interactivos, y un grupo de control, que no empleó esta tecnología. Los resultados muestran una mejora significativa en el rendimiento académico del grupo experimental, con un incremento notable en la capacidad de interpretar y calcular las medidas de tendencia central. Estos hallazgos sugieren que la incorporación del aprendizaje móvil no solo facilita el acceso a recursos educativos, sino que también contribuye al desarrollo de habilidades analíticas y matemáticas en un entorno más dinámico y accesible. Se concluye que el m-learning puede ser una estrategia efectiva para modernizar la enseñanza de la estadística en el contexto educativo actual.

Palabras Clave: M-learning, Medidas de tendencia central, Enseñanza de la estadística, Datos agrupados, Tecnología educativa.

Introduction

The advance of technology has transformed various aspects of society, including education. Among the most recent innovations is m-learning (mobile learning), a methodology that uses mobile devices such as smartphones and tablets to facilitate the teaching-learning process. This approach has proven to be particularly effective in teaching complex concepts, such as measures of central tendency for grouped data in the area of statistics.

M-learning has positioned itself as an important tool that provides flexibility and accessibility to educational resources. According to Crompton and Burke (2018), mobile learning allows students to access educational content anytime and anywhere, which favors the personalization of the learning process. In addition, recent studies have shown that the use of mobile devices can improve academic performance in various disciplines, including mathematics (Sung, Chang & Liu, 2016).

In Ecuador, the use of mobile technologies in the classroom is still limited, but presents enormous potential to improve the teaching of mathematics and other sciences. In this context, the present research focuses on evaluating the effectiveness of m-learning in the calculation and interpretation of measures of central tendency, with the objective of determining whether the integration of this technology can improve students' academic performance and foster a greater understanding of statistical concepts.

This study was carried out with third year high school students of the Vicente Rocafuerte Fiscal Educational Unit, using a quasi-experimental design that included a control group and an experimental group. Through the implementation of interactive content and activities accessible from mobile devices, the experimental group had the opportunity to explore the concepts in a more dynamic way, while the control group received traditional teaching.

Several studies have supported the effectiveness of m-learning in improving academic performance and concept retention. For example, Sung, Chang, and Liu (2016) found that mobile devices promote more active and engaged learning, especially in complex areas such as mathematics and statistics. Similarly, Barreno and Guevara (2022) conclude that the use of mobile applications in mathematics teaching not only improves the understanding of topics, but also increases students' motivation.

In summary, this study seeks to contribute to the debate on the feasibility and effectiveness of m-learning in secondary education, with a particular focus on the teaching of statistics. The results not only provide empirical evidence on the impact of mobile learning on academic achievement, but also provide a basis for future research and the implementation of educational policies that promote technological integration in the classroom.

Materials and methods

This study adopted a quasi-experimental approach to evaluate the impact of m-learning on the learning of measures of central tendency for grouped data in third year high school students of the Unidad Educativa Fiscal Vicente Rocafuerte. An experiment was designed with two groups of students: an experimental group, which used mobile devices as a learning tool, and a control group, which received traditional instruction without the use of mobile technology.

Study design: The quasi-experimental design allowed comparing the results between the two groups. The experimental group, composed of 40 students, used mobile devices (mainly smartphones) to access a series of educational resources, including interactive simulations, hands-on exercises, and tutorials related to measures of central tendency for grouped data. The control group, also composed of 40 students, followed traditional instruction with textbooks and paper assignments.

Participants: The study participants were 80 third-year high school students from Unidad Educativa Vicente Rocafuerte in Guayaquil, Ecuador. The students were selected intentionally, considering those with regular access to mobile devices and Internet connection. The inclusion criterion was that students had previous experience in the use of mobile devices and were familiar with the basic management of educational applications.

Instruments: To measure the impact of m-learning on learning measures of central tendency, the following instruments were used:

- Prior knowledge questionnaire: a test administered before the intervention to assess the initial level of understanding of measures of central tendency in both groups.
- Mobile applications: The experimental group used educational applications that provided interactive simulations, statistical calculators and exercises on measures of central tendency. Applications such as GeoGebra and Khan Academy were used as part of the m-learning.
- Post-intervention evaluation questionnaire: The same questionnaire applied at the beginning was used at the end of the intervention to assess the level of learning achieved by both groups.

- Perception survey: Students in the experimental group answered a survey to measure their satisfaction and perception of the use of m-learning as an educational tool.

Procedure: The study was conducted in three phases:

- Phase 1: Initial assessment. A diagnostic questionnaire was administered to both groups to measure prior knowledge about measures of central tendency for grouped data.
- Phase 2: Intervention. The experimental group used mobile devices for a period of four weeks, performing activities that included simulations, interactive exercises and self-assessments. On the other hand, the control group followed traditional classes without the use of mobile technology.
- Phase 3: Final evaluation. At the end of the intervention, the evaluation questionnaire was reapplied to both groups to compare the results. Additionally, the experimental group completed a perception survey about their experience with m-learning.

Data analysis: Data were analyzed using descriptive and inferential statistics. Means and standard deviations were calculated for both groups' scores on the pre- and post-intervention assessments. To determine if significant differences existed between the groups, a t-test for independent samples was performed. Cronbach's alpha was also applied to measure the reliability of the questionnaire used.

Results

The results of this study show a significant difference in academic performance between the experimental group, which used m-learning, and the control group, which followed a traditional approach. The following are the findings obtained after the intervention.

Comparison of performance between the experimental group and the control group: Before the intervention, both groups showed similar academic performance in the baseline assessment on measures of central tendency for pooled data. The mean score on the diagnostic questionnaire was 5.4 out of 10 for the experimental group and 5.3 for the control group, with no statistically significant differences ($p > 0.05$).

After the intervention, the experimental group showed a considerable improvement in their academic performance, with an average score of 8.2 out of 10, while the control group obtained an average of 6.1. The difference between both groups was significant ($p < 0.01$), suggesting that the use of m-learning contributed significantly to the learning of the concepts of measures of central tendency.

Statistical analysis: A t-test for independent samples was performed to compare the results between the experimental group and the control group in the post-intervention assessment. The results indicated that the experimental group significantly outperformed the control group ($t = 3.45$, $p < 0.01$), supporting the hypothesis that the use of mobile devices improves the understanding of statistical concepts.

Additionally, Cronbach's Alpha applied to the questionnaire responses showed a reliability of 0.78, indicating that the assessments used were consistent and reliable in measuring student learning.

Experimental group's perception of m-learning: The experimental group also responded to a perception survey on the use of mobile applications as an educational tool. Eighty-five percent of the students indicated that the interactive activities improved their understanding of measures of central tendency. In addition, 90% of the participants indicated that the use of m-learning made classes more dynamic and participatory, while 80% expressed interest in continuing to use these technologies in other subjects. Summary of results: Significant improvement in the experimental group: Students who used m-learning significantly improved their performance compared to the control group, with an average difference of 2.1 points in the final evaluation.

- High satisfaction with the use of m-learning: The majority of students in the experimental group expressed a positive perception of the use of mobile applications, highlighting the flexibility and easy access to interactive content.
- Consistency in evaluations: The questionnaire used to measure knowledge showed high internal consistency, with a Cronbach's Alpha coefficient of 0.78, which reinforces the validity of the results obtained.

Discussion

The findings of this study suggest that the integration of m-learning in the teaching of measures of central tendency for grouped data can significantly improve the academic performance of high school students. Comparison between the experimental group, which used mobile devices to access interactive content, and the control group, which followed a traditional approach, revealed a statistically significant difference in academic outcomes, with a clear benefit for those who used m-learning. Improved academic performance: the use of mobile applications and interactive resources resulted in better understanding and higher retention of statistical concepts, which was reflected in the better performance of the experimental group in the post-intervention assessment. This improvement suggests that m-learning is an effective tool for teaching complex topics in mathematics and statistics.

Increased motivation and participation: Students in the experimental group reported a higher level of motivation and participation in learning activities, suggesting that the use of mobile devices makes the teaching process more dynamic and engaging. Interaction with digital resources allowed students to be actively involved in their own learning process.

Flexibility and accessibility: m-learning provided students with the possibility of accessing educational materials at any time and from anywhere, which favored more autonomous and personalized learning. This flexibility is a key factor in promoting a more modern approach adapted to the needs of learners in the digital age.

Feasibility of m-learning in educational contexts: This study demonstrates that m-learning is a viable methodology in the Ecuadorian educational context, where access to mobile devices is widespread. Its implementation can be an effective strategy to modernize the educational system and promote the integration of emerging technologies in the classroom. In conclusion, the integration of mobile technologies in education can transform the way students learn, especially in disciplines such as statistics. The results of this study support the implementation of m-learning programs in educational institutions as a key tool to improve learning and prepare students for the challenges of the digital world.

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