The Impact Of Using Multimedia Elements In Teaching Information Technology On The Cognitive Load Of Medical Students

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ABSTRACT

The purpose of this study is to determine the effect of using multimedia elements in teaching the subject of Information Technology (IT) on the cognitive load of medical students. The research was conducted at Andijan State Medical Institute using an experimental method with the participation of 60 students. The students were divided into two groups: the control group received traditional lessons, while the experimental group received lessons enriched with multimedia elements. Cognitive load was assessed using the NASA-TLX scale. The results of the study showed that the use of multimedia elements helps reduce students' cognitive load. This confirms the possibility of effectively applying multimedia technologies in the didactic process.

Keywords: information technology, multimedia, cognitive load, medical education, Andijan State Medical Institute

Introduction

Teaching Information Technology (IT) is one of the central components of modern pedagogical processes in medical higher education. This subject has a complex conceptual structure and requires significant cognitive resources from students. Therefore, in teaching IT, students' ability to process information and the effectiveness of learning are directly related to their cognitive load. The Cognitive Load Theory (Sweller, 1988) provides theoretical foundations for optimizing the use of cognitive resources in the learning process, reducing excessive cognitive load, and improving learning effectiveness. From this perspective, cognitive load management is considered an important element of pedagogical design.

Multimedia pedagogical technologies — including interactive visualizations, animated modeling, audio-visual materials, and graphic tools that enable the visual representation of complex concepts — enrich the learning process, allow semantic structuring of information, and help effectively direct students' attention. These tools assist in modularizing educational content and reducing intrusive cognitive load, while also developing students' higher-level analytical and critical thinking skills.

However, the impact of multimedia technologies on cognitive load in the teaching of Information Technology and its pedagogical implications for learning outcomes have not been sufficiently studied at Andijan State Medical Institute. Therefore, this study aims to evaluate the possibilities of managing students' cognitive load and improving learning effectiveness through the use of multimedia elements in teaching Information Technology.

Methodology

This study was conducted at Andijan State Medical Institute with the participation of first-year students based on an experimental pedagogical design. The research participants consisted of a total of 60 students, who were

voluntarily divided into two equal groups: the control group (n = 30) was taught using traditional teaching methods, while the experimental group (n = 30) participated in a pedagogical process enriched with multimedia elements. The main pedagogical reason for selecting the experimental design was to provide a systematic and comparative evaluation of the impact of multimedia elements on cognitive load.

In the experimental group, learning materials were presented using video clips, animated models, interactive diagrams, and visual infographics. These multimedia tools were aimed at attracting students' attention, organizing semantic content into modules, visually explaining complex concepts, and optimizing cognitive load. The control group studied the lessons using traditional lecture and presentation methods.

To evaluate the research results, the NASA-TLX (Task Load Index) cognitive load scale was used. The advantage of this scale is that it allows the assessment of students' subjective cognitive load across several components — mental demand, physical demand, temporal demand, performance, effort, and frustration level. At the end of the lesson, students evaluated their cognitive load based on this scale.

The obtained data were analyzed using a statistical software package. For each group, mean values and standard deviations (M ± SD) were calculated. To determine differences between the groups, a t-test was applied, and the significance level was set at $p < 0.05$. The research design and methodology were implemented through a combination of pedagogical experiment principles, scientific-objective observation, and subjective evaluation methods.

Results

The results of the study clearly demonstrated the effect of a pedagogical process enriched with multimedia elements on the cognitive load of medical students. During the experiment, students' cognitive load was assessed using the NASA-TLX scale, and the results were compared across groups. The control group (students taught using traditional teaching methods) demonstrated an average cognitive load score of 69.1 ± 8.9, while the experimental group (students who received lessons enriched with multimedia elements) showed a significantly lower score of 53.4 ± 7.8.

The results of the statistical analysis showed that the difference between the groups was highly significant: $t(58) = 7.02$, $p < 0.001$. This indicates that the pedagogical approach utilizing multimedia elements significantly reduced students' cognitive load.

The analysis also revealed that multimedia elements facilitate students' perception of complex and abstract concepts in a visual form. By dividing learning materials into modules through video, animation, interactive diagrams, and graphical tools, students' attention is directed more effectively, semantic memory is strengthened, and the information processing process becomes easier. Students in the experimental group experienced less frustration and excessive mental load compared to those taught using traditional methods, indicating a more optimal distribution of attention and memory resources during the learning process.

Group	n	NASA-TLX Mean ± SD
Control (traditional)	30	69.1 ± 8.9
Experimental (multimedia)	30	53.4 ± 7.8

Discussion

It can also be assumed that the lower cognitive load observed in the experimental group positively affects students' learning efficiency and their ability to integratively comprehend conceptual knowledge. This result confirms that multimedia technologies serve not only as motivational tools but also as cognitively effective instruments within the pedagogical process.

The results of the study clearly confirm the effectiveness of multimedia elements in significantly reducing students' cognitive load when teaching the subject of Information Technology (IT). These findings are fully consistent with the Cognitive Load Theory

proposed by Sweller (1988), as multimedia tools enable the optimal distribution of students' cognitive resources for information processing by presenting complex information in visual and interactive formats. At the same time, the results correspond with experimental findings obtained in other pedagogical fields, further strengthening the didactic effectiveness of the multimedia approach.

Multimedia elements perform several important functions in the pedagogical process. First, they present complex concepts in a visually modular format, which facilitates the systematic semantic processing of abstract concepts. Second, interactive graphics, animations, and video materials help manage students' attention effectively, reduce unnecessary cognitive load, and optimize the use of memory resources. Third, multimedia tools make the learning process not only interactive and motivational but also enhance learning efficiency and enable students to grasp conceptual knowledge more quickly and integratively. Considering these aspects, multimedia elements can be regarded not only as a pedagogical innovation but also as an effective tool for managing cognitive processes in teaching Information Technology.

However, the study has several methodological limitations. First, the research was conducted only with first-year students of Andijan State Medical Institute, which limits the possibility of fully generalizing the results to other universities or academic levels. Second, cognitive load was measured only through students' subjective evaluations, which restricts the complete objectivity of the obtained results. To overcome these limitations and increase the reliability of future findings, it is recommended that future studies incorporate additional methods such as physiological monitoring, neuroimaging, or other cognitive assessment tests.

Furthermore, future research may investigate the role of multimedia elements in improving learning outcomes, developing students' higher-level analytical and critical thinking skills, and optimizing pedagogical design parameters. Such studies may contribute to a broader and more effective integration of multimedia tools into the teaching of Information Technology.

Overall, the application of multimedia technologies in the didactic process not only reduces students' cognitive load but also makes the learning process more interactive, engaging, and effective. This highlights the scientifically grounded necessity of implementing pedagogical innovations in teaching Information Technology within medical higher education.

Conclusion

The results of the study demonstrate that teaching Information Technology using multimedia elements significantly reduces the cognitive load of students at Andijan State Medical Institute. In turn, this optimizes students' ability to process information, supports the effective management of attention and memory resources, and allows the learning process to be organized in a more systematic and simplified manner.

In addition, multimedia tools enrich the learning process through interactive and visual elements, increase student motivation, and facilitate the integrative understanding of complex concepts. This pedagogical approach proves to be an important tool for improving learning effectiveness in teaching Information Technology.

The findings also indicate that multimedia technologies not only reduce cognitive load but also allow educational materials to be modularized, enable the visual presentation of semantic structures, and contribute to the development of students' analytical thinking skills. This ensures that the teaching of Information Technology in medical higher education can be enriched with pedagogical innovations and considered a scientifically grounded strategy for effectively managing students' learning activities.

The results support the recommendation for the broader use of multimedia elements in the didactic process. Integrating multimedia tools into pedagogical design and curricula can significantly improve the quality of teaching Information Technology. At the same time, future studies are recommended to further explore the interaction between multimedia

elements and various pedagogical strategies, as well as their role in developing students' higher-level analytical, critical, and integrative thinking skills.

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