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A FUZZY EVALUATION MODEL OF THE IMPACT OF AUDIO AND VIDEO INFORMATION ON KNOWLEDGE ACQUISITION

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Abstract. *Currently, as in other fields, the application of IT in education has been accepted as a necessity. In the organization of teaching, technical means - projectors, smart boards, video-audio means, digital laboratory equipment, etc. are widely used. The purpose of these devices is to provide faster and more accurate transfer of information to students. For this purpose, these tools are divided into three groups and studied in the article. Video transmission, audio transmission, and both video and audio transmission. A fuzzy model was proposed for the evaluation of the student's knowledge obtained by using technical means. A calculation experiment was conducted based on the model. The results showed that the model can serve as a basis for the assessment of knowledge when different technical tools are used. Thus, consistent application of the model by conducting surveys in different groups for different subjects will lead to more general results.*

Keywords. *information transfer, audio information, video information, fuzzy model, knowledge assessment*

INTRODUCTION

In the modern era of information technologies, characterized by rapid technological change, advanced infrastructure, and the automation of virtually all sectors of production, the formation and development of the information society impose increasingly high requirements on the quality of specialist training. As in many other fields, the application of information technologies (IT) in education has therefore become a necessity.

This manifests itself on the one hand in the application of technical means in the organization of education - from projectors, smart boards, video-audio tools, to digital laboratory equipment for various purposes and various digital devices, and on the other hand, in the use of various software systems in lectures, seminars and laboratory classes.

In such environments, students primarily acquire knowledge related to their specialization through auditory and visual channels. However, the intensive use of these technologies also leads to the emergence of new issues associated with the human factor. Consequently, the study of human–computer interaction, particularly processes related to auditory and visual perception, has become an important interdisciplinary research direction.

Currently, alongside the utilization of unique human psychophysiological characteristics in the auditory and visual perception of information, increasing attention is also being paid to the effective use of human cognitive abilities.

In psychology, research on the perception of sound and visual information through human memory is one of the main priorities of this field [1], Currently, great attention is paid to the study of visual memory within the framework of cognitive psychology. In [2], the possibility of rapid visual classification of multiple objects by humans was investigated. In [3], the visual perception of objects and ensembles was analyzed.

Experiments measuring the volume and accuracy of visual memory when multiple objects are stored in memory, such as a description of a visual ensemble, have shown that the volume and accuracy of human visual memory for objects and ensembles are the same. In [4], the effect of the method of visual information reproduction on memory retention was studied.

The problem of memory in the learning process has long attracted the attention of educators working both in higher education and in general secondary education. Consequently, this problem occupies an important place in educational research. In order to improve the quality of learning, it is necessary to understand why learners tend to forget educational information quickly and which instructional methods can ensure longer retention of knowledge. The study of these issues begins with the construction of a mathematical model of the direct learning process.

Problem Statement

The aim of this study is to develop a fuzzy model to assess the impact of the use of audio and visual aids on the quality of teaching.

Methodology

The process of acquiring knowledge using audio and visual aids in a learning environment represents a complex multifactorial process. Each component of this process is interdependent and can be evaluated with a certain degree of uncertainty. One of the most commonly used methods for modeling such processes is the construction of an evaluation model using a fuzzy approach. To apply the fuzzy approach, the student's learning process can be divided into three components:

- learning using only audio information, denoted as event A;
- learning using only video information, denoted as event B;
- learning using both audio and video information simultaneously, denoted as event D.

In this case, the event (C) of the student acquiring knowledge using technical means can be evaluated as the effect of these events separately and together.

$$C = (AUB)UD \tag{1}$$

Here, the symbol U indicates the occurrence of events A, B, and D separately, that is, the use of either audio or video information in learning knowledge, or the receipt of information in the form of both audio and video information at the same time.

Thus, we consider that the event (C) representing the student's assimilation of information presented through audio and video in teaching is determined by the occurrence of either event A, event B, or both events simultaneously.

If we denote the membership of video materials (event B) in the knowledge acquisition process (event C) by μ(B), and the membership of audio events (event A) in the learning process by μ(A), then we can obtain

$$\mu(C) = max[\mu(A), \mu(B), \mu(D)] \tag{2}$$

by applying the Zadeh operation to the membership function for the case where event C occurs.

To perform calculations using equation (2), the following variants are considered.

Variant I

Lectures are given simultaneously using all means: audio explanations, video materials, and the combined use of both audio and video. In this case, each of the events A, B, and D occurs.

Variant II

Lectures are given only using audio means. In this case, only event A occurs.

Variant III

Lectures are given only using video means. In this case, only event B occurs.

Let's use the "method of constructing membership functions based on statistical data" to construct the membership functions μ(A), μ(B), and μ(D). The method is performed in the following sequence:

First, a student's preparation for a particular subject is determined by the number of lectures specified in the curriculum. During each lecture, the occurrence of events A, B, or D is recorded.

Second, students participate in a survey as experts. They are asked to evaluate the effectiveness of using audio and visual aids separately and together in mastering the learning materials. The results of the survey are recorded and later used to build membership functions.

A matrix $B = (b_{ij})$ is constructed consisting of the results of the query. Here, i- denotes terms at learning levels (e.g., “less”, “more”, etc.), and j denotes events (A, B, D).

For each term, the following value is calculated:

$$k_i = \sum_{i=1}^{3} b_{ij} \quad (3)$$

For each term, the maximum value of the sums calculated using equation (3) is determined:

$$k_{max} = \max(k_1, k_2, k_3, k_4) \quad (4)$$

The membership function for each i-th event is determined by the following formula:

$$\mu(i,j) = \frac{b_{ij\cdot}}{k_{max}} \quad (5)$$

where the letter j represents the ordinal number of the linguistic terms "very low", "low", "average", and "very good".

The membership functions are then normalized and defuzzified according to:

$$\mathrm{Y}(i,j) = \frac{\mu(i,j)\cdot}{\sum_j \mu(i,j)} \quad (6)$$

Finally, the maximum value of the defuzzified membership functions is calculated using formula (2).

Computational Experiment

Variant I

Lectures are conducted using all media: both audio and video, and a combination of both.

Suppose that in 2 out of 15 lectures, the lecture is conducted only with the teacher's oral explanation. Such cases usually occur in the teaching of humanities, where the teacher presents the lecture he has prepared to the audience orally. This means that event A occurs twice.

In 5 lectures, the material is presented via a projector without verbal explanation. In this case, the lecture is displayed on the screen in the form of slides and students take notes as they read the material. Thus, event B occurs five times.

In the remaining 8 lectures, the teacher explains the material using slides or video. Therefore, event D occurs eight times.

Variant II

Lectures are conducted using only audio tools. In this case, only event A occurs.

Variant III

Lectures are conducted using only video tools; therefore, only event B occurs.

The results of the student survey for each option are expressed using the linguistic terms "very low", "low", "average" and "very good" to describe the level of knowledge acquisition. The results obtained from a group of 15 students are presented in Table 1.

Since event A occurs twice in option I, the total number of surveys in the group of 15 students will be 30, 75 for event B and 120 for event D.

Knowledge acquisition level	Variant I			Variant II	Variant III
	A	B	D	A	B
“Very low”	7	11	30	77	30
Low	5	17	45	68	45
Medium	10	27	30	50	70
Very good	8	20	15	30	80

As a result of formula (3) for variant I,

The answer “The lecture had a very small impact on learning” was obtained $k_1 = 48$ times,

The answer “The lecture had a small impact on learning” was obtained $k_2 = 67$ times,

The answer “The lecture had a moderate impact on learning” was obtained $k_2 = 67$ times,

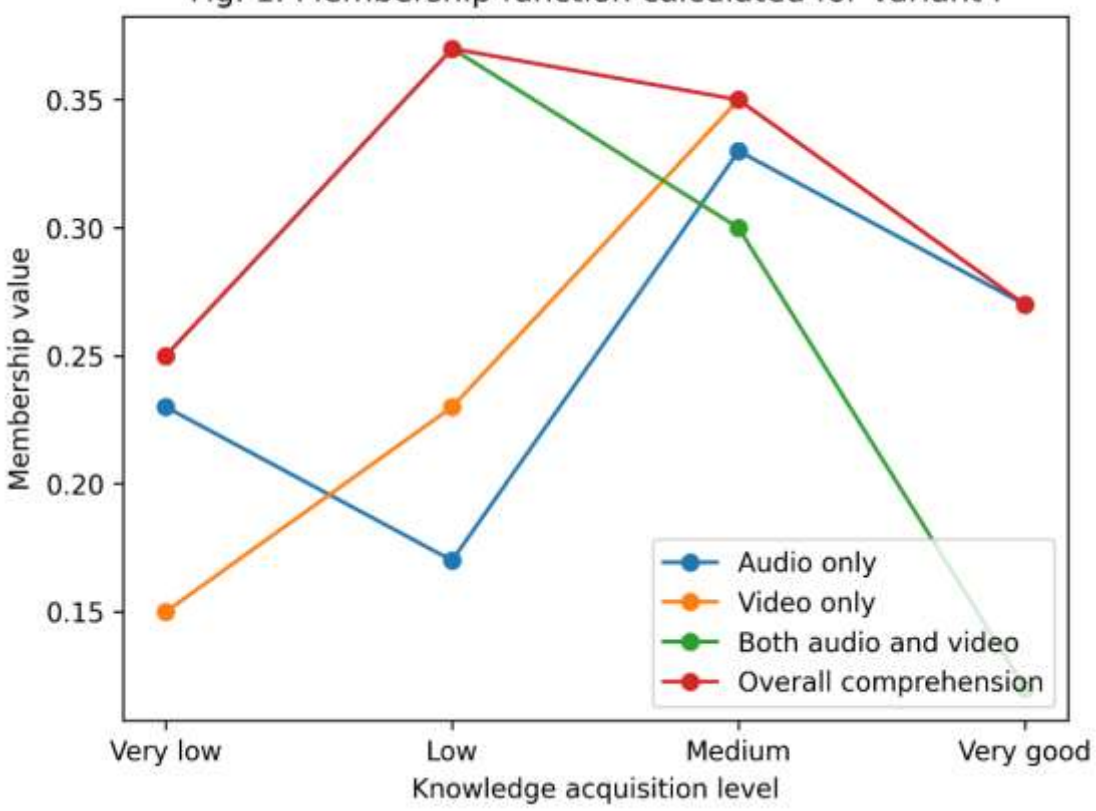
The answer “The lecture had a very good impact on learning” was obtained $k_4 = 43$ times.

If we apply formula (4), we obtain $k_{max} = \max(k_1, k_2, k_3, k_4) = 67$.

In other variants, since only one event occurs, formula (3) is not applied. For variant II, $k_{max} = 77$, and for variant III, $k_{max} = 80$ are taken. Membership functions for each variant are constructed using formula (5) and defuzzification is performed using formula (6).

As a result of the calculations, the membership function of event C is constructed by normalizing it in linguistic terms. Thus, as a result of the calculations carried out according to Table 1, the membership functions of students' knowledge acquisition using audio and video data in 15 lectures are shown in Figure 1-Figure 3.

Fig. 1. Membership function calculated for Variant I



According to Figure 1, the best alternative linguistic term is "low". This indicates that the overall level of knowledge acquisition for the 15 lectures is assessed as low according to the survey results. The level of knowledge acquisition for this option is 0.37.

The results shown in Figure 2 for Variant II show that if lectures are conducted using only audio tools, the level of knowledge acquisition will be 0.34.

The calculations presented in Figure 3 for Variant III show that the level of knowledge acquisition is 0.36.

Fig. 2. Membership function for Variant II

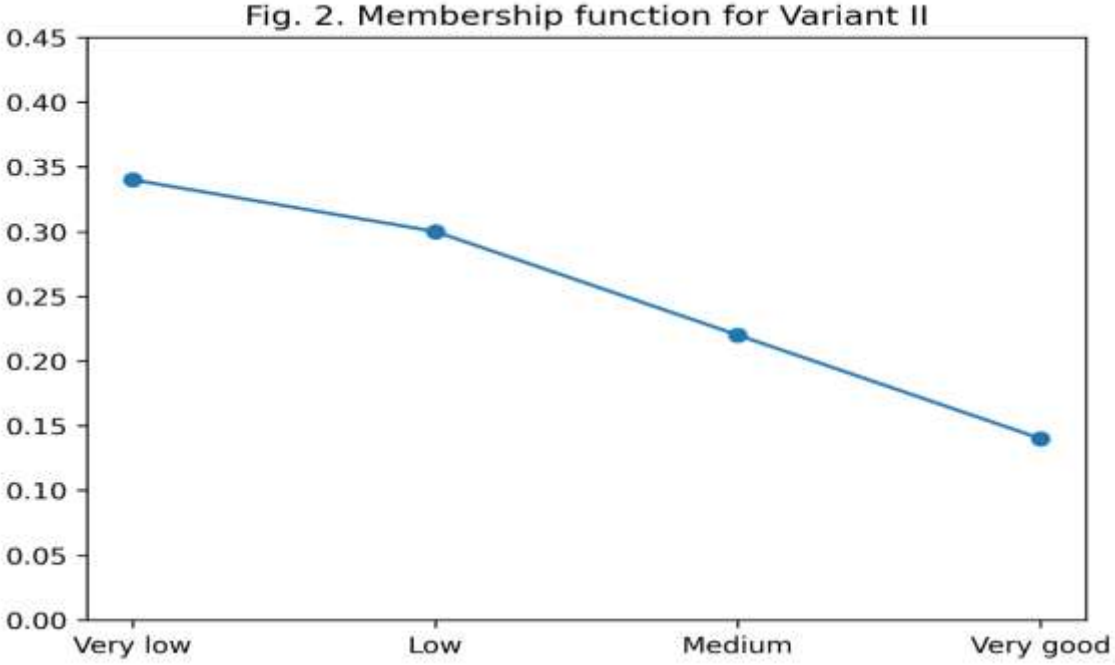
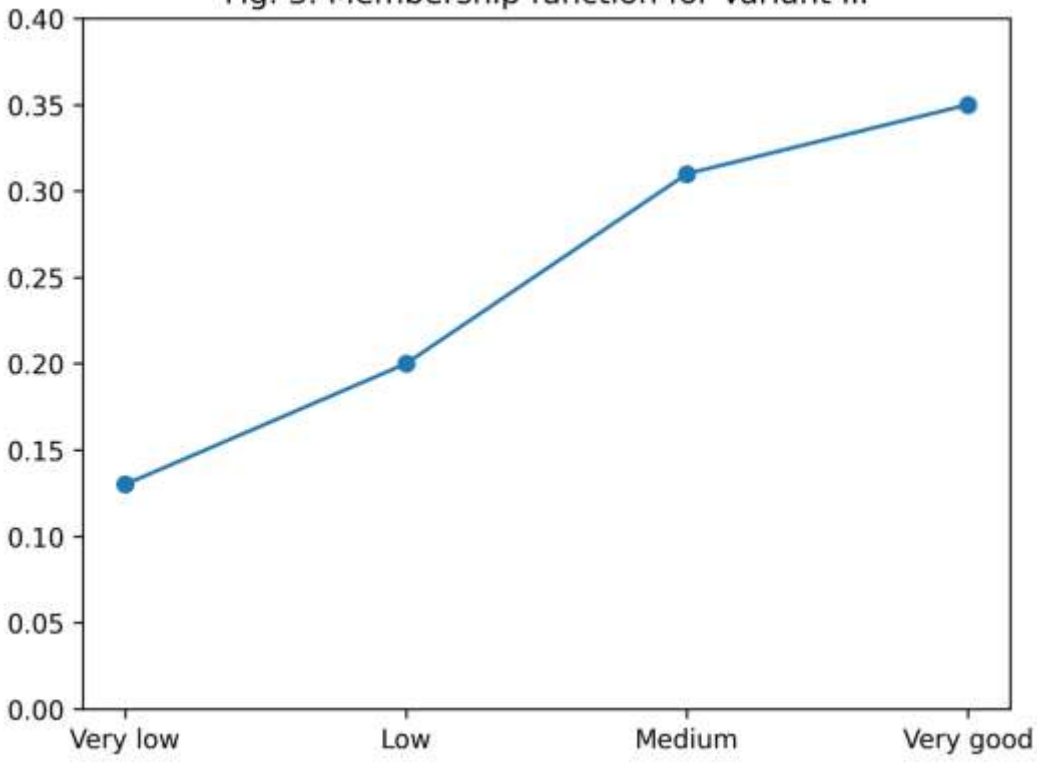


Fig. 3. Membership function for Variant III



A comparison of the results obtained for all three options shows that the highest level of knowledge acquisition occurs in Variant I, where both audio and video tools are used simultaneously.

CONCLUSION

The process of acquiring knowledge using audio and video materials depends on many factors, from the structure of lecture materials to the knowledge and individual characteristics of students. Of course, it is impossible to assess the impact of all these factors separately.

Although the proposed method is based on expert opinions, it can be improved by taking into account the results of attestations (colloquium, independent work and final exam) in different subjects and groups, as well as in the subject. Thus, summarizing the results of the research in the article, we can note the following.

1. The article proposes a fuzzy model of the process of acquiring knowledge using audio and video materials based on expert surveys.

2. The model takes into account three cases of information delivery - when information is provided only by video means, when information is provided only by audio means, and finally, when information is provided simultaneously with the help of both audio and video means. Under the above-mentioned conditions, a computational experiment was conducted using the proposed model in accordance with the results of a survey conducted on the materials (presentation, video data, and teacher explanations) of 30 hours of lecture classes held in a group of 15 students.

3. Analysis of the results of the experiment showed that the model can play a key role in assessing knowledge when using various technical means. Thus, it was determined that the level of assimilation is higher if lectures are conducted with both audio and video.

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