



**ORGANIZATION OF EXPERIMENTAL PEDAGOGICAL
EVALUATION FOR MULTIMEDIA TEACHING OF RADIATION-
MATTER INTERACTION IN HIGHER MEDICAL EDUCATION**

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Abstract.

The rapid digital transformation of medical education requires the integration of innovative educational technologies into the teaching of fundamental scientific disciplines. *Radiation-matter interaction, one of these disciplines* , plays a crucial role in the education of future healthcare professionals in diagnostic radiology, nuclear medicine, oncology, and radiation protection. However, the abstract nature and theoretical complexity of this subject significantly hinder effective learning when taught using traditional teaching methods. This study aims to demonstrate the pedagogical specificity of organizing and implementing an experimental evaluation of multimedia teaching for the *radiation-matter interaction course* in medical higher education institutions. A quasi-experimental design with control and experimental groups was established. Quantitative analysis revealed statistically significant improvements in conceptual understanding and learning motivation among students who received multimedia instruction ($p \leq 0.05$). These results confirm the effectiveness of structured integration of multimedia content in competency-based medical education.

Keywords:

Radiation-matter interaction; teaching medical physics; multimedia learning; virtual laboratories; educational experimentation; digital educational technologies .





Radiation-based technologies are fundamental to modern medicine, particularly in radiology, nuclear medicine, and oncology. Understanding radiation-matter interactions is essential to ensure accurate diagnoses and patient safety. However, traditional teaching methods often struggle to effectively convey the abstract physical mechanisms underlying radiation behavior in biological tissues [1,2].

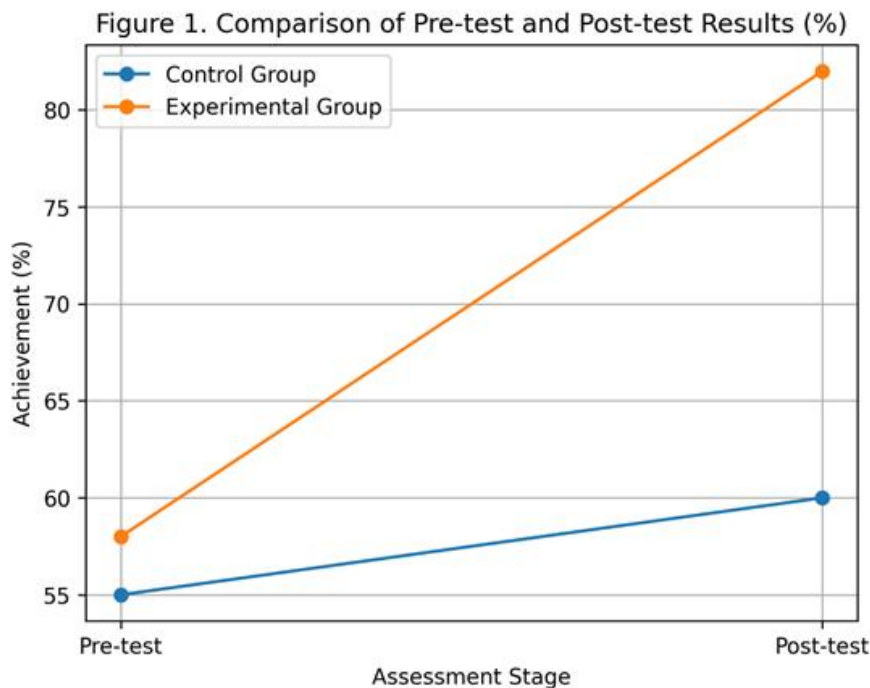
Recent studies highlight the pedagogical benefits of multimedia learning environments, which facilitate visualization, interactivity, and deeper conceptual understanding [3]. This research examines the pedagogical effectiveness of multimedia-based teaching through an experimental evaluation conducted in medical higher education institutions.

The study used a quasi-experimental design with experimental and control groups. The experimental groups received instruction using multimedia tools (virtual laboratories, simulations, interactive animations), while the control groups received traditional lectures. Over 300 medical students participated in the study. Learning outcomes were measured using pre-tests, post-tests, expert assessments, and motivational surveys. Statistical reliability





was ensured using the *Student t- test* . Comparative analysis of academic



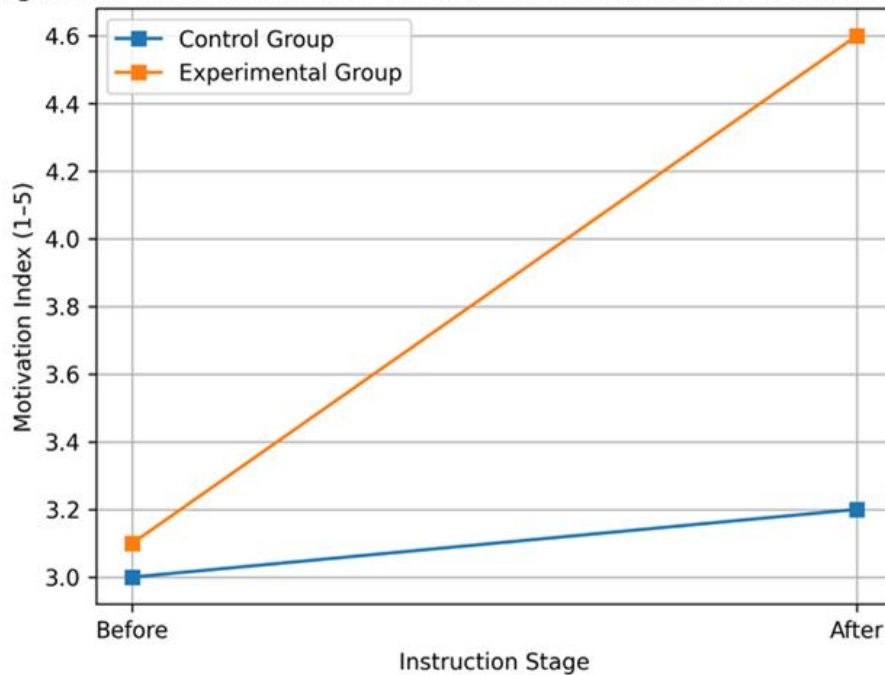
performance demonstrated significant improvement in the experimental groups. In figure 1 illustrates the comparison of mean achievement scores before and after the educational intervention. The experimental group demonstrated a 30-35% improvement in conceptual mastery compared to the control group ($p \leq 0.05$).

Figure 2 presents the dynamics of learning motivation indicators. Multimedia instruction significantly improved cognitive engagement and intrinsic motivation, in line with constructivist learning theory [3,4].





Figure 2. Student Motivation Index Before and After Multimedia Instruction



The absorbed dose of ionizing radiation, which is essential for medical applications, is expressed as follows:

$$D = E/m$$

where D – absorbed dose (Gy), E – energy absorbed (J), m – mass of irradiated tissue (kg).

This formula has been actively applied in virtual laboratory simulations, allowing students to model dose distribution in biological tissues.

Student's t- test :

$$t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}}}$$

where: $\bar{X}_1, \bar{X}_2$ – mean values of experimental and control groups, S_1^2, S_2^2 – variances, n_1, n_2 – sample sizes.

The obtained t-values *exceeded the critical thresholds* ($p \leq 0.05$), thus confirming statistical significance. The results demonstrate that multimedia teaching significantly improves the understanding of radiation-matter interaction





mechanisms. Visualizing abstract physical processes through simulations bridges the gap between theory and clinical application. These findings are consistent with international research highlighting the effectiveness of digital learning environments in teaching medical physics [2,4,5].

Educational trials confirm that multimedia teaching of radiation-matter interaction significantly improves learning outcomes, analytical thinking, and professional skills among medical students. The proposed pedagogical model is adaptable, scalable, and easily integrated into modern medical curricula that comply with international educational standards.

References

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