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INTERACTIVE TEACHING METHODS AS A TOOL FOR ENHANCING LEARNING OUTCOMES IN THE COURSE "ELECTRICAL LIGHTING"

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Abstract: The increasing demand for technically competent specialists requires the modernization of teaching approaches in higher education, particularly in engineering and technical disciplines. The course "Electrical Lighting" combines theoretical knowledge with practical skills related to lighting sources, energy efficiency, electrical parameters, and the selection of appropriate lighting systems. However, traditional teacher-centered instruction often limits students' active participation, independent reasoning, and ability to apply theoretical concepts to practical situations. This study examines the didactic effectiveness of interactive teaching methods in the course "Electrical Lighting". The research focuses on the use of Concept Analysis, Summary/Resume, Step-by-step technology, SWOT analysis, and problem-based assignments. These methods were applied to the study of lighting sources, including incandescent, fluorescent, DRL, and LED lamps. The findings indicate that interactive methods contribute to a deeper understanding of technical concepts, improve students' analytical and comparative thinking, and strengthen the connection between theoretical knowledge and professional practice. In particular, the SWOT analysis of LED lamps helps students evaluate lighting technologies from technical, economic, and environmental perspectives. The study concludes that the systematic integration of interactive methods into the teaching of "Electrical Lighting" can enhance students' cognitive activity, critical thinking, and professional competencies.

Keywords: interactive teaching methods; electrical lighting; technical education; pedagogical technology.

Introduction

The development of modern society is closely connected with technological progress, digital transformation, and the increasing role of energy-efficient engineering solutions. These changes require higher education institutions to train specialists who are not only able to reproduce theoretical knowledge but can also analyze technical processes, compare engineering solutions, and make independent professional decisions. In this context, the improvement of teaching methods in technical disciplines has become one of the most important tasks of contemporary higher education.

Technical education has a specific didactic nature. It requires the integration of theoretical concepts, practical skills, analytical thinking, and professional decision-making. Therefore, the effectiveness of teaching technical subjects depends not only on the content of the curriculum but also on the methods used to organize the learning process. Traditional lecture-based instruction can provide students with basic information; however, it does not always ensure sufficient student engagement, practical orientation, and development of independent thinking.

The course "Electrical Lighting" plays an important role in the preparation of future

specialists in technical fields. It introduces students to the principles of electrical energy use, lighting sources, illumination parameters, electrical characteristics of lamps, and modern energy-saving lighting technologies. The course also develops students' ability to select appropriate lighting equipment for different practical conditions. For this reason, the teaching of "Electrical Lighting" should be based on methods that connect theory with practice and encourage students to participate actively in the learning process.

Interactive teaching methods offer such an opportunity. They are based on cooperation between the teacher and students and create an educational environment in which learners become active participants rather than passive recipients of information. Through discussion, analysis, comparison, group work, and problem-solving activities, students develop not only subject knowledge but also critical thinking, communication skills, and professional competence.

The relevance of this study is determined by the need to improve the effectiveness of teaching "Electrical Lighting" through interactive and learner-centered approaches. The use of such methods is especially important because the subject includes many technical concepts, practical calculations, and comparative analysis of lighting sources. Interactive methods can help students understand these concepts more deeply and apply them in real technical situations.

Despite the growing importance of interactive pedagogical technologies in higher education, their systematic application in technical disciplines is still not always sufficiently developed. In many cases, technical subjects are taught mainly through traditional explanations, while students have limited opportunities to analyze, compare, discuss, and independently evaluate technical objects.

In the course "Electrical Lighting", this problem becomes particularly significant because students must understand not only definitions and theoretical principles but also the operational characteristics, advantages, disadvantages, and application areas of different lighting sources. Therefore, there is a need to identify teaching methods that can improve students' cognitive activity and support the formation of practical professional skills.

The aim of this study is to analyze the effectiveness of using interactive teaching methods in the course "Electrical Lighting" and to demonstrate their role in improving students' understanding of lighting sources, technical concepts, and practical decision-making skills.

This study addresses the following research questions:

1. How can interactive methods be effectively integrated into the teaching of the course "Electrical Lighting"?
2. What role do Concept Analysis, Summary/Resume, Step-by-step technology, and SWOT analysis play in improving students' understanding of lighting sources?
3. How do interactive methods contribute to the development of students' analytical, critical, and independent thinking skills?
4. In what ways can interactive methods strengthen the connection between theoretical knowledge and practical application in technical education?

The scientific significance of the study lies in the methodological justification of interactive teaching methods as an effective tool for improving the quality of technical education. The study shows how learner-centered and activity-based approaches can be adapted to the specific content of the course "Electrical Lighting".

The practical significance of the study is that the proposed methods can be used by

teachers of technical disciplines during lectures, seminars, laboratory classes, and practical training. The developed methodological approach may help students master technical terminology, compare lighting devices, evaluate energy efficiency, and make reasoned decisions when selecting lighting sources.

The novelty of this study is associated with the systematic application of several interactive methods to the teaching of "Electrical Lighting". Unlike traditional approaches, the proposed methodology combines Concept Analysis, comparative evaluation, group-based Step-by-step learning, and SWOT analysis within a single educational process. This integrated approach allows students to study lighting sources from theoretical, technical, practical, economic, and environmental perspectives.

Materials And Methods

This study is based on the methodological analysis and practical application of interactive teaching methods in the course "Electrical Lighting". The course content includes the study of basic lighting concepts, electrical parameters, types of lighting sources, their operating principles, technical characteristics, advantages, disadvantages, and areas of practical application.

The following interactive methods were selected for the organization of the learning process:

- Concept Analysis method;
- Summary/Resume method;
- Step-by-step technology;
- SWOT analysis method;
- problem-based questions and practical assignments.

The general structure of the interactive teaching methods used in the course and their expected educational outcomes is presented in Figure 1.

Structure of interactive teaching methods used in the course "Electrical Lighting"

As shown in Figure 1, each interactive method performs a specific didactic function. Concept Analysis contributes to the systematic understanding of technical terminology, while the Summary/Resume method develops comparative thinking. Step-by-step technology supports group work skills, SWOT analysis promotes critical thinking, and problem-based assignments strengthen students' practical competence.

These methods were selected because they correspond to the specific didactic features of the course. "Electrical Lighting" requires students to understand theoretical concepts, compare technical characteristics, analyze real lighting systems, and make practical decisions. Therefore, the use of interactive methods creates favorable conditions for active learning and professional competence formation.

The Concept Analysis method was used to introduce and systematize the basic terminology of the course. Students worked with key concepts such as illumination, luminous flux, power, efficiency, brightness, glare, wavelength, voltage, incandescent lamp, fluorescent lamp, DRL lamp, and LED lamp.

This method helps students move from mechanical memorization to meaningful understanding. For example, when analyzing the concept of luminous flux, students determine its physical meaning, unit of measurement, and practical importance in lighting design. Similarly, the analysis of illumination allows students to understand how light distribution affects working conditions, visual comfort, and energy efficiency.

The use of Concept Analysis also helps students identify relationships between

different terms. For instance, power and efficiency are closely related to energy consumption, while luminous flux and illumination are connected with the practical quality of lighting. As a result, students develop a more systematic understanding of the subject.

Table 1. Key concepts used in the Concept Analysis method in teaching "Electrical Lighting"

Concept	Meaning
Illumination	The amount of luminous flux falling on a unit area of an illuminated surface; measured in lux (lx).
Luminous flux	The radiation energy emitted by a lighting source and perceived as light; measured in lumen (lm).
Power	The amount of electrical energy consumed by a lighting device per unit time; measured in watts (W).
Efficiency	The degree to which the energy consumed by a lighting device is converted into useful light.
Brightness	The visible intensity of an illuminated or light-emitting surface.
Glare	Visual discomfort caused by excessive brightness of a light source.
Wavelength	The distance between two corresponding phases of a light wave, determining the color and spectrum of radiation.
Voltage	The potential difference that causes electric charges to move in an electrical circuit; measured in volts (V).
Incandescent lamp	A traditional lighting source that emits light when an electric current heats a filament.
Fluorescent lamp	A gas-discharge lamp that produces light through luminescence and has relatively high energy efficiency.
DRL lamp	A high-pressure mercury vapor discharge lamp mainly used for outdoor lighting.
LED lamp	A semiconductor lighting source characterized by high energy efficiency and long service life.

The Summary/Resume method was applied to compare different types of electric lighting lamps. Students analyzed incandescent, fluorescent, and LED lamps according to their advantages and disadvantages.

Incandescent lamps were characterized by simple structure, low cost, easy connection, and natural color rendering. At the same time, they have several disadvantages, including high energy consumption, short service life, overheating, and low efficiency.

Fluorescent lamps were evaluated as more energy-efficient sources with higher luminous efficacy and longer service life compared with incandescent lamps. However, their disadvantages include the presence of mercury, complex disposal requirements, reduced performance at low temperatures, and possible delay during switching on.

LED lamps were identified as the most energy-efficient lighting sources. Their main advantages include low power consumption, long service life, ecological safety, and low heat generation. Nevertheless, they may have a higher initial cost, require special drivers, and be sensitive to voltage fluctuations.

Table 2. Comparison of electric lighting lamps based on the Summary/Resume

method

Type of lamp	Advantages	Disadvantages
Incandescent lamps	Simple structure; low cost; natural color rendering; easy connection.	High energy consumption; short service life; overheating; low efficiency.
Fluorescent lamps	Energy-saving; higher luminous efficiency; longer service life than incandescent lamps; lower power consumption.	Contain mercury; complicated disposal; poor operation at low temperatures; possible delay when switched on.
LED lamps	Very energy-efficient; very long service life; low heat generation; environmentally friendly.	High initial cost; require a special driver; directional luminous flux; sensitivity to voltage fluctuations.

The use of the Summary/Resume method enables students to compare different lighting sources according to several technical and operational criteria. This comparison helps them understand that the selection of a lighting device should be based not only on its cost, but also on energy efficiency, service life, environmental safety, and reliability under specific operating conditions. Therefore, this method contributes to the development of analytical thinking and supports the practical orientation of the course.

The Summary/Resume method allowed students to compare lighting sources not only descriptively but also analytically. It developed their ability to summarize technical information, identify essential characteristics, and make justified conclusions.

Step-by-step technology was used to organize students' learning activities in a gradual and systematic manner. This method is especially effective when the educational material consists of several interconnected technical components that should be studied in a logical sequence.

In the course "Electrical Lighting", students were divided into small groups. Each group received a specific task related to one type of lighting source or one aspect of lighting systems. The topics included the technical characteristics of incandescent lamps, the operating principles of fluorescent lamps, the energy efficiency of LED lamps, and the structure and electrical circuits of lighting sources.

The organization of group work was based on the following structure:

Table 3. Expert worksheet for applying Step-by-step technology in teaching the course "Electrical Lighting"

Group	Topic
Group 1	Technical characteristics, advantages, and disadvantages of incandescent lamps
Group 2	Operating principles and operational features of fluorescent lamps
Group 3	Energy efficiency and application areas of LED lamps

Group 4	Structure, operating principles, and electrical circuits of lighting sources

This method enabled students to study the material step by step, beginning with basic information and moving toward more complex analysis. Each group collected information, discussed the topic, identified key ideas, and presented the results to the class.

The main advantage of Step-by-step technology is that it creates an active educational environment. Students do not receive ready-made information only from the teacher; instead, they participate in searching, analyzing, explaining, and presenting knowledge. As a result, the learning process becomes more student-centered and practice-oriented.

The SWOT analysis method was applied during practical classes to evaluate LED lamps as one of the most widely used modern lighting technologies. This method helps students analyze a technical object from different perspectives and identify its strengths, weaknesses, opportunities, and threats.

In the context of "Electrical Lighting", SWOT analysis was used not only as a pedagogical tool but also as a means of forming technical decision-making skills. Students were asked to analyze LED lamps and complete the SWOT table.

Table 4. SWOT analysis of LED lamps in the course "Electrical Lighting"

Strengths	**Weaknesses**
Low energy consumption	High initial cost
Long service life	Requirement for a special driver
Low heat generation	Sensitivity to voltage fluctuations
Environmental safety	Directional luminous flux
Opportunities	**Threats**
Wider use of energy-saving technologies	Increase in low-quality products on the market
Application in smart lighting systems	High initial installation costs
Expansion of use in industrial and domestic lighting	Problems related to electrical network instability

The SWOT analysis showed that LED lamps have significant advantages in terms of energy efficiency, service life, and environmental safety. At the same time, their practical use may be limited by high initial cost, sensitivity to voltage changes, and the need for additional electronic components.

From a pedagogical point of view, this method encouraged students to evaluate lighting technologies critically. They learned that the choice of a lighting source should not be based only on one parameter, such as energy efficiency. It is also necessary to consider cost, reliability, maintenance, environmental impact, and operating conditions.

Problem-based assignments were also used to strengthen students' practical understanding of the course. These assignments were designed to create situations in which students had to apply theoretical knowledge to solve real or close-to-real technical problems.

For example, students could be asked to select the most appropriate lighting source for a classroom, laboratory, industrial workshop, or outdoor area. In solving such tasks, they had to consider illumination level, energy consumption, lamp lifetime, installation cost, environmental safety, and maintenance requirements.

Case-based model of an interactive lesson on selecting a lighting source for a classroom.

As shown in Figure 2, the problem-based task is implemented through a sequence of

interactive activities, including concept analysis, lamp comparison, group discussion, SWOT analysis, and decision-making. This approach allows students to apply theoretical knowledge to a practical situation and justify their choice of lighting source based on technical, economic, and operational criteria.

Problem-based learning is important because it develops the ability to make reasoned decisions. In technical education, students should not only know the characteristics of devices but also be able to explain why a particular solution is more suitable for a given situation.

Thus, the combination of Concept Analysis, Summary/Resume, Step-by-step technology, SWOT analysis, and problem-based assignments created a comprehensive methodological approach to teaching "Electrical Lighting".

3. RESULTS

The use of interactive methods in teaching the course "Electrical Lighting" demonstrated several important didactic outcomes. First, the Concept Analysis method helped students understand basic terms more deeply. Students were able to explain such concepts as illumination, luminous flux, power, efficiency, brightness, glare, wavelength, and voltage not as isolated definitions but as interconnected elements of lighting systems. This contributed to the formation of a systematic understanding of the subject.

Second, the Summary/Resume method improved students' ability to compare different lighting sources. Through the comparative analysis of incandescent, fluorescent, and LED lamps, students identified the advantages and disadvantages of each type of lamp. This process developed their analytical thinking and helped them understand the importance of energy efficiency, service life, ecological safety, and operating conditions.

Third, Step-by-step technology increased student participation in the learning process. Group work encouraged students to exchange ideas, discuss technical information, and present their conclusions. This method also developed communication skills, responsibility, and the ability to work collaboratively.

Fourth, the SWOT analysis of LED lamps contributed to the development of critical thinking. Students learned to analyze modern lighting technologies not only from the perspective of their strengths but also by considering possible limitations and risks. This is particularly important in technical education, where future specialists must be able to evaluate the practical applicability of different technologies.

The main learning outcomes achieved through the use of interactive methods can be summarized as follows:

Table 5. Main learning outcomes achieved through interactive teaching methods

Interactive method	Main educational effect
Concept Analysis	Systematic understanding of technical terminology
Summary/Resume	Comparative analysis of lighting sources
Step-by-step technology	Development of group work and presentation skills
SWOT analysis	Formation of critical and technical decision-making skills
Problem-based assignments	Application of theoretical knowledge to practical situations

Overall, the use of interactive methods increased students' cognitive activity and strengthened the connection between theoretical knowledge and practical application. The results indicate that interactive teaching methods can serve as an effective tool for improving

the quality of instruction in the course “Electrical Lighting”.

Discussion

The findings of the study show that interactive methods are particularly suitable for teaching technical disciplines. Unlike traditional instruction, where students mainly listen to the teacher and reproduce information, interactive learning creates conditions for active participation, independent analysis, and practical application of knowledge.

In the course “Electrical Lighting”, this approach is especially important because the subject includes both theoretical and applied components. Students must understand physical quantities, electrical parameters, lamp characteristics, lighting efficiency, and the practical use of lighting systems. Therefore, teaching methods should support not only memorization but also analysis, comparison, and decision-making.

The Concept Analysis method proved to be effective for developing a conceptual foundation. Technical terms are often difficult for students if they are presented separately from practical examples. When students analyze the meaning, unit of measurement, and practical significance of each concept, they develop a deeper and more stable understanding.

The Summary/Resume method is useful for comparing different types of lamps. This method helps students understand that each lighting source has both advantages and disadvantages. For example, incandescent lamps are simple and inexpensive, but they consume more energy and have a short service life. Fluorescent lamps are more efficient but have environmental and disposal-related limitations. LED lamps are highly efficient and durable, but their initial cost and sensitivity to voltage fluctuations should also be considered.

Step-by-step technology supports active and collaborative learning. By dividing the topic into several parts and assigning them to different groups, the teacher encourages students to take responsibility for their learning. This approach also helps students develop presentation skills and the ability to explain technical information clearly.

SWOT analysis is particularly valuable because it develops a balanced view of modern technologies. In many cases, students may perceive LED lamps only as the best and most advanced lighting source. However, SWOT analysis helps them understand that even modern technologies have certain limitations. This type of analysis is important for developing professional judgment.

The integration of several interactive methods within one course creates a more complete didactic system. Each method performs a specific function: Concept Analysis forms the theoretical basis, Summary/Resume develops comparison skills, Step-by-step technology organizes collaborative learning, SWOT analysis develops critical thinking, and problem-based assignments connect knowledge with practice.

Therefore, the effectiveness of interactive methods in teaching “Electrical Lighting” is determined not by the use of one isolated method, but by their systematic and purposeful combination.

4.1. Practical Implications

The results of this study may be useful for teachers of technical disciplines who aim to increase students’ active participation and practical understanding of professional subjects. In teaching the course “Electrical Lighting”, interactive methods should be applied systematically during lectures, seminars, laboratory classes, and practical training.

First, the Concept Analysis method can be used at the beginning of a topic to help students understand basic technical terms such as illumination, luminous flux, power, efficiency, voltage, and lighting source. Second, the Summary/Resume method is

recommended for comparing different types of lamps according to their energy efficiency, service life, environmental safety, cost, and operational limitations. Third, Step-by-step technology can be effectively used for organizing group work and developing students' communication and presentation skills.

SWOT analysis is particularly useful during practical classes, as it allows students to evaluate lighting technologies from technical, economic, and environmental perspectives. Problem-based assignments should also be included in the learning process, because they help students apply theoretical knowledge to real technical situations, such as selecting appropriate lighting sources for classrooms, laboratories, industrial facilities, or outdoor areas.

Thus, the systematic use of interactive methods can make the teaching of "Electrical Lighting" more active, practice-oriented, and professionally relevant.

Conclusion

The study confirms that the use of interactive methods in teaching the course "Electrical Lighting" has significant pedagogical and practical value. The application of Concept Analysis, Summary/Resume, Step-by-step technology, SWOT analysis, and problem-based assignments helps students master technical concepts more effectively and apply them in practical situations.

Interactive methods increase students' cognitive activity, develop independent and critical thinking, and strengthen their ability to analyze technical objects. In particular, the comparison of incandescent, fluorescent, and LED lamps helps students understand the importance of energy efficiency, service life, environmental safety, cost, and operating conditions.

The use of SWOT analysis in the study of LED lamps showed that students can evaluate lighting technologies from technical, economic, and practical perspectives. This contributes to the formation of professional competencies that are necessary for future specialists in technical fields.

Thus, interactive teaching methods can be considered an effective pedagogical tool for improving the quality of technical education. Their systematic use in the course "Electrical Lighting" makes the learning process more active, meaningful, and practice-oriented.

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