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Utilization of Automation Studio Software to Improve the Creative Thinking Abilities of Electrical Engineering Students in Designing Electropneumatic Circuits

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Abstract— This study aimed to analyze the impact of using Automation Studio software to enhance the creative thinking skills of electrical engineering students in designing electropneumatic control systems. Creative thinking is a critical skill for electrical engineering students, particularly in the design of electropneumatic systems. Automation Studio serves as a tool that facilitates the development of these skills by providing a practical platform for circuit design and simulation. The study employed a quasi-experimental design with a pretest-posttest control group. A total of 23 fifth-semester electrical engineering students participated in this study. Data were collected through tests and performance evaluations of students' design skills. The results indicated a significant improvement in students' creative thinking skills. Learning outcomes increased by 30%, from a pre-test score of 67.5 to a post-test score of 87.5. Additionally, design skills improved by 34.9%, with scores rising from 65.5 to 88.33. These findings suggest that Automation Studio can effectively enhance students' creative abilities in designing electropneumatic control systems. This study highlights the potential of Automation Studio as a teaching tool in engineering education to foster creativity in system design. It provides valuable insights for educators seeking to integrate simulation software into their curriculum to improve their design and problem-solving skills. This research contributes to the limited body of knowledge on the application of Automation Studio in developing creative thinking skills among electrical engineering students, particularly in the context of electropneumatic system design.

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1. Introduction

Automation Studio has the potential to foster students' creative thinking when used in teaching. Integrating electrical and pneumatic components into a control system provides students with practical experience with real-world technology, thereby enhancing their problem-solving abilities and creativity. This is supported by research emphasizing the importance of learning to use Automation Studio to promote creativity and teamwork (Pektaş, 2015; Pérez et al., 2020).

Additionally, virtual design studios have been proposed as a technique to broaden design learning by facilitating cooperation between educational institutions and disciplines (Iranmanesh & Onur, 2021; Fleischmann, 2020). Student cooperation and communication have improved owing to the integration of digital technologies and social media into design studio culture, an effect also observed in architectural education where first-year students benefit from collaborative spatial design tasks that enhamce their engagement and creativity (Chakravarty & Sharma, 2024). Simulation software such as Automation Studio has been demonstrated to provide students with hands-on experience in modeling and managing systems, thereby improving their understanding of complex technical processes.

The COVID-19 pandemic has led to significant changes in the design education landscape, with educators exploring virtual design studios and immersive technologies to enhance design instruction. This demonstrates the potential of using new technologies, such as Automation Studio, to ensure continuous student engagement and learning in challenging situations. Overall, the integration of Automation Studio in educational settings aligns with broader trends in design education, emphasizing the importance of studio-based learning, collaboration, and digital technologies in enhancing creativity and problem-solving skills. This evidence supports the claim that Automation Studio can provide unique opportunities to develop students' creative thinking in an educational context.

This supports the notion that technology can enhance academic performance (Marshalsey & Sclater, 2019). Additionally, recreational programming, such as Computerization Studio, has been demonstrated to display and replicate pneumatic and electrical systems (Cheguri et al., 2023). This aligns with the potential utility of Media Mechanization Studio in providing students with hands-on experience in displaying and managing such systems, thereby improving their understanding of the complex technical processes. Architectural design studios have undergone significant changes following the global pandemic, with educators exploring virtual design studios and immersive technologies to strengthen design instruction (Fleischmann, 2020; Jenek et al., 2021). This illustrates the capacity of design education to leverage new technologies, such as Media Mechanization Studio, to ensure continued student engagement and learning in challenging circumstances. Media Automation Studio has the potential to enhance students' creative thinking when employed in teaching. Integrating electrical and pneumatic components within a control system can offer students valuable direct experiences with real-world technology, which may enhance their problem-solving skills and creativity. This is supported by design education research that emphasizes the importance of using Automation Studio media to foster creativity and teamwork (Pektaş, 2015). Moreover, creative thinking can be further enhanced through structured learning interventions, such as retrieval-based techniques, which have been shown to improve long-term retention and ideation skills (Vishnu Vandana & Rao, 2024).

This study investigated the potential of design thinking to foster independent learning in engineering students through the application of design thinking (Avsec & Jagiełło-Kowalczyk, 2021). The research indicated that empathy, collaboration, negotiation, leadership, and social consciousness can all be cultivated in students through design activities and reviews. This finding supports the notion that employing Media Automation Studio, which incorporates design and problem solving, can contribute to the development of creative thinking in students (Park & Kim, 2021). Additionally, this research examined the role of visual communication in design studios to enhance students' creative thinking. It was found that integrating the film space into the creative design process can stimulate creative thinking. Consequently, using Media Automation Studio, which leverages visual communication, may further stimulate students' creative thinking.

Overall, the integration of Media Robotization Studio in instructional settings aligns with broader trends in design education, emphasizing the importance of studio-based learning, collaboration, and the incorporation of digital technologies to enhance creativity and problem-solving skills. Evidence from the relevant literature supports the assertion that Media Automation Studio offers distinct opportunities for fostering students' creative thinking within an educational context.

2. Literature Review

A. Software Automation Studio

1) Studio-Based Learning

Studio-based learning has long been recognized as a foundational element in design education, creating an interactive, hands-on environment that encourages experimentation and creativity among students. This model is significant because it allows for immediate feedback on students' work, fostering an atmosphere that promotes collaboration and peer-to-peer interactions, which are essential for effective learning (Peimani & Kamalipour, 2022; Nyboer et al., 2024). Moreover, studio-based learning emphasizes the importance of collaborative efforts, wherein both instructors and students participate actively in the learning process. Research indicates that this collaborative atmosphere not only enhances engagement but also serves as a mentorship system, allowing students to learn from each other's experiences and insights (Abdel-Aziz, 2021; Davies et al., 2024).

2) Collaboration and Digital Technologies

The integration of digital technologies, such as Software Automation Studio, into studio-based learning environments introduces significant opportunities for enhanced collaboration and creativity among students. A multitude of studies emphasizes this evolution in educational practices through digital means. For instance, the supportive role of technology in learning environments fosters collaborative efforts and allows for the implementation of multimodal projects that reflect creative dimensions often overlooked in traditional curricula, thereby enhancing the overall educational experience (Silvhiany et al., 2023; Micklethwaite et al., 2020).

3) Enhancing Creativity and Problem-Solving Skills

Software Automation Studio offers unique opportunities for fostering creative thinking and problem-solving abilities. Research indicates that digital tools can significantly enhance the creative process by providing a platform for experimentation, rapid prototyping, and iteration (Inman et al., 2024). In an educational setting, these capabilities allow studens to engage deeply with the material, explore alternative solutions, and develop a more nuanced understanding of the design principles.

Evidence from the literature supports the assertion that integrating Media Automation Studio into education can lead to improved creative outcomes. For instance, Anderson and Krathwohl (Wilson, 2016) found that students who utilized digital tools in their projects demonstrated higher levels of creativity and innovation compared to those who relied solely on traditional methods. Moreover, the ability to automate repetitive tasks allows students to focus on the creative aspects of their projects, thereby enhancing their overall learning experience.

4) Summary of the literature review

In conclusion, the integration of Software Automation Studio in educational settings aligns with the evolving landscape of design education, which prioritizes studio-based learning, collaboration, and the use of digital technologies. Evidence suggests that this approach not only enhances students' creative thinking and problem-solving skills but also prepares them for the demands of the modern workforce. As digital technologies continue to evolve, their role in education is likely to expand, offering even greater opportunities for innovation and creativity in the classroom.

Figure 1 depicts Automation Studio Software, a comprehensive tool used to simulate and design electropneumatic circuits. This software is integral to educational settings, particularly for electrical engineering students, as it provides a practical platform for visualizing and understanding complex control systems. Automation Studio allows students to create, simulate, and test electropneumatic systems, enhancing their creative thinking and problem-solving abilities by providing a hands-on learning experience.

Fig. 1 : Automation Studio Software

Several references support the use of software, such as Automation Studio, in engineering and automation education.. For instance, Suárez and Abril (Suárez et al., 2021) highlighted the development of an electro-pneumatic system for practical training, emphasizing the construction of test benches as an educational strategy to facilitate and accelerate student learning. This suggests that products such as Automation Studio can provide valuable hands-on training experiences.

Ramdani et al. (Ramdani et al., 2019) focused on supporting electro-pneumatic practicums in vocational higher education using a dual design-based pneumatic simulator, emphasizing the need for appropriate training resources and the complexity of electro-pneumatic systems. This supports the idea that students can learn and practice electro-pneumatic control in a simulation environment using software, such as Automation Studio.

Gazali et al. (Gazali et al., 2022) explained the design of a PLC-based electro-pneumatic system training module, highlighting its correct functioning and suitability for programmable logic controller (PLC) learning simulations. This suggests that software such as Automation Studio, which can be used for PLC programming and simulation, can effectively teach the principles of electropneumatic control.

In summary, these references support the use of software such as Automation Studio in education and training related to electropneumatic control. These studies highlight the benefits of using software for practical practice, simulation, and programmable logic controller (PLC) programming in engineering and automation.

B. Electro-pneumatic Control

Electropneumatic control combines pneumatic and electrical technologies to control various automated processes. Automation Studio software helps understand, simulate, and document these systems, enabling students and professionals to learn and grow in this field. The electropneumatic circuit combines electrical and pneumatic control circuits, as shown in Figure 2.

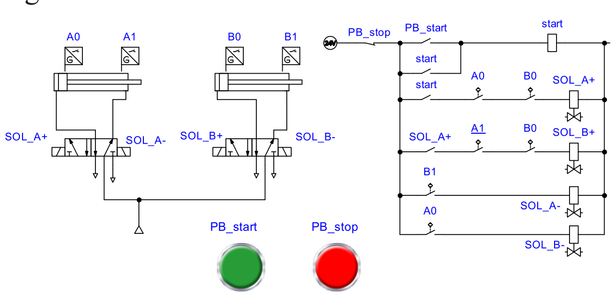

Fig. 2 : Electropneumatic control circuit

C. Designing Elektro-pneumatic Control

The ability to design and control electro-pneumatic systems is highly valued in the modern workforce, with a growing emphasis on digital transformation and the need for specialized skills in technology-based environments (Trenerry et al., 2021; Obermayer et al., 2022).

Electropneumatic systems are advantageous owing to their low weight, size, and ease of installation and maintenance (Szabo et al., 2020). Electropneumatic systems are advantageous owing to their low weight, size, and ease of installation and maintenance (Haouari et al., 2019).

The design and control ofelectropneumatic systems require knowledge from various disciplines. Mathematics and control theory are essential for optimal control and model-based design (Wang et al., 2021; Bartyś & Hryniewicki, 2019). The integration of electro-pneumatic systems with programmable logic controllers (PLCs) further emphasizes the need for expertise in computer science and engineering (Duțu et al., 2022; Sukardjo et al., 2023). Additionally, knowledge of physics, thermodynamics, and materials science is required to understand the behavior and performance of electro-pneumatic systems (Erzan Topçu & Bali, 2021; Lou & Zhu, 2020).

D. Creative Thinking Ability

Beghetto characterized inventive reasoning as the capacity to offer new points of view, create new and significant thoughts, pose further inquiries, and produce answers to issues (Susilowati et al., 2022). Creative thinking involves developing new ideas or concepts to solve problems, and even creating new ways as alternative solutions (Cullen & Hertel, 2023). Munandar describes creative thinking abilities, including fluency, originality, flexibility, and elaboration (Sukardjo et al., 2023;Yaniawati et al., 2020). Epstein outlined four core competencies of creativity: capturing new things, challenging existing thought patterns and behavior, expanding knowledge, and surrounding oneself with contemporary social and environmental stimuli (Israel-Fishelson & Hershkovitz, 2022). Creative thinking involves adapting to change and stimulating knowledge growth through social and environmental experiences.

3. Research Methods

This study utilizes an experimental method with a pre-test and post-test control group design to investigate the effects of using Automation Studio software on students' creative thinking in electropneumatic control systems.

A. Research Design

The research employed a pre-test and post-test experimental design with both control and experimental groups. The control group received traditional instruction in electropneumatic control system design without using Automation Studio, whereas the experimental group utilized the software as part of their learning. This study compares the learning outcomes of these two instructional approaches.

X1 : Students use Automation Studio software to learn and designing electropneumatic systems.

X2 : Students use conventional tools and methods without software.

O1 – O4 : Test criteria to evaluate creative thinking abilities in electropneumatic control design.

The experiment consisted of eight face-to-face sessions, each lasting 90 min over a period of eight weeks.

An overview of the experimental design, including group assignments and test procedurres, is presented in Table 1.

Table : I
QUAS I-Experimental Research Design

Group	Pretest	Experiment	Posttest
Experiment	Q_1	Q_3	Q_3
Control	Q_2	Q_4	Q_4

B. Participants

This study was conducted with a sample of 23 electrical engineering students who were enrolled in their fifth semester at the Faculty of Electrical Engineering. The participants ranged in age from 18 to 19 years old, with the group consisting of 20 male students and 3 female students. To ensure an unbiased distribution, the students were randomly assigned to one of two groups: 1) The experimental group, which included 12 students who utilized Automation Studio as part of their learning process, and 2) The control group, made up of 11 students who received traditional classroom instruction without the aid of Automation Studio.

C. Procedure

1) Pre-Test

A standardized test will be administered to both groups to measure their creative thinking abilities before the intervention. The test will include questions and problems related to electropneumatic circuit design, assessing creativity, problem-solving, and innovative thinking.

2) Intervention

The control group will receive traditional instruction in designing electropneumatic circuits without the use of Automation Studio software, whereas the experimental group will use Automation Studio software as part of their learning process and receive instructions and tasks to complete using the software. The intervention period will last for eight weeks, with both groups meeting twice a week for 90-minute sessions.

3) Post-Test

After the intervention period, the same standardized test will be administered to both groups to measure any changes in creative thinking abilities. The test conditions will be identical to those of the pre-test.

D. Data Collection Tools

1) Standardized Creative Thinking Test

The test is designed to evaluate aspects of creative thinking such as fluency, flexibility, originality, and elaboration in the context of electropneumatic circuit design. It includes both multiple-choice questions and open-ended problems require a detailed circuit design and explanation.

2) Automation Studio Performance Metrics (for the experimental group)

Usage data from Automation Studio will be tracked, including time spent on tasks, number of iterations, and complexity of designs created. Feedback will also be collected from students regarding their experience and perceived usefulness of the software.

3) Observation and Instructor Notes

Instructors will observe and take notes during sessions, focusing on student engagement, problem-solving approaches, and collaboration. These notes supplement quantitative data and provide a context for the observed changes in creative thinking.

4) Student Surveys

Surveys will be administered to gather qualitative data on student attitudes, confidence in problem solving, and perceived improvements in creative thinking abilities. The questions addressed the overall learning experience and the specific impact of using the Automation Studio.

E. Data Analysis

1) Pre-Posttest Scores

The pre-test serves as a critical baseline for assessing the initial knowledge and skill levels of the students in both the experimental and control groups. Before any intervention is applied, all participants will take the pre-test to measure their understanding of key concepts and their problem-solving abilities related to the electrical engineering curriculum. The pre-test is designed to cover a range of topics that will later be explored during the instructional period, ensuring that both groups start from a similar foundation in terms of their academic performance.

Statistical analysis employed to compare the pre-test and post-test scores within each group. The primary objective of this analysis is to determine the extent of improvement or change in performance following the intervention. A paired sample t-test will be used to assess whether there is a statistically significant difference between the pre-test and post-test scores within both the experimental and control groups, indicating the effectiveness of the instructional methods used in each.

2) Post-Test Scores

The post-test serves as a vital tool for assessing the impact of the instructional interventions—whether Automation Studio or traditional methods—on the students' learning outcomes. Administered after the instructional period, the post-test is designed to evaluate the students' understanding, skills, and ability to apply the concepts taught during the course. It mirrors the pre-test in terms of content and complexity, enabling a direct comparison of the students' performance before and after the intervention.

A key focus of the post-test analysis is to identify the degree of improvement or change between the pre-test and post-test scores within each group. A paired sample t-test used to determine if there is a statistically significant increase in the scores within the experimental group, which would indicate the effectiveness of Automation Studio. The same test applied to the control group to evaluate the impact of traditional instruction.

3) Qualitative Data

A Thematic analysis was conducted on the student surveys and instructor notes to identify key themes and insights regarding the learning process and the effectiveness of Automation Studio in enhancing creative thinking.

F. Ethical Considerations

All participants provided informed consent to participate in the study and were informed of their right to withdraw at any time without consequences. Anonymity and confidentiality of all participant data were ensured. Data were securely stored and used only for research purposes.

G. Assessment Of Creative Thinking

The ability to design industrial electrical automation systems was measured using a written test of 50 multiple-choice questions covering basic principles, electrical concepts, system components, pneumatic work, component analysis, problem solving, and system design.

Table 2 delineates the various aspects and criteria utilized to evaluate creative thinking skills within the context of designing electro-pneumatic control systems, focusing on four principal areas: Basic Knowledge, Component Analysis, Problem Solution, and System Design. Basic Knowledge assesses the

Table II :
Assessment of Creative Thinking Abilities in Designing Electro-pneumatic Control Systems

Aspect	Description
Basic knowledge	Understand the basic principles of electro-pneumatics, including electrical concepts, pneumatic components, and how systems work.
Component Analysis	Able to analyze the function and interaction of components in the system, such as sensors, actuators, valves and controllers
Solution to problem	Identify and resolve possible problems in the system with strong analytical thinking.
System Design	Able to design electro-pneumatic control systems by considering needs, limitations and performance

fundamental understanding of electro-pneumatic principles and comprehension of theoretical concepts.

Component Analysis evaluates the capability of analyzing and interpreting the functionality of different system components and their interactions. Problem Solution measures the ability to identify issues and formulate innovative solutions to address them. System Design appraises proficiency in creating efficient and effective designs for electropneumatic systems, integrating both theoretical knowledge and creative insight. Collectively, these domains not only assess theoretical understanding but also gauge practical application and innovative problem-solving skills essential for the successful design of electropneumatic control systems.

Multiple-choice questions (MCQs) are generally not the most effective tool for assessing creative thinking skills, especially in technical fields such as designing electropneumatic control systems. Creative thinking often involves the ability to generate original ideas, solve complex problems in novel ways, and apply knowledge in innovative contexts, which are challenging to measure using the fixed options provided by MCQs.

However, MCQs can be designed to partially assess certain aspects of creative thinking by including questions that require higher-order thinking skills. For example, questions that present complex scenarios and ask students to choose the best solution from several plausible options can evaluate their critical thinking and problem-solving skills to some extent.

Here are five multiple-choice questions from a set of 50 questions about electro pneumatic control systems.

Question 1:

Scenario: You are designing an electropneumatic sorting system for a warehouse. The system uses sensors to detect the size of packages, and pneumatic cylinders to sort them into three bins (small, medium, and large). The packages move on a conveyor belt, and it is necessary to ensure that the sorting is efficient and accurate.

Question: Which configuration would best optimize the sorting speed and accuracy of the system?

A. Place all sensors at the end of the conveyor belt, and use a single pneumatic cylinder for sorting.

B. Sensors are placed at the beginning of the conveyor belt and three pneumatic cylinders are used, one for each bin.

C. Sensors are placed at intervals along the conveyor belt and two pneumatic cylinders are used for sorting.

D. Use one sensor at the beginning and one at the end of the conveyor belt, with two pneumatic cylinders for sorting.

E. Place sensors only in front of each bin and use three pneumatic cylinders, one in each bin.

Question 2:

Scenario: In an automated bottling plant, you are tasked with designing a control system to fill bottles with precise amounts of liquid. The system uses a pneumatic actuator to control the filling valve, and sensors to monitor the liquid level in the bottles.

Question: Which control strategy would ensure the most accurate filling process?

A. Use a timer to control the opening and closing of the filling valve.

B. Use of a single sensor to detect when the bottle is full and close the valve.

C. Use two sensors : one to start filling and another to stop filling when the desired level is reached.

D. Use a pressure sensor to control the flow rate of the liquid. E. Manual override is used to control the filling process.

Question 3:

Scenario: You are developing a pneumatic control system for automated car washing The system must manage various stages, such as washing, rinsing, and drying, using different pneumatic actuators.

Question: Which approach would provide the most efficient and reliable operation of car wash stages?

A. Use a single central controller to manage all stages sequentially.

B. Use individual controllers for each stage with no communication between them.

C. Use a central controller with feedback sensors at each stage to adjust the operations dynamically.

D. Use manual controls to switch between stages.

E. Use of a timer-based system to control the duration of each stage.

Question 4:

Scenario: In a manufacturing line, you are asked to design a pneumatic system that must handle delicate materials without causing damage. The system uses pneumatic grippers to pick and place the items.

Question: Which pneumatic gripper configuration is most suitable for handling delicate materials?

A. Use high-pressure pneumatic grippers to ensure firm grip.

B. Use of low-pressure pneumatic grippers with adjustable force control.

C. Use pneumatic grippers with fixed pressure settings.

D. Use of mechanical grippers instead of pneumatic grippers. E. Use of pneumatic grippers with a rapid release mechanism.

Question 5:

Scenario: You are designing an emergency stop system for an automated pneumatic assembly line. The system must immediately halt operations to prevent accidents when triggered.

Question: Which design would ensure the most reliable and immediate response?

A. Use of a software-based emergency stop button linked to the control system.

B. Use of a mechanical emergency stop button directly connected to a pneumatic shut-off valve.

C. Use a wireless emergency stop button for ease of access.

D. Use an emergency stop button connected to an alarm system that alerts operators.

E. Use a time-delayed emergency stop button to allow the system to shut down safely.

4. Results And Discussion

A. Results.

The learning outcomes for the experimental and the control group were assessed using Automation Studio media. The experimental group demonstrated significant improvement in their scores. Specifically, there was a 30% increase in performance, which translates to an enhancement of 20 points. This improvement elevated their average scores from 67.5 to 87.5. In contrast, the control group showed improvement, albeit to a lesser extent. Their performance increased by 25%, corresponding to a gain of 15.57 points. Consequently, their scores rose from an average of 67.82 to 77.39.

The data highlights the effectiveness of Automation Studio media in enhancing learning outcomes, with the experimental group benefiting more substantially than the control group.

Table 3 presents the pre-test and post-test results of both the experimental and control groups in a quasi-

Table III :
Ruesults of Quasi-experimentalresearch

Grup	Pretest	Experiment*	Posttest
Experiment	67.5	X_1	87.5
Control	67.82	X_2	77.39

experimental study. It shows the average scores of the experimental group (from 67.5 in the pretest to 87.5 in the posttest) and the control group (from 67.82 in the pretest to 77.39 in the posttest). The focus was on evaluating the improvement in performance after applying different interventions: X1 for the experimental group and X2 for the control group. The table highlights the general outcome of the intervention in both groups.

Table IV :
Results of Assessing Creative Thinking Abilities in Designing Electro-pneumatic Control Systems

Aspect	Experiment	Control
Basic knowledge	92.50	90.45
Component Analysis	82.5	73.64
Solution to problem	86.67	73.64
System Design	88.33	71.82
Average value	87.5	77.4

Table 4 shows the detailed differences in assessment results between the experimental and control groups. The differences in the assessment results indicate that the experimental group outperformed the control group in various aspects. Specifically, in term of basic knowledge, the experimental group scored 2.05% higher score. In component analysis, they scored an 11.86% higher score. Their scores for solving problems were 13.03% higher, and in system design, they outscored the control group by 16.51%. These results illustrate significant improvements in the experimental group's creative thinking abilities across all assessed aspects compared to the control group.

Table 5 presents the results of a basic knowledge test conducted on the experimental and control groups. The test covers four categories: basic principles, electrical concept, system components, and pneumatic work.

Table V :
Basic Knowledge Test Results

Grup	Basic knowledge			
	Basic principles	Electrical Concept	System Components	Pneumatic Work
Experiment	22.5	23.3	24	22.5
Control	22.7	23.6	24	20.5

Comparing the performance of the experimental and control groups, it is evident that the control group scored slightly higher in both basic principles (22.7 vs. 22.5) and electrical concepts (23.6 vs. 23.3), indicating a marginally better understanding of these areas. However, the scores demonstrate that both groups possessed comparable levels of knowledge. In the category of system components, both groups achieved identical scores (24), highlighting equal understanding between them. Notably, in the area of pneumatic work, the experimental group outperformed the control group (22.5 vs. 20.5), suggesting a superior undestanding of this concept within the experimental group. Overall, the data shows that while there are slight variations in specific areas, the experimental and control group generally have a similar level of knowledge, with the experimental group showing a particular strength in pneumatic work.

B. Discussion

The integration of electropneumatic control planning in educational curricula significantly enhances students' imaginative capabilities. This assertion is supported by several key findings and examples drawn from this study.

First, the use of Automation Studio software provides a virtual platform for students to simulate and design electropneumatic circuits. This hands-on experience is crucial for fostering creative thinking skills. The research demonstrates that utilizing Automation Studio can improve the creative thinking abilities of electrical engineering students, as evidenced by a 30% increase in learning outcomes and a 34.9% improvement in design skills.

Second, the apability to create, simulate, and test various designs allows students to experiment with different solutions, thereby promoting creativity and innovation. The simulation software offers students practical experience in modeling and managing systems, enhancing their understanding of complex technical processes.

Thirdly, the experimental group using Automation Studio exhibited significant improvement in creative thinking and problem-solving skills compared to the control group using traditional methods. The experimental group achieved an average score of 88.33, which was significantly higher than that of the control group (71.82), indicating substantial

Table VI :
The Impact of Using Automation Studio Software on the Creative Thinking Abilities of Electrical Engineering Students.

Category	Details
Aim / Objective	The aim of this study is to investigate the impact of using Automation Studio software on the creative thinking abilities of electrical engineering students.
Research Question	What is the effect of using Automation Studio software on the creative thinking abilities of electrical engineering students?
Observations	The experimental group using Automation Studio exhibited significant improvement in creative thinking and problem -solving skills compared to the control group using traditional methods.
Findings	The results of this study indicate that using Automation Studio software enhances the creative thinking abilities of electrical engineering students.
Comparison	The experimental group achieved an average score of 88.33, significantly higher than the control group's 71.82, indicating a substantial enhancement in learning outcomes.
Correlation	The use of Automation Studio software is positively correlated with improved creative thinking abilities in electrical engineering students.
Interpretation	The findings suggest that Automation Studio software provides a comprehensive, interactive, and practical platform for designing and simulating electro-pneumatic controls, which enhances students' creative thinking abilities.
Reasoning	The iterative design process and immediate feedback in a virtual environment encourage students to develop creative solutions to problems.
Speculation	Further research could explore the longterm impact of using Automation Studio software on students' creative thinking abilities and its potential applications in other fields.
Supporting Data	The study employed a pre-posttest experimental method with control and experimental groups to show that the experimental group excelled in problem-solving and system design.
Caution	The findings may not be generalizable to other populations or contexts, and the study only focused on a specific software tool.
Study Significance	This study contributes to the understanding of how studio-based learning with digital tools can enhance creativity in engineering education.
Application/ Implication	The findings suggest thatincorporating Automation Studio software into electrical engineering curricula could improve students' creative thinking abilities and problem-solving skills.
Novelty	The study's focus on the impact of a specific software tool on creative thinking abilities in electrical engineering students is a novel contribution to the field.
Limitation	The study only focused on a specific software tool and did not explore other tools or methods for enhancing creativity in engineering education.

enhancement in learning outcomes.

Automation Studio enables detailed analysis and design of system components, fostering a deeper understanding and innovative thinking. This component analysis evaluates the ability to analyze and interpret the functionality of different system components and their interactions, which is essential for proficient system design.

In additionally, the iterative design process and immediate feedback in a virtual environment encourage students to develop creative solutions to problems. The study, employing a pre-posttest experimental method with control and experimental groups, showed that the experimental group excelled in problem solving and system design.

Furthermore, the collaborative nature of studio-based learning with digital tools enhances creativity through peer-to-peer interaction and reflective practice. This environment promotes iterative cycles of creation and critique, which are essential for developing design thinking skills.

Finally, integrating electrical and pneumatic components within a control system using Automation Studio provides a practical experience with real-world technology, enhancing students' imaginative capabilities. This direct experience with real-world technology is invaluable for fostering problem-solving skills and creativity.

In conclusion, Automation Studio software significantly enhances the creative thinking abilities of electrical engineering students by offering a comprehensive, interactive, and practical platform for designing and simulating electropneumatic controls. This approach not only improves technical skills, but also fosters a deeper understanding and innovative thinking, which are crucial for solving complex engineering problems.

The impact of using automation studio software on the creative thinking abilities of electrical engineering students is shown in Table 6.

Conclusion

Based on the research results, it can be concluded that the application of Automation Studio software significantly enhances the ability of electrical engineering students to design electropneumatic control systems. The experimental group demonstrated superior performance, achieving an average score of 88.33 compared to 71.82 in the control group. Additionally, the study indicated a 30% improvement in learning outcomes, with scores increasing from 67.5 to 87.5. Furthermore, there was a notable enhancement in design skills within the experimental group, as evidenced by a 34.9% increase from the pretest score of 65.5 to the posttest score of 88.33.

These findings suggest that Automation Studio is a valuable tool for improving the educational outcomes of students in electrical engineering. It not only boosts their technical skills but also fosters creativity in designing more complex electropneumatic circuits. Future research and development should continue to leverage this software to enrich students' learning experiences and capabilities in this field. Automation Studio can play a pivotal role in the education of future electrical engineers through ongoing improvements and creative applications.

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