



Acceptability of Sequential Motor Control System for Induction Motor Simulator as Teaching Tool

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Abstract.

Efficient and exceptional laboratory facilities are essential for technology education, providing students with hands-on experience in using educational tools. These facilities should mirror the state-of-the-art equipment found in the industry, allowing students to gain practical experience and hone their skills in real-world scenarios. Therefore, the researchers aim to assemble and assess the acceptability level of the Sequential Motor Control System for Induction Motor Simulator as a teaching tool. It was conducted at Bohol Island State University- Calape Campus. The simulator has become an essential piece of equipment to enhance modern instructional systems. It not only provides valuable insights for students but also proves beneficial for faculty members. The performance of the experimental trainer board received outstanding ratings in terms of performance as a device, performance as teaching tool, convenience of use, safety, assembly of parts and cost. Remarkably, performance as teaching tool achieved the highest rank, indicating that the innovative design significantly contributed to an enhanced teaching-learning process, fostering better comprehension of motor control concepts.

Keywords: teaching tool, induction motor, motor controller, simulator

Introduction

In today's fast-paced world, technology is advancing at an unprecedented rate, bringing transformative changes to nearly every aspect of our lives. It affects the way individual communicate, learn and think (Allen, 2019). The field of education is no exception, with educators continually seeking innovative ways to enhance the learning experience and better engage students in the classroom. Advancement in technology, can support and enhance students' performance by incorporating a technological tool into their instructional design (Labadi and Sant, 2020). The integration of advanced tools and systems into educational practices has become imperative in this new era of technological progress.

According to the theory of Friedrich Froebel's which highlights the importance of self-activity in the learning process (Curtis, 2015). This principle holds significant value in education as it provides students with the opportunity to actively participate in real-life

operations, leading to the acquisition of knowledge through hands-on experiences and self-directed activities.

Utilizing technology devices for teaching has demonstrated its efficacy in helping students grasp concepts by visualizing and experiencing actual processes (Nacorda, 2015). The use of instructional tool provides added convenience in delivering instructions, making it easier to explain complex topics through practical hands-on demonstrations.

One area that stands at the forefront of this technological revolution is the sequential motor control system for induction motors. Traditionally, induction motors have been widely used in various industrial applications, but their intricate internal workings and complex control mechanisms can present significant challenges for students to grasp. However, with the advent of this cutting-edge teaching tool, educators now have an opportunity to revolutionize the way they teach motor control principles.

With this, the researcher intent to assemble and assess the acceptability of implementing a Sequential Motor Control System for Induction Motors Simulator as an innovative teaching tool in educational institutions. The simulator integrating power circuit and halogen lights offering protection against short circuits. It features measuring instruments for monitoring voltage and current within the circuit, timers, magnetic contactors, relays, a pilot light for output display, and push buttons to control start and stop operations. Additionally, a buzzer alerts the operator in case of motor overloading, and it effectively controls AC induction electric motors.

Also with the use of the simulator will probe into its potential benefits, such as improved learning outcomes, enhanced student engagement, and a deeper understanding of motor control concepts. Moreover, it will address any concerns or reservations that educators may have and provide compelling evidence to underscore the system's effectiveness.

Using this device will provide various aspects of the sequential motor control system, from its fundamental design to its practical applications in the classroom. By incorporating this hands-on, experiential learning approach, it is anticipated that motor control, which may have previously seemed enigmatic and overwhelming, become a fascinating subject for students.

The use of a sequential motor control system aligns perfectly with the shift towards project-based learning and the integration of Outcomes-Based education in modern education. It enables students to not only understand theoretical principles but also gain valuable practical experience in real-world motor control scenarios.

As educators, it is essential to embrace the innovative technologies and teaching methods that can empower the students to become critical thinkers, problem solvers, and confident learners. By exploring the acceptability of the sequential motor control system for induction motors as a teaching tool, educator's open doors to an exciting and dynamic

learning experience that prepares students for the challenges of tomorrow's technological landscape.

STATEMENT OF OBJECTIVES

This study aims to assemble the Sequential Motor Control System for Induction Motor Simulator as a teaching tool. Specially, it seeks to answer the acceptability level of the device in terms of performance, convenience of use, safety, assembly of parts and cost.

Methodology

This study employed descriptive research design utilizing research questionnaires to assess the level of performance and gather the valuable data for the acceptability level of the Sequential Motor Control System for Induction Motor Simulator as a Teaching Tool. The study was conducted at Bohol Island State University in which industrial motor control topic is part of the course. The researcher selected 40 respondents which includes 20 (twenty) 3rd year students of Bachelor of Science in Industrial Technology major in electrical technology and ten (10) electrical technology instructor.

Results and Discussion

Table 1. Acceptability of Sequential Motor Control System for Induction Motor Simulator in terms of Performance as a Device

N=40

PERFORMANCE AS DEVICE	WM	DESCRIPTIO N	RANK
1. Demonstrates that the protection devices for short circuit installed serves to its purpose.	3.71	Highly Acceptable	3
2. Shows that protection and alarm devices were functional when motor overloading happen.	3.65	Highly Acceptable	4
3. Simulates the automatic sequential operation.	3.89	Highly Acceptable	1
4. Simulate other motor control operation which includes start-stop, forward-reverse, wye-delta, automatic reversing, multiple push button, jogging and inching	3.76	Highly Acceptable	2
AVERAGE	3.75	Highly Accepted	

Data were obtained, collated which was supported by tables that show the responses of the respondents on the acceptability level of the of the Sequential Motor Control System for Induction Motor as a Teaching Tool. Table 1 presents the acceptability of Sequential Motor Control System for Induction Motor in terms of Performance as a Device as perceived by electrical technology students and electrical experts.

The table shows that item demonstrate protection devices for short circuit installed serves to its purpose. It received a rank of 3.71 and is considered highly Accepted" with a rank of 3 among the listed items. This suggests that the device is performing well and is deemed to be effective in its intended purpose.

Item shows that the protection and alarm devices were functional when motor overloading happens. It received a rank of 3.65 and is also considered "Highly Accepted" with a rank of 4 among the listed items. This indicates that the device is performing satisfactorily and functioning well.

Item simulates automatic sequential operation received the highest rank of 3.89 and is deemed "Highly Accepted" with a rank of 1 among the listed items. This shows that the device operated on automatic sequential exceptionally well-regarded.

Item simulates various other motor control operations, including start-stop, forward-reverse, wye-delta, automatic reversing, multiple push button, jogging, and inching, received a rank of 3.76 and is "Highly Accepted" with a rank of 2 among the listed items. This indicates that it performs effectively and is well-liked by respondents.

Overall Average: The average rank of all the listed devices is 3.75, which is considered "Highly Accepted." This means that, on average, all items are performing well and are widely accepted by respondents. This suggests that the performance of the simulator as a device are functioning effectively and are highly accepted by respondents. Although, item simulates automatic sequential operation, received the highest rank and stands out as exceptionally well-performing but average rank indicates that in overall, the simulator is performing satisfactorily and meeting their intended purposes.

Table 2. Acceptability of Sequential Motor Control System for Induction Motor Simulator in terms of Performance as Teaching Tool
N=40

PERFORMANCE AS TEACHING TOOL	WM	DESCRIPTION	RANK
1. Increase the performance of the students on different motor controllers.	3.79	Highly Acceptable	2
2. Enhances the student's skills in motor control troubleshooting.	3.74	Highly Acceptable	3
3. Helps the teaching and learning process for an in-depth understanding on motor control lesson.	3.87	Highly Acceptable	1
4. Enhances the students ability in motor control designing.	3.69	Highly Acceptable	5
5. Improves the knowledge of the students on how the motor control devices works.	3.73	Highly Acceptable	4
AVERAGE	3.76	Highly Accepted	

Table 2 presents the acceptability of Sequential Motor Control System for Induction Motor Simulator in terms of performance as teaching tool. Based on the result,

it obtains the average weighted mean of 3.76 which described as highly accepted by the respondents.

Item on helps the teaching and learning process for in-depth understanding on motor control lesson obtained the highest weighted mean of 3.87 which ranked 1 and described as “Highly Accepted”. This means that the simulator is particularly effective in facilitating a deeper understanding of motor control concepts.

Increase the performance of the students on different motor controllers ranked as 2, enhances the student’s skills in motor control troubleshooting ranked as 3, and improves the knowledge of the students on how the motor control devices works ranked as 4 and enhances the students’ ability in motor control designing ranked as 5, having the weighted mean of 3.79, 3.74, 3.73, 3.69 respectively.

This prove that the simulator is highly acceptable by the respondents to be utilized in the electrical technology laboratory as a teaching tool since it effectively enhances the knowledge and skills of the students required in the industry particularly on motor control.

Table 3. Acceptability of Sequential Motor Control System for Induction Motor Simulator in terms of Convenience of Use

N=40

CONVENIENCE OF USE	WM	DESCRIPTION	RANK
1. Shows that terminals are expose to the operator for easy access.	3.89	Highly Acceptable	1
2. Shows the roller installed provide easy mobility from one place to another.	3.51	Highly Acceptable	3
3. Equip with label for parts and terminals for identification.	3.30	Acceptable	4
4. Shows that the components installed were accessible to the operator.	3.80	Highly Acceptable	2
AVERAGE	3.63	Highly Accepted	

Table 3 displays the acceptability of the Sequential Motor Control System for Induction Motor Simulator in terms of convenience of use. Based on the average mean of 3.63, respondents described this as highly acceptable, indicating that the convenience of use is well-regarded and appreciated.

Among the items evaluated under convenience of use, the one concerning terminals being exposed to the operator for easy access received the highest rank of 1, described as highly acceptable. This feature allows students to effortlessly perform the wiring installation for desired motor control designs.

Additionally, the item about components being easily accessible to the operator achieved a rank of 2, while the item pertaining to the installation of rollers providing easy

mobility from one place to another ranked 3. Both these features, with weighted means of 3.80 and 3.51, respectively, were also described as highly acceptable.

Furthermore, the item related to the simulator being equipped with labels for parts and terminals for identification obtained the lowest weighted mean of 3.30. Nevertheless, it remains acceptable to the respondents.

Sequential Motor Control System for Induction Motor Simulator demonstrates a high level of acceptability in terms of convenience of use. Its various features, such as accessible terminals, easy-to-reach components, and rollers for mobility, have been highly appreciated by the respondents. Although the labeling aspect received a slightly lower mean, it still meets the respondents' expectations and contributes to the overall positive perception of the simulator's convenience of use.

Table 4. Acceptability of Sequential Motor Control System for Induction Motor Simulator in terms of Safety

N=40

SAFETY	WM	DESCRIPTION	RANK
1. Shows that circuit breaker and halogen lamp installed protect the device against short circuit.	3.96	Highly Acceptable	1
2. Shows that the manual switch installed serves to its purpose.	3.81	Highly Acceptable	6
3. Shows that parts and accessories are properly installed.	3.95	Highly Acceptable	2
4. Shows that terminals exposed to the user are properly insulated.	3.77	Highly Acceptable	7
5. Shows that conductors are properly connected and insulated.	3.93	Highly Acceptable	3
6. Display the device structure which is well polished	3.89	Highly Acceptable	4
7. Shows that wiring connections are properly enclosed .	3.85	Highly Acceptable	5
AVERAGE	3.88	Highly Acceptable	

Table 4 presents the acceptability of Sequential Motor Control System for Induction Motor Simulator in terms of Safety. Based on the result, safety of the simulator is highly acceptable having average weighted mean of 3.88 which means that the simulator is highly acceptable by the respondents. This proved that the simulator's robust safety features, highly acknowledged by the respondents, create a conducive learning environment where students can embrace creativity, curiosity, and innovation as they delve into the complexities of motor control. This enhanced level of safety fosters a more enriched and effective learning experience, allowing students to apply their theoretical knowledge in practical scenarios with confidence and proficiency.

The simulator's exceptional safety features are evident through the installation of a circuit breaker and a halogen lamp, which serve to protect both the device and the students during short circuit experiences. This significant aspect received the top rank of 1 and was described as "highly acceptable" by the respondents. These safety measures instill confidence in students, allowing them to explore various motor control designing techniques and conduct experiments using the simulator without any hesitations. The presence of the protection devices ensures that any erroneous wiring connections are promptly detected and isolated, preventing potential hazards and minimizing risks.

Despite receiving the lowest weighed mean of 3.77 and being ranked at 7, the item pertaining to properly insulated terminals exposed to the user was still described as highly acceptable by the respondents. This means that the simulator may not fully meet all the respondents' desires or requirements.

Based on the study of Leoncio, 2014 which stated that Philippine Electrical Code serves as the national standard for ensuring the safety of individual, building, and their contents from potential hazards associated with electricity usage. In the context of this study, the selection and installation of devices in the trainer were guided by the Code's mandated standards. This approach ensures the protection of users and the devices themselves in accordance with established safety protocols.

Table 5. Acceptability of Sequential Motor Control System for Induction Motor Simulator in terms of Assembly of Parts

N=40

ASSEMBLY OF THE PARTS	WM	DESCRIPTION	RANK
1. Installed components are secure and unmovable.	3.35	Acceptable	4
2. Components are properly labeled	3.26	Acceptable	6
3. Installed components can be assembled and dismantled.	3.45	Highly Acceptable	3
4. Indicates that correct position of wiring	3.55	Highly Acceptable	2
5. Illustrates that installed components are accessible and visible to the user. .	3.30	Acceptable	5
6. Represent that installed components are installed according to the technical plan.	3.59	Highly Acceptable	1
AVERAGE	3.42	Highly Accepted	

Table 5 illustrates the acceptability of the Sequential Motor Control System for the Induction Motor Simulator in relation to the assembly of its parts. The respondents' responses show that the assembly of the simulator's components is highly acceptable, as evidenced by the weighted mean score of 3.42, which describe as "highly acceptable" range. This indicates that the respondents observed a strong alignment between the

simulator's representation and organization of components, meeting their expectations and fulfilling its intended purpose effectively.

The simulator's individual components were ranked based on their weighted mean scores, shedding light on specific aspects of its assembly. Notably, the component that ranked 1 is the installed components according to the technical plan, boasting a highly acceptable weighted mean score of 3.59. This aspect adheres to electrical code standards, a crucial consideration in selecting and installing electrical components.

Following closely in ranked 2 are the correctly positioned wirings, receiving a highly acceptable weighted mean score of 3.55. This finding suggests that the respondents appreciated the precise arrangement of the wiring in the simulator.

Securing the ranked 3 is the components that can be assembled and dismantled, with a weighted mean score of 3.45, denoting high acceptability. Respondents recognized the practicality of this feature, enabling ease of assembly and disassembly.

In rank 4 is the secure and unmovable components, scoring an acceptable weighted mean of 3.35. While not rated as highly as the top-ranked aspects, respondents still acknowledged the stability and firmness of these components.

Occupying the rank 5 is the accessible and visible components for students, deemed acceptable with a weighted mean score of 3.30. This implies that respondents appreciated the ease with which students can interact with and observe these components.

Lastly, ranked is the properly labeled components, which achieved an acceptable weighted mean score of 3.26. Though receiving the lowest rank among the aspects, respondents still found the labeling of components satisfactory.

The Sequential Motor Control System for the Induction Motor Simulator garnered high overall acceptability, with its assembly meeting or exceeding the expectations of the respondents. The results emphasize the importance of adhering to technical plans and electrical code standards while offering user-friendly and practical features. Despite some aspects receiving lower ranks, they remain acceptable and contribute to the simulator's effectiveness as a valuable teaching tool.

Table 6. Acceptability of Sequential Motor Control System for Induction Motor in terms of Cost

N=40

COST	WM	DESCRIPTION	RANK
1. Obtained the total cost of the device of Sixty-two thousand three hundred ninety pesos (P62,390.00)	3.40	Acceptable	1
AVERAGE	3.40	Acceptable	

Table 6 illustrates the acceptability of the Sequential Motor Control System for the Induction Motor Simulator in terms of cost. The total cost of the simulator amounting to P62, 390.00 pesos obtained an average weighted mean of 3.40. This score indicates that the cost is acceptable by the respondents. This means that the respondents found that the cost of the simulator to be reasonable and within an acceptable range.

The simulator obtained higher cost attributed to the utilization of quality materials by the researcher which aimed in ensuring enhanced during its operation. According to Morano (2024), there's a need to establish quality standards for basin materials and electrical work, ensuring the safe utilization of electricity for various purposes such as light, heat, power, communications, and signaling. In connection with this the researcher able to select and installed quality materials for the safeguarding of the simulator and the students.

Table 7. Acceptability of the Sequential Motor Control System for Induction Motor Simulator Summary

N=40

CRITERIA	AVERAGE WEIGHTED MEAN	DESCRIPTION	RANK
Performance as device	3.75	Highly Acceptable	3
Performance as teaching tool	3.88	Highly Acceptable	2
Convenience of use	3.63	Highly Acceptable	4
Safety	3.76	Highly Acceptable	1
Assembly of parts	3.42	Highly Acceptable	5
Cost	3.40	Acceptable	6
Average	4.61	Highly Acceptable	

The table present the summary of the acceptability of the Sequential Control System for Induction Motor Simulator, including average weighted mean scores and qualitative descriptions for each criterion. Rankings for each criterion have been determined based on their respective average weighted mean scores.

Performance as a teaching tool securing the top (Rank 1) with a highly acceptable average weighted mean score of 3.76. This indicates that the simulator effectively supports teaching activities and was greatly appreciated by respondents.

Safety achieved the highest average weighted mean score of 3.88, securing second rank (Rank 2). This criterion was described as "highly acceptable," signifying that respondents highly valued the safety aspects of the simulator

Performance as a device obtained an average weighted mean score of 3.75, earning it the third rank (Rank 3) and described as "highly acceptable."

Convenience ranked fourth (Rank 4) with an average weighted mean score of 3.63, also described as "highly acceptable." This suggests that respondents found the simulator user-friendly and convenient.

Assembly of parts held the fifth position (Rank 5) with an average weighted mean score of 3.42, which is considered "highly acceptable."

Cost was ranked sixth (Rank 6) with an average weighted mean score of 3.40 and was described as "acceptable." Although not rated as highly as the other aspects, the cost was still deemed acceptable by respondents.

The overall average weighted mean obtained was 4.61, reflecting a "highly acceptable" rating by respondents. This shows that the simulator is well-suited for use in electrical technology laboratory for enhances students' skills effectively and experience the real world of work on their field.

Conclusion

The respondents highly accepted the Sequential Motor Control System for Induction Motor Simulator as a teaching tool across various aspects, including device performance, teaching tool performance, convenience of use, safety, assembly of parts, and cost. This simulator proves to be a significant instructional aide, operating at its peak efficiency and enabling students to gain a profound understanding of motor control operations. Additionally, it prioritizes students' safety, making it an ideal and valuable tool for educational purposes.

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