DEVELOPMENT OF MCSC LEARNING MODULE FOR THE BEET STUDENTS OF BATANGAS STATE UNIVERSITY-JPLPC MALVAR

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Abstract

This study was intended to develop and assess a learning module for the Motor Control and Sequential Control course that was specifically designed for Batangas State University- JPLPC Malvar Campus students enrolled in the program Bachelor of Electrical Engineering Technology (BEET) program. In order to improve the knowledge and skills of learners with control and automation systems that are essential in industrial settings, the module was created to bridge the gap between theoretical knowledge and practical application. It was based on constructivist learning theory and the ADDIE instructional design paradigm.

Utilizing a descriptive-developmental approach, the study evaluated how adequate the current laboratory resources are. Pre-tests, lectures, simulations, laboratory exercises, and post-tests were all incorporated into the 18-week academic term. 23 second-year BEET students took part in the evaluations, which focused on workmanship, speed, schematic interpretation, circuit functionality, and safety. The module's content, instructional design, and layout were evaluated further by experts.

The results showed adequate laboratory resources, but lacking of learning materials. Learners' practical performance significantly improved between pre- and post-assessments, particularly in terms of craftsmanship and speed of execution of laboratory activities. Students reported a significant desire to suggest and reuse the module, while same respondents agreed that the learning module was easy to use. Based on expert assessments, the module's content, design, and layout all exceeds criteria.

The study concludes that the module is an effective tool that promotes the development of motor control and sequential control skills. For relevant technical courses, it suggests frequent updates, the incorporation of multimedia content, and continuous module development.

Keywords: Learning Module, Control Automation, Motor Control Skills, Sequential Control

1. INTRODUCTION

For the creation of accurate and effective automated systems, engineering and robotics, students must learn motor control and sequential control. While sequential control deals with managing a sequence of activities or processes, motor control is concerned with controlling mechanical movements. It is essential to comprehend these ideas in order to build and optimize systems that call for coordinated actions and automated reactions. As stressed by Kuo (2018), engineers can improve system performance and reliability by learning these control methodologies.

The ability to control and direct the motion of industrial machine systems known as electrical motor control, and it is essential for developing and putting into practice efficient electrical engineering technology solutions. Conversely, sequential control refers to the capacity to plan, organize, and carry out a sequence of actions or tasks. This is a necessary skill for creating complex automation and control systems.

The Batangas State University's Electrical Engineering Technology program prepares students with the skills necessary to enter careers in the design, application, installation,

manufacturing, operation, and/or maintenance of electrical systems. Graduates of this degree program typically have strengths in the building, testing, operation, and maintenance of existing electrical systems and are well prepared to develop and implement electrical systems. (https://batstateu.edu.ph/)

One of the courses this program has is the Motor Control and Sequential Control consist of seven contact hours stated on the latest implemented curriculum based on PACUIT Proposal and CMO No. 20 S. 2013. This major course is designed to bridge theoretical knowledge with practical application in electrical engineering technology. As electric motors are integral to modern technology, understanding their operation and control is crucial for engineers and technologists. This course provides a comprehensive study of motor principles, control systems, and performance analysis. Through lectures, hands-on laboratory exercises, and real-world projects, students gain both cognitive insights and practical skills. The curriculum also emphasizes safety and ethical considerations, preparing students to address engineering challenges responsibly. By the end, students are equipped to design, analyze, and implement effective motor systems in diverse applications.

Motor Control and sequential control is a major course included in the Bachelor of Electrical Engineering Technology program. This course is composed of seven contact hours (2 hours lecture, 5 hours laboratory) a week, in accordance with the newly implemented curriculum of Batangas State University this Academic Year 2004-2025. The College of Engineering Technology of the BatState-U-JPLPC Malvar Campus is equipped with appropriate lecture room and laboratory areas wherein the students taking this particular discipline could enhance learning and skills needed for these students to be ready for the increasing demand of the industry. Trainers, equipment, motor control components, as well as hand and power tools are being provided for the students to utilized in every laboratory or hands-on activities. These activities are essential for the field of Engineering Technology as mentioned by David Kolb emphasizing the importance of “Learning by doing” wherein he stressed the idea that learning is a process whereby knowledge is created through the transformation of experience. Kolb's model outlines a cyclical process of concrete experience, reflective observation, abstract conceptualization, and active experimentation.

Presently, additional learning materials could be a great aid in fostering student’s knowledge and skills in the area of motor control and sequential control. Anchoring one of the program’s objectives, the researcher desires to contribute a comprehensive learning module that could facilitate quality technical-vocational education and training towards holistic competency and proficiency of the individuals in the field of motor control and sequential control.

Statement of the Problem

This study seeks to develop a learning module for the course Motor Control and Sequential control to be utilized by the Bachelor of Electrical Engineering Technology students of the Batangas state University-JPLPC Malvar Campus.

Specifically, it sought to answer the following:

1. What is the profile of the students in terms of age?
2. How do the respondents assess the adequacy of laboratory resources in terms of:
   2.1 laboratory facilities;
   2.2 laboratory components and equipment;
   2.3 laboratory tools; and
   2.4 learning materials?
3. What is the pre and post scores of the students in the laboratory activities in ELC terms of

3.1. workmanship;
3.2. speed;
3.3. accuracy of interpretation of schematic diagram;
3.4 functionality; and
3.5 safety?

4. Is there a significant difference between the pre-test and post-test result of the students?
5. What is the assessment of the students on the developed MCSC module in terms of:
   5.1 ease of use; and
   5.2 intention to use?
6. What is the experts' evaluation on the developed MCSC learning module in terms of:
   6.1 Contents;
   6.2 Design, and
   6.3 Layout
7. Based on the results of the study, what learning module may be proposed?

Hypothesis: There is no significant difference between pre and post assessment test of the students.

2. RESEARCH DESIGN

This part describes the process used to create a learning module on motor control and sequential control using a descriptive experimental approach. The objective of this methodology was to methodically assess and characterize how the module affects participants' motor and sequential control abilities. The study employed a methodical approach in which participants engaged with the learning module for a particular period of time, and various assessments were used to carefully record their progress. Important factors include participant's feedback, the module's efficacy in improving motor abilities, and the retention of sequential control. Participant surveys, observational checklists, and initial and final assessments were examples of data gathering techniques. In order to determine important changes and correlations and to provide light on the impact of the module, statistical studies were carried out.

The goal of this research design's first phase is to describe the current procedures and requirements pertaining to Batangas State University JPLPC Malvar's Motor Control and Sequential Control instruction. This involved gathering comprehensive data regarding the instructional strategies, available laboratories, materials and equipment, and the knowledge and abilities of the students in this field. To gather information and paint a complete picture of the current situation, surveys, interviews, observations, and documents can all be used.

The new learning module's design and development are the focus of the research's second phase. Here, the researcher identifies the precise areas in need of development or improvement using the descriptive outcomes from the first phase. The needs and gaps found during the description phase will inform the researcher's development of the new module's objectives, content, instructional strategies, and assessment techniques. The main objective is to develop a learning module that solves these gaps and is in line with the program's educational objectives.

2.1. Respondents of the Study

The respondents of this study consist of 23 second year students of Batangas State University- JPLPC Malvar taking Bachelor of Electrical Engineering Technology. The respondents were being chosen by the researcher for these respondents are capable and well-informed in providing necessary data in the conduct of the study.

2.2. Population and Sampling

The population for this study consists of 23 students of the Bachelor of Industrial Technology major in Electrical Technology. Purposive sampling technique used in determining the research respondents since the study will be exclusive for Motor Control and Sequential Control course.

2.3 Research Procedure

The researcher composed a letter directed to the Dean of the College of Engineering Technology in the Batangas State University-JPLPC Malvar noted by the thesis adviser. In order to provide the research instrument to the respondents, the researcher additionally created a thesis letter of authorization that was approved by the graduate school dean and thesis adviser. To examine and assess the validity and reliability of the instruments, the researcher wrote a validation letter and sent to several experts of this endeavor. The research instruments were given to the respondents in person. As the researcher provided a brief overview of the study, the respondents gave the respondents ample time to complete the questionnaire, the researcher gave the respondents a week to gather all the information required. The researcher follows up with the responders after a week. The researcher acknowledged the respondents for their assistance and cooperation in this study after gathering the responses and ensured that they were complete. Respondents were given an assurance that all information would be handled in complete confidence and used exclusively for the study's objectives.

When it comes to the development of the learning module, ADDIE Model was utilized. The process of instructional design was first built upon the analysis step. Through comprehensive needs assessments, the research determines the Motor Control and Sequential Control learning deficits at this phase. To determine the current understanding of the respondents. This includes surveys, interviews, and observations. To ensure compatibility with the suggested learning module, an evaluation of the technological resources such as laboratory components, equipment, facility, tools, and learning materials. The competencies that students should have by the end of the module are then determined by defining learning objectives.

The design stage concentrates on organizing the course material and creating effective instructional tools. To improve retention of knowledge and development of students' skills, teaching methods are based in cognitive and psychomotor theories of learning. To suit the needs and interests of the students, a variety of teaching strategies are utilized, including interactive simulations using motor control and sequential control software and practical wiring activities. Beginning with basic ideas and working its way to more complex circuits of industrial motor control. The module is designed to offer a logical order of topics. In order to ensure that students can demonstrate ability through both theoretical assessments and practical exercises.

Pre-assessment and post-assessment tools have been integrated into the module's design so as to facilitate for the assessing of learning improvements. It included detailed lab exercises that could be performed with the Electrical Technology laboratory trainers and equipment, ensuring complete resource availability. Learners may engage with both tangible and digital formats due to such activities, which were developed for hands-on wiring exercises and can be aided by simulation software for motor control. The learning module were created and the appropriate trainer or prototype control panel were utilized. These materials will be compatible with industrial application of motor control system. A key aspect of this stage is technology integration, which ensures that students efficiently practice motor control and sequential control concepts with motor control and sequential control software simulator. Reviews and revisions were conducted using Technology Acceptance Model to highlight the module’s ease of use and the users’ intention to use the learning module.

Deploying the learning module to the intended students were done in the implementation stage. To find possible use concerns as well as possibilities for development, a pilot testing were carried out to the third-year electrical technology students taking the more advanced course related to Motor Control and sequential Control. The course instructor facilitated the utilization of the module for the students to use it effectively. This stage required constant observation and feedback gathering in order to continuously develop the learning module. The module undergone essential evaluation and drafting. It had simulations, instructional content, and diagrams. Feedback from learners and expert evaluators resulted in modifications. The process of evaluation is ongoing and continues at every stage of the learning module's development. Formative evaluation entails gathering input during the learning process in order to make the required corrections and improvements.

The completed module underwent evaluation with students taking the Motor Control and Sequential Control course during the implementation phase. In actual classroom environments, facilitator made sure the students could apply the content effectively. Lastly, the assessment phase included both formative and summative techniques, such as student feedback and pre/post examinations, to evaluate the effectiveness and guided the improvements.

3. RESULTS AND DISCUSSION

This presents the details regarding the results of the study. It also consists of the analysis and interpretation of the collected data. The findings were analyzed and interpreted to answer the research questions presented in this study.

3.1. Result of Student's Assessment on the Conduciveness of Laboratory Facility

Table 3. Students' Perception about the Conduciveness of Laboratory Facility

The laboratory has…	Mean	Verbal Interpretation
1. an appropriate area for electrical activities.	4	Very Adequate
2. the presence of laboratory safety precautions.	3.7	Very Adequate
3. proper ventilation and sufficient lighting source	4	Very Adequate
4. a safe workplace for students' hands-on activities	3.91	Very Adequate
5. a fire extinguisher in case of a fire and first aid kit in case of accidents	4	Very Adequate
Overall Mean	3.9	Very Adequate

Legend: 3.25- 4.0 (VA), 2.50- 3.24 (A), 1.75-2.49 (I), 1.0-1.74 (VI)

Table 3 indicates the students' perception about the conduciveness of laboratory facility being used in the course Motor Control and Sequential Control. Each item was rated as "Very Adequate" with an overall mean of 3.9. This implies that most students consider the laboratory facilities are sufficient for their learning requirements. In particular, they firmly support the presence of essential components such as a proper workspace, safety precautions, adequate lighting and ventilation, and emergency preparedness.

The College of Engineering Technology provides a conducive space for laboratory activities, particularly for Electrical Engineering Technology major courses. The electrical laboratory room is equipped with working tables installed with convenience outlet for the students to access electrical power supply in testing circuits. The classroom is fully air-conditioned. For safety compliance, first aid kit and fire extinguisher, safety signages are available throughout the laboratory.

Related to this, Cannon and Newberry (2016), electrical engineering laboratory experiences improve students' motivation, engagement, and comprehension of challenging concepts, effectively bridging the gap between theoretical knowledge and practical application in the field of engineering education.

3.2. Result of Student's Assessment on the Adequacy of Laboratory Components and Equipment

Table 4. Students' Perception about the Adequacy of Laboratory Components and Equipment

The laboratory has an adequate…	Mean	Verbal Interpretation
1. number of single-phase supply, 3-phase power supply, and convenience outlet.	4	Very Adequate
2. number of motor control and sequential control trainers with single-phase and three-phase induction motors	3.78	Very Adequate
3. number of control components and indicators (push button switch, limit switch and industrial sensors)	3.65	Very Adequate
4. number of electromechanical components (magnetic contactors with overload relay, control relays, time-delay relay)	3.26	Very Adequate
5. number of indicator lights (start indicator, stop indicator, trip indicator)	3.65	Very Adequate
Overall Mean	3.66	Very Adequate

Legend: 3.25- 4.0 (VA), 2.50- 3.24 (A), 1.75-2.49 (I), 1.0-1.74 (VI)

Table 4 presents the students' perception about the adequacy of laboratory components and equipment. With an overall mean of 3.66 (Very Adequate), the majority of learners believe that the laboratory is adequately equipped. Power supply systems and control trainer availability are attributed with the highest scores. Electromechanical components fell into the "Very Adequate" interpretation, while having a slightly lower mean (3.26), which indicates satisfaction with the tools available for motor control and sequential control practices.

The facility comprises of control components including 20 motor control and sequential control trainers. Multiple electromechanical components including timers, sensors, and indicators, are also available to support various kinds of laboratory activities.in terms of ventilation, the laboratory is fully air-conditioned, ensuring comfortable working and learning space for students. For safety, fire extinguisher, first aid kit, and safety signages are very evident in the laboratory room.

Following this, modern laboratory equipment improves electrical technology students' learning, according to Ocampo and Villanueva (2020). Their case study demonstrates how practical application of modern tools enhances understanding and skill development, enhancing the educational process overall and increasing students' field proficiency across the curriculum.

3.3. Result of Student's Assessment on the Adequacy of Hand Tools in the Electrical Technology Laboratory

Table 5. Students' Perception about the Adequacy of Hand Tools in the Electrical Technology Laboratory

The laboratory has an adequate…	Mean	Verbal Interpretation
1. number of cutting/splicing tools (long nose pliers, side cutting pliers, diagonal cutting pliers, etc.)	3.21	Very Adequate
2. number of stripping tools	3.17	Adequate
3. number of driving tools	3.73	Very Adequate
4. number of multimeters	3.69	Very Adequate
5. unit of power tools (hand drill, drill press, etc.)	3.52	Very Adequate
Overall Mean	3.46	Very Adequate

Legend: 3.25- 4.0 (VA), 2.50- 3.24 (A), 1.75-2.49 (I), 1.0-1.74 (VI)

The table 5 presents students' perception about the adequacy of hand tools in the electrical technology laboratory. Learners perceived that hand tools, particularly driving tools (3.73) and multimeters (3.69), are adequately available, according to the table's overall mean of 3.46, which is interpreted as "Very Adequate". The item with the lowest rating, stripping tools (3.17), is still favorable but indicates a somewhat lower level of sufficiency than other items.

Adequate number of splicing tools, driving tools, multimeters, hand drills and drill press are available in the laboratory room. However, there is a need to improve the available number of stripping tools as sometimes, students while performing laboratory activities need to borrow these tools from one another.

in line with this, Alvarado and Sarmiento (2023) emphasize how laboratory tools are integrated into the curriculum for electrical engineering. Through experiential learning that is in line with industry demands, researchers highlight how practical skills and student engagement are improved by hands-on resources, better preparing graduates for future advances in technology and career opportunities.

3.4. Result of Student's Assessment on the Adequacy of Learning Materials for the course Motor Control and Sequential Control

Table 6. Students' Perception about the Adequacy of Learning Materials for the course Motor Control and Sequential Control

The laboratory has an adequate…	Mean	Verbal Interpretation
1. educational posters for motor control and sequential control.	3.3	Very Adequate
2. number of motor control and sequential control books.	2.4	Inadequate
3. motor control and sequential control learning module.	2.3	Inadequate
4. copies of motor control and sequential control schematic diagrams intended for industrial applications.	2.6	Adequate
5. copies of educational videos related to motor control and sequential control.	2.2	Inadequate
Overall Mean	2.6	Adequate

Legend: 3.25- 4.0 (VA), 2.50- 3.24 (A), 1.75-2.49 (I), 1.0-1.74 (VI)

Table 6 presents students' perception about the adequacy of learning materials for the course motor control and sequential control. The overall mean for this table was the lowest at 2.6, which is interpreted as "Adequate". The result shows inadequacy of the availability of essential resources including books (2.4), modules (2.3), and instructional videos (2.2), although they find some materials, such as schematic diagrams (2.6), to be rather satisfactory. This indicates a significant resource gap that may have an impact on the standard of instruction and skill improvement.

Learning materials are also available for students' utilization in the course. However, current number of Motor Control and Sequential Control books and learning modules, and related educational videos are inadequate to fully meet the learners' needs.

To that end, in order to increase student involvement in electrical technology education, Alvarado and Reyes (2016) explore an interactive learning module. According to their research, the module increases student-centered approach of education, and effectiveness by encouraging active learning, collaboration, and a deeper comprehension of complex ideas.

3.5. Result of Student's Assessment on the Adequacy of the Available Learning Materials for the course Motor Control and Sequential Control

Table 7. Students' Perception about the Adequacy of the Available Learning Materials for the course Motor Control and Sequential Control.

	The laboratory has an adequate…	Mean	Verbal Interpretation
1.	up-to-date laboratory manual.	3	Adequate
2.	module for all the experiments	2.9	Adequate
3.	software required for the laboratory experiments	3.4	Adequate
4.	E-books and other digital resources	2.5	Adequate
5.	trainers appropriate for laboratory experiments	3.5	Adequate
	Overall Mean	3.1	Adequate

Legend: 3.25- 4.0 (VA), 2.50- 3.24 (A), 1.75-2.49 (I), 1.0-1.74 (VI)

Table 7 provides the students' perception about the adequacy of the available learning materials for the course Motor Control and Sequential Control. With the 3.1 overall mean, students agreed that there are somehow available printed and online learning materials. The student respondents agreed about the availability of up-to-date laboratory manual (3), module for all the experiments (2.9), software required for the laboratory experiments (3.4), E-books and other digital resources (2.5), and trainers appropriate for laboratory experiments (3.5)

Learning materials such as laboratory manual, module for experiments, software for laboratory activities, digital resources, and trainers are available and being utilized by the students. Module for laboratory activities differs from the learning module for Motor Control and Sequential control in the sense that the first one comprises only schematic diagrams for hands-on activities while the other includes the comprehensive discussion of the whole topics, formative written assessment, as well as hands-on exercises.

In support of this in electrical technology education, Zamora and Delos Santos (2023) emphasize the value of developing flexible learning materials. They demonstrate that, in despite difficulties in the development process, well-designed modules greatly improve student understanding and engagement with intricate technical concepts, leading to more effective and adaptable learning experiences.

3.6. Paired Sample T-test Results

Table 8. Pre-assessment and post-assessment comparison of criteria scores with Paired Sample T-test

	Pretest		Posttest					
Criteria	M	SD	M	SD	Statistic	df	P	Mean Difference
A	4.87	1.392	7.65	0.487	-10.75	22	<.001	-2.783
B	4.96	0.706	7.83	0.491	-16.89	22	<.001	-2.87
C	10	0	10	0	NaN	22	NaN	0
D	10	0	10	0	NaN	22	NaN	0
E	9.48	1.163	10	0	-2.15	22	0.043	-0.522

The data shows the performance of participants performed on five significant measures prior to and following an intervention of the learning module.

There was a noticeable improvement in the participants' workmanship. Their average score was 4.87 prior to the intervention and afterwards improved to 7.65. Given that the change is statistically significant ($p < .001$). This implies that their capacity of completing tasks showing very

high skills was significantly enhanced.

The speed at which participants finished tasks also showed a noticeable and significant improvement. The average score increased from 4.96 (Low Skilled) to 7.83 (High Skilled), with a p-value of $p < .001$, which is very significant.

Remarkably, learners met the requirement with an ideal score of 10 (Very High Skilled) on both the pretest and posttest. Students had a high level of accuracy of interpretation of schematic diagram before the intervention with the module.

The functionality scores were excellent before and after. This implies that from the beginning, participants were already able to provide outputs that were completely functional. This constancy shows competency even though there was no statistical improvement.

The mean score for safety increased from 9.48 to 10. The rise was statistically significant ($p = 0.043$). This implies that even among individuals who were already aware about safety, the intervention was able to increase overall awareness and use of safety procedures.

3.7. Result of Student's Assessment on the Motor Control and Sequential Control module in terms of Ease of Use

Table 9. Student's Assessment on the Motor Control and Sequential Control module in terms of Ease of Use

The Motor Control and Sequential Control Module has:	Mean	Verbal Interpretation
1. layout that is easy to understand.	3.9	Very Easy to Use
2. features that are user-friendly.	3.6	Very Easy to Use
3. clear instructions in every written and performance task.	3.8	Very Easy to Use
4. provided hands-on activities that is relevant and helpful in developing students' skills.	3.6	Very Easy to Use
5. provided rubrics that guides the students for better performance.	3.9	Very Easy to Use
Overall Mean	3.7	Very Easy to Use

Legend: 3.25- 4.0 (VH), 2.50- 3.24 (HI), 1.75-2.49 (LI), 1.0-1.74 (VL)

Table 9 provides the student's assessment on the motor control and sequential control module in terms of ease of use**.** The overall mean of 3.7, indicates " Very Easy to Use", shows high level of user satisfaction. The module layout is relatively easy to understand for the learners, and value the relevance of the hands-on activities. This confirms the module's accessibility and pedagogical effectiveness.

The Motor Control and Sequential Control module is developed to make learning easy, and designed in order for the learners to gain knowledge and improved skills while enhancing their competency in required criteria of the course. Each of the seven chapters composed of pre-assessment, discussion of the topics, figures, diagrams, and actual pictures of the components being discussed. After which, post-assessments are included to evaluate the learning improvements of the students in the course.

In accordance with this, to increase the involvement of learners in electrical technology education, Alvarado and Reyes (2016) developed an interactive learning module. According to their research, it fosters teamwork, improves comprehension of difficult ideas, and supports dynamic, interesting learning opportunities.

3.8. Result of Student's Assessment in Terms of their intention of Using the Motor Control and Sequential Control Learning Module

Table 10. Student's Assessment on the Motor Control and Sequential Control module in terms of Intention to Use

As a student, I prefer to:	Mean	Verbal Interpretation
1. recommend the learning module to the next students that will take the Motor Control and Sequential Control course.	3.4	Very High Intention
2. recommend the learning module to others for their skill development.	3.7	Very High Intention
3. use the Motor Control and Sequential Control learning module in the future similar tasks.	3.7	Very High Intention
4. revisit the learning module to reinforce my understanding of motor control concepts.	3.6	Very High Intention
5. use the learning module as a primary reference for future projects in industrial motor control.	4	Very High Intention
Overall Mean	3.7	Very High Intention

Legend: 3.25- 4.0 (VH), 2.50- 3.24 (HI), 1.75-2.49 (LI), 1.0-1.74 (VL)

Table 10 shows learners' assessment on the motor control and sequential control module in terms of ease of use. Students exhibit a desire to recommend and reuse the module, as indicated by the overall mean of 3.7 (Very High Intention). Learners found the motor Control and Sequential Control Learning module useful for future projects and skill reinforcement in addition to instruction, demonstrating the module's long-term usefulness.

The learning module could be beneficial not only for the students but for other practitioners and technicians which are in the field of machine control. This learning material includes applicable schematic diagrams that could be applied in several industrial controls and machineries.

To that end, the advantages of modular learning in electrical technology education have been studied by Pangilinan and Sison (2022). According to the study, it increases comprehension of difficult technical concepts, promotes student interaction, and provides flexibility, each of these improves learning results.

3.9. Result of the Experts' Evaluation for the Content of the Motor Control and Sequential Control Learning Module

Table 11. Experts' Evaluation for the Content of the Motor Control and Sequential Control Learning Module

	Mean	Verbal Interpretation
1. The content is aligned with the curriculum and benchmarks for the subject area.	2.6	Exceeds Criteria
2. The content is up-to-date for the academic subject and the context in which the content is presented.	2.7	Exceeds Criteria
3. The level of complexity or difficulty of content is appropriate.	2.7	Exceeds Criteria
4. The content is accurate and helps to achieve the program educational objectives, student outcomes, and intended learning outcomes specified in the course.	2.7	Exceeds Criteria
5. The content includes problem-centered connections to life in a context that allows students to reflect on the university core values.	2.9	Exceeds Criteria
Overall Mean	2.7	Exceeds Criteria

Legend: 2.25-3 (EC), 1.50-2.24 (MC), .75-1.49 (PMC), 0-.74 (DMC)

Table 11 presents the experts' evaluation for the content of the Motor Control and Sequential Control Learning Module, the module content received an overall mean of 2.7, which is interpreted as "Exceeds Criteria." Experts pointed out that the content is reliable and in line with learning outcomes (2.7), comprises problem-based connections that reflect core values (2.9), is up-to-date (2.7), appropriately complex (2.7), and aligns well with curriculum standards (2.6). These findings support the module's academic relevance and instructional integrity.

In the development of the module, alignment with the curriculum, updated contents, and other essential factors were considered. Learning objectives were crafted based on the Intended Learning Outcomes of the course and by the Bloom's Taxonomy of Learning. Experiments ang assessments included in the module could help the students to achieve these learning outcomes by providing learner centered instructions.

Following this, the significance of high-quality content in learning modules is emphasized by Tolentino et al. (2020). High ratings were given to their localized digital modules, particularly for their content, which demonstrated how well-organized, relevant content can significantly enhance student understanding, engagement, and the overall efficacy of learning tools.

3.10. Result of the Experts' Evaluation for the Instructional Design of the Motor Control and Sequential Control Learning Module

Table 12. Experts' Evaluation for the Instructional Design of the Motor Control and Sequential Control Learning Module

	Mean	Verbal Interpretation
1. The number of opportunities for interactions to make learning easier is clearly manifested in the material.	2.6	Exceeds Criteria
2. The material requires learners to become actively engaged in order to learn.	2.6	Exceeds Criteria
3. Directions are clear and complete enough for students to perform required tasks.	2.7	Exceeds Criteria
4. The material includes appropriate assessment.	2.6	Exceeds Criteria
5. It accommodates diverse learning styles and ability levels.	2.3	Exceeds Criteria
Overall Mean	2.5	Exceeds Criteria

Legend: 2.25-3 (EC), 1.50-2.24 (MC), .75-1.49 (PMC), 0-.74 (DMC)

With an overall mean of 2.5 for instructional design being shown in table 11, the module met the requirements. Experts agreed that the module offers clear directions (2.7), assessments (2.6), and chances for student engagement and interaction (2.6). The instructional material's capacity to accommodate different learning styles received the rating of 2.3.

Systematic process of planning was done in the development of the Motor Control and Sequential Control Learning Module. The development includes assessment of the needs in the course in terms of laboratory resources including modules. Goals and outcomes that are based in the ILOs were considered as well as the proper assessment included in the material. These components make the learning module acceptable in terms of instructional designed as evaluated by the experts.

Consistent with this, Miranda et al. (2020) developed a 3D engine assembly simulation module for senior high school. Researchers evaluated material according to ISO 25010 standards, with a focus on instructional design. The module was beneficial despite the lack of physical laboratory materials since it successfully improved student learning, engagement, and comprehension of engineering technology.

3.11. Result on the Experts' Evaluation for Layout of the MCSC Learning Module

Table 13. Experts' Evaluation for Layout of the MCSC Learning Module

	Mean	Verbal Interpretation
1. The material is interactive and provides high quality sensory experiences to all users.	2.6	Exceeds Criteria
2. Structure and format of the material have enough order and clarity to allow students to access content and explicitly ideas and sequences.	2.7	Exceeds Criteria
3. Multimedia and technology integrated in the instructional material engage students in absorbing or expressing details from the material.	2.1	Meets Criteria
4. The color, size of print, spacing, quantity, and type of visuals are suitable for the abilities and needs of intended students.	2.4	Exceeds Criteria
5. Layout is clear and intuitive that provides students opportunities to find what they need.	2.7	Exceeds Criteria
Overall Mean	2.5	Exceeds Criteria

Legend: 2.25-3 (EC), 1.50-2.24 (MC), .75-1.49 (PMC), 0-.74 (DMC)

The experts' evaluation on the module's layout and design is shown in Table 12, where it acquired an overall mean of 2.5 (Exceeds Criteria). The module's clarity, user-friendly design (2.7), and suitable use of formatting and images (2.4) were commended by experts. Multimedia integration matched expectations while receiving a slightly lower rating (2.1). The module received favourable reviews in general, suggesting that it has considerable potential for instructional efficacy.

The contents, visuals, and activities are presented and organized in the module in such way that the students could comprehend each lesson even in a self-paced learning. The discussions were arranged in two-column lay-out to avoid overlapping page content. Together with these, each discussion is followed by figures carefully selected in order for the students to visualized what concept is being discussed. Fonts and spacing are also given a consideration to make the material easy to read. Assessments are separated from the content to highlight these tasks in every beginning and ending of each chapter.

In support of this, a Competency-Based Learning Module in 3D Structural Modelling was developed by Bonifacio and Madera (2021) for Drafting students. The study, which was assessed by experts and educators, revealed that the module's effectiveness was significantly increased by its clear layout and design, which improved student engagement, comprehension, and the overall engineering technology education learning experience.

4. CONCLUSION

Based on the result of this study, these conclusions have been drawn.

The laboratory resources of the College of Engineering Technology at the Batangas State University-JPLPC Malvar Campus have adequate laboratory resources in terms of laboratory facilities, laboratory components and equipment, laboratory tools. These resources play a pivotal role in students' development of knowledge and skills in terms of hands-on activities, especially in the major courses.

Additionally, learning materials are also available in the Electrical Technology Laboratory.

On the other hand, the students found the ease of use of the Motor Control and Sequential Control Learning Module.

Besides, the study shows the strong intention of the learners to utilize the learning module.

Moreover, the Motor Control and Sequential Control Learning Module significantly helps to improve the students' skills in workmanship, speed, accuracy of interpretation of schematic diagrams, and safety in performing the laboratory activities.

With regards to the hypothesis of the study, the paired sample t-test results verify that the students' pre- and post-test scores in workmanship, speed, and health and safety differ statistically significantly. As a result, the null hypothesis, claiming that no substantial difference develops, is rejected. This suggests that the developed learning module successfully enhanced students' practical performance in motor control and sequential control.

Lastly, the study showed that the learning module "Exceeds Criteria" in terms of content, instructional design, and layout.

5. RECOMMENDATIONS

The researcher humbly offered the following recommendations based on the significant findings of the study.

1. Key laboratory resources such as books, modules, and instructional videos were significantly lower, despite students' acceptance that there are some learning resources accessible. These learning materials may be created or acquired that are especially suited to motor control and sequential control as well as the expansion of digital resources including e-books and software.
2. The learning module has been shown to be effective in improving students' performance in laboratory exercises, especially in terms of their speed and workmanship. Additionally, students highlighted the module's importance as an instructional tool by showing a strong intention to recommend and utilize it. It is suggested to continue using the module in future semesters in light of these beneficial results.
3. Regular evaluations and modifications of the Motor Control and Sequential Control Learning Module should be carried out based on input from subject matter experts and students to make sure it stays engaging and relevant specially with the fast-growing innovation of the industry's technology. Digitalizing the module should also be taken into consideration.
4. Instructional videos and tutorials available online regarding the different motor control connection could also be provided for the students to have a digital guide in studying several circuit connections in the course Motor Control and Sequential control.
5. Utilize mobile applications such as simurelay, EKTS, Factory I/O to simulate the circuits in the module and reinforce learning.
6. Include pictorial diagrams for the students to visualize the actual connections of each of the components in every given circuit.
7. Improvements remain necessary though the learners were majority agreed that the hand tools and lab equipment are generally sufficient. To better support hands-on activities, it is recommended to increase the supply of tools with lower ratings, including stripping tools. Furthermore, it is recommended that you use advanced and updated training equipment in order to improve learning outcomes and stay up with changing industry standards.
8. Adopting the Motor Control and Sequential Control learning module to students who are not competent in interpretation of schematic diagram, making the circuit function, and in health and safety practices since it was tried out among competent students in these criteria.
9. It is humbly recommended that, given the module's beneficial impacts, additional research with regards to the development of other learning module be carried out, that it be developed for use in other courses, and that longer-term effects be studied through larger-scale further research.

ACKNOWLEDGEMENTS

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APPENDIX A

QUESTIONNAIRE FOR STUDENT RESPONDENTS
DEVELOPMENT OF MCSC LEARNING MODULE FOR BEET STUDENTS OF BATANGAS STATE UNIVERSITY- JPLPC MALVAR

Part I: Demographic Profile

Direction: Please mark (/) and write the necessary information.

1. Age

☐ 18-20 years old
☐ 21-23 years old
☐ 24 years old and above

Part II. Assessment of available laboratory resources:

Direction: This part of the survey questionnaire aims to assess the perception of the students on the adequacy of laboratory resources. Please mark (/) corresponding to your assessment. Please use the scale provided as your reference.

Numerical Rating	Verbal Interpretation
4	Very Adequate (VA)
3	Adequate (A)
2	Inadequate (I)
1	Very Inadequate (VI)

2.1. Laboratory Facility

(The laboratory has…	4 (VA)	3 (A)	2 (I)	1 (VI)
1. an appropriate area for electrical activities.				
2. the presence of laboratory safety precautions.				
3. proper ventilation and sufficient lighting source				
4. a safe workplace for students' hands-on activities				
5. a fire extinguisher in case of a fire and first aid kit in case of accidents				

2.2. Laboratory Components and Equipment

The laboratory has…	4 (VA)	3 (A)	2 (I)	1 (VI)
1. number of single-phase supply, 3-phase power supply, and convenience outlet.				
2. number of motor control and sequential control trainers with single-phase and three-phase induction motors				
3. number of control components and indicators (push button switch, limit switch and industrial sensors)				
4. number of electromechanical components (magnetic contactors with overload relay, control relays, time-delay relay)				
5. number of indicator lights (start indicator, stop indicator, trip indicator)				

2.3. Laboratory Tools

The laboratory has…	4 (VA)	3 (A)	2 (I)	1 (VI)
1. number of cutting/splicing tools (long nose pliers, side cutting pliers, diagonal cutting pliers, etc.)				
2. number of stripping tools				
3. number of driving tools				
4. number of multimeters				
5. unit of power tools (hand drill, drill press, etc.)				

Part III. Assessment of the adequacy of laboratory learning materials:

Direction: This part of the survey questionnaire aims to assess the perception of the students on the adequacy of laboratory learning materials.

3.1. Visual Learning Materials

The laboratory has…	4 (VA)	3 (A)	2 (I)	1 (VI)
1. educational posters for motor control and sequential control.				
2. number of motor control and sequential control books.				
3. motor control and sequential control learning module.				
4. copies of motor control and sequential control schematic diagrams intended for industrial applications.				
5. copies of educational videos related to motor control and sequential control.				

3.2. Printed and Online Learning Materials

The laboratory has…	4 (VA)	3 (A)	2 (I)	1 (VI)
1. up-to-date laboratory manual.				
2. module for all the experiments				
3. software required for the laboratory experiments				
4. E-books and other digital resources				
5. trainers appropriate for laboratory experiments				

Part IV. Assessment of the students on the development of MCSC module: Direction: This part of the survey questionnaire aims to assess the perception of the students on acceptability of the Motor Control and Sequential Control Learning Module. Please mark (/) corresponding to your assessment. Please use the scale provided as your reference.

Numerical Rating	Verbal Interpretation
4	Very Easy to Use (VE)
3	Easy to Use (EU)
2	Difficult to Use (DU)
1	Very Difficult to Use (VD)

4.1 Ease of Use

The Motor Control and Sequential Control Module has:	4 (VE)	3 (EU)	2 (DU)	1 (VD)
1. layout that is easy to understand.				
2. features that are user-friendly.				
3. clear instructions in every written and performance task.				
4. provided hands-on activities that is relevant and helpful in developing students' skills.				
5. provided rubrics that guides the students for better performance.				

Direction: This part of the survey questionnaire aims to assess the perception of the students intention of utilizing the Motor Control and Sequential Control Learning Module. Please mark (/) corresponding to your assessment. Please use the scale provided as your reference.

Numerical Rating	Verbal Interpretation
4	Very High Intention (VH)
3	High Intention (HI)
2	Low Intention (LI)
1	Very Low Intention (VL)

4.2 Intention to use

As a student, I prefer to:	4 (VH)	3 (H)	2 (LI)	1 (VL)
1. recommend the learning module to the next students that will take the Motor Control and Sequential Control course.				
2. recommend the learning module to others for their skill development.				
3. use the Motor Control and Sequential Control learning module in the future similar tasks.				
4. revisit the learning module to reinforce my understanding of motor control concepts.				
5. use the learning module as a primary reference for future projects in industrial motor control.				

Prepared by:

TEDDY G. PIAMONTE
MaEd- THE, Student Researcher

APPENDIX B
INSTRUCTIONAL MATERIAL EVALUATION FORM

	Reference No.: BatStateU-FO-COL-15	Effectivity Date: January 3, 2017			Revision No.: 00

INSTRUCTIONAL MATERIAL EVALUATION FORM

College	College of Engineering Technology	Semester	2nd	Academic Year	2024-2025

☐ Highly Recommended ☐ Recommended ☐ Not Recommended

Developer: TEDDY G. PIAMONTE

Title: MOTOR CONTROL AND SEQUENTIAL CONTROL

Course where the IM will be utilized: ELC 221- MOTOR CONTROL AND SEQUENTIAL CONTROL

Intended Audience: BACHELOR OF ELECTRICAL ENGINEERING TECHNOLOGY (2ND YEAR)

Media Format:

☒ Learning Module ☐ Hand-out ☐ Activity Sheet ☐ E-Book ☐ Powerpoint Presentation ☐ Hyper Media ☐ Audio CD ☐ Film ☐ Computer Software

Others: (Please Specify) _____

The presented instructional material will be rated by the members of the local review committee on instructional materials as to the following criteria.

CONTENT To be rated by the Content Specialist	**Exceeds Criteria**	**Meets Criteria**	**Partially Meets Criteria**	**Does Not Meet Criteria**
	3	**2**	**1**	**0**
1. The content is aligned with the curriculum and benchmarks for the subject area.				
2. The content is up-to-date for the academic subject and the context in which the content is presented.				
3. The level of complexity or difficulty of content is appropriate.				
4. The content is accurate and helps to achieve the program educational objectives, student outcomes, and intended learning outcomes specified in the course.				
5. The content includes problem-centered connections to life in a context that allows students to reflect on the university core values.				

Evaluated by:	Remarks:
Date of Evaluation: _____	

INSTRUCTIONAL DESIGN To be rated by the Pedagogical Specialist	**Exceeds Criteria**	**Meets Criteria**	**Partially Meets Criteria**	**Does Not Meet Criteria**
	3	**2**	**1**	**0**
1. The number of opportunities for interactions to make learning easier is clearly manifested in the material.				
2. The material requires learners to become actively engaged in order to learn.				
3. Directions are clear and complete enough for students to perform required tasks.				
4. The material includes appropriate assessment.				
5. It accommodates diverse learning styles and ability levels.				
Evaluated by: **Date of Evaluation: _____**	Remarks:			

LAYOUT To be rated by the Technology Specialist	**Exceeds Criteria**	**Meets Criteria**	**Partially Meets Criteria**	**Does Not Meet Criteria**
	3	**2**	**1**	**0**
1. The material is interactive and provides high quality sensory experiences to all users.				
2. Structure and format of the material have enough order and clarity to allow students to access content and explicitly ideas and sequences.				
3. Multimedia and technology integrated in the instructional material engage students in absorbing or expressing details from the material.				
4. The color, size of print, spacing, quantity, and type of visuals are suitable for the abilities and needs of intended students.				
5. Layout is clear and intuitive that provides students opportunities to find what they need.				
Evaluated by: **Date of Evaluation: _____**	Remarks:			

APPENDIX C
RUBRIC OF PERFORMANCE ASSESSMENT IN LABORATORY ACTIVITIES

CRITERIA	PERFORMANCE INDICATOR					Earned Points
	9-10 points	7-8 points	5-6 points	3-4 points	1-2 points	
A. Workmanship (25%)	All electrical components were properly mounted and tightly screwed/ fixed.	Electrical components were properly mounted with up to 1 slightly loose screw.	Electrical/ Electronic components are not properly mounted showing loose wire and screw.	Electrical components were not properly mounted with loose screws.	Electrical components were not installed correctly.	
B. Accuracy of interpretation of schematic diagram (20%)	Able to identify all electrical component present in the given diagram and can identify each function in the entire circuitry.	Can name only 80% of electrical component's schematic symbols present in the given diagram and identify each function in the entire circuitry	Can name only 50% of electrical component's schematic symbols present in the given diagram and identify each function in the entire circuitry	Able to identify 20% of the components present in the given diagram.	Unable to define given symbol.	
C. Functionality (30%)	The load/s is/are properly working with the exact function/s at the initial testing.	The load/s is/are properly working with the exact function/s after 1 extra troubleshooting.	The load/s is/are properly working but not in exact function.	The load/s is/are properly working but not in exact function with 1 extra troubleshooting.	The load is not working/ short circuit	

D. Health and Safety, (15%)	Showed the following standards: 1. Safety precautions was followed 2. Working place is clean and orderly	One of the following standards was not followed: 1. Safety precautions 2. Cleanliness and orderliness of working place		Two of the following standards were not followed: 1. Safety precautions 2. Cleanliness and orderliness of working place	Did not follow the safety standards showing carelessness at work.	
E. Speed, (10%)	Used lees than 70% of the allotted time	Used 100% of the allotted time	Extended at least half the value of the time of work to finish the output	Extended an equivalent of the full value of the time of work to finish the output	Was not able to finish the output within the allotted/ extended time	

APPENDIX D
RUBRIC FOR WRITTEN ASSESSMENT

Criteria	4 - Excellent	3 - Good	2 - Satisfactory	1 - Needs Improvement
Clarity & Organization	Ideas are well-structured, logical, and easy to follow.	Mostly clear and organized, with minor lapses.	Some organization, but ideas may be unclear or disjointed.	Partially answers the prompt with missing key points.
Content & Explanation	Provides strong, well-explained points with relevant details.	Addresses the topic with good explanations but lacks depth.	Covers the topic but lacks strong details or explanations.	Minimal or weak content with little to no explanation.
Grammar & Mechanics	Free from grammar, spelling, and punctuation errors.	Few minor errors that do not affect readability.	Noticeable errors that slightly impact clarity.	Frequent errors that make understanding difficult.
Relevance & Completeness	Fully addresses all parts of the prompt with insightful responses.	Mostly complete, but may lack some details.	Partially answers the prompt with missing key points.	Incomplete response with little relevance to the topic.