Original Article

Improving Selected Electrical Engineering Students' Abilities of Using Technological Tools

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Abstract

This article deals with the effects of using technological lab tools, specifically inverting and non-inverting operational amplifiers, on improving the abilities of 3rd-year Electrical Engineering students at the University of Gondar, Ethiopia. It has cultivated a culture of continuous improvement and collaboration of eighteen students who were grouped into three teams. The performance of students' ability was evaluated using tests, attitude and creativity measurements. The tests were administered just to measure the students' knowledge and skills before and after the intervention. Besides, questionnaire was employed in order to measure overall use of electronics lab tools during the actual training sessions. Gaps or issues on two applied electronics lab tools were seen with respect to the current curricula and instructional strategies, student performance and understanding, motivation and involvement of students, comments from both teachers and students. On the other hand, students were supposed to relate and blend their theoretical knowledge with practical abilities when they access to exchange practical skills. Towards this end, they were guided to do the same design circuit across groups. Empirical data were gathered from peer assessment, observation, and pre- and post-tests were described descriptively considered time. The findings indicated a significant improvement in students' comprehension and performance when utilizing technological tools during electronics lab training periods. The implementation of inverting operational amplifier improves the test score of the student by 41.11%. There was an increase in both technical proficiency and problem-solving skills among the participants.

Keywords: Amplifier, Circuit, Electronics Lab

1. Introduction

Today, in a rapidly evolving world, technology has become an integral part of our daily lives. It paves the way for various advancements in education, including the incorporation of technological tools to enhance learning experiences. Since education is a social activity, teachers who spend a lot of time getting to know their students directly associated with higher levels of educational quality. On the other hand, opportunities for students would be visualizing, analyzing, and discussing ideas in groups to enhance the quality of instruction. More student-centered learning environments result from the incorporation of modern technologies into courses of study.

During the information age, electronics lab tools should motivate students by making their lessons more real-world experiences and bringing them into the 21st century (Kolesnikova, 2016). Employing technology in the classroom has become essential to educating students for the needs of a rapidly changing technological environment. In section two, a third-year Electrical Engineering student investigates the usage of inverting and non-inverting operational amplifiers. The Electrical Engineering department recognizes the need to provide students with practical experience that bridges the gap between theoretical knowledge and practical applications. In these regards, inverting and non-inverting operational amplifiers are fundamental components in analog circuit and hence they are essential for future electrical engineers.

Then, teachers need to meet the expectations of the students; effective teaching and learning involve the use of various methods and approaches. Due to the complex, numerical, and heterogeneous character of electrical engineering education in particular, effective teaching strategies must be used to improve student performance (Kuo, 2015). Since the world is moving rapidly into digital media and information, the role of technological lab tools in education is becoming more and more important. Effective use of technological tools like computers, simulation software, hardware tools and others for education can enhance the quality and accessibility of education, standard, learning motivation and environment. Improving the abilities of selected Electrical Engineering students using technological lab tools can empower them to become adept problem solvers and innovative thinkers. This initiative aligns with the evolving landscape of Electrical Engineering, ensuring that students not only graduate with theoretical knowledge but also possess the practical skills (Rahman *et al*., 2012).

Ultimately, the goal is to cultivate a cohort of graduates who are well-prepared to contribute meaningfully to the advancements and innovations in Electrical Engineering. The overarching principles and educational theories that support the idea of improving 3rd year Electrical Engineering students' abilities are possible through the use of technological lab tools. Here are some theoretical perspectives that lend credence to this initiative, such as experiential learning, simulation and modeling, and active learning strategies. By integrating these theoretical principles, educational institutions can build a robust framework for improving the abilities of electrical engineering students (Koretsky & Magana, 2019).

Impact of technological electronics lab tools is addressed in this paper. In actuality, using the lab equipment directly wasn't encouraged by the conventional teaching method. In these regards, there are many other factors that prevent all students from taking practical classes in the same way. For instance, lack of willingness to participate in practical classes, lack of sufficient laboratory facilities, and lack of readiness of teachers to teach practical classes. Similarly, previous studies in 3rd year Electrical Engineering education have explored various methods to enhance students' skills with technological electronics lab tools.

The following are research questions which are addressed in this paper. These are

1) What traditional approaches were employed just before the research began?

2) What are the problems experienced by teachers and students regarding technology use in their classroom, if tools are available? If not available, what is the department is / doing to install tools?

3) What kind of support do teachers and LAB assistants need to make productive use of technology in the classroom?

4) What are the views /efforts of teachers and LAB assistants in participation and support for increasing technology use in course curriculum or study?

The objective of this study was, therefore, to enhance the impact of technological electronics lab tools on improving selected Electrical Engineering students. The novelty of this paper was tailored learning paths, collaborative practical based learning and continuous feedback from 3rd year electrical engineering students. The contribution and practical implications of this study was by addressing specific student groups and personalized learning.

2. Review of related works

Incorporating the learning styles of students in the teaching process makes learning easier for students to enhance their interest and understanding (Raiyn, 2016). The implementation of educational technology and the utilization of Information communication technology (ICT) are important components in a higher education institute (Seitebakeng, 2018). There have been shortcomings in the development of accommodations for students with learning disabilities using assistive technology. A study on the micro level, following the progress of six students who had some form of a learning disability (Floyd & Judge, 2012). The study was completed through the use of a piece of technology called classmate reader.

There is a common situation where most of the staff members have awareness and access to it. However, author finding come with some doubt that the awareness of the staff members does not guarantee the integration of ICT into the teaching-learning system. A reading and comprehension passage was given to all students. Students were then asked to test using traditional pen and paper methods, followed by a second assignment completed using the classmate reader. The results showed that the use of assistive technology is effective support and accommodation for students with learning disabilities.

In a use of technology in the classroom to strengthen inclusion of all types of learners, a variety of ways that technology can support inclusive practice (Bourdeaux, 1981). For instance, mobile technologies can provide an authentic and meaningful learning experience. Audio visual (including video conferencing and presentation software) media not only provide an authentic and meaningful experience, but they also foster a sense of community.

Practical works improve students' understanding, their problem-solving skills, and nature of science by having them duplicate the actions of scientists (Shana & Abulibdeh, 2020). According to the Shana and Abulibdeh, students should behave like scientists and adhere to scientific procedures when solving a scientific subject. Developing accurate observations and descriptions, turning ideas into real-world applications, keeping students interested in research, and encouraging a rational and acceptable way of thinking are some of the motives identified in (Sofoklis *et al*., 2017). These authors investigate the positive impact of technology tools on student's knowledge. They recommend that technology-aided education must be installed in classrooms to bring about an overall quality of education. Blended learning could be enhanced by technology (Creswell & Creswell, 2018). These authors describe distance learning and made group instructions through technology and in-person interaction.

Teachers need to be cautious when evaluating the efficiency of technology integration and carefully select appropriate learning programmers. Learning technologies offer an unparalleled chance to enhance education, facilitate personalized learning, and promote greater involvement and wider educational opportunities (Erduran, 2018). Erduran described that learning technologies are resources and tools created especially for the use of combined instructional. In this study unexpected finding can be considered as divergent skill levels, influence of self and group learning and implications for curriculum design.

The traditional teaching (lecture) method is very common in education especially at university level. In this education context, the educator can deliver the message via the "chalk-and-talk" method, uniform curriculum and overhead projector transparencies. Traditional surveys and questionnaires are often used to collect quantitative data on students' abilities and experiences with technological tools.

3. Research Methods

The current study addresses challenges faced by selected 3rd year Electrical Engineering students. In the first place, to assess the problem, sample groups were selected and questionnaires were prepared and distributed to them. In the modern era of world education, many innovative technological lab tools like electronics lab are available for teachers to use in their classrooms. Professional practical training must be provided and continuously encouraged by stakeholders for implementation of electronics lab tools. Teachers are required to integrate technology into their classrooms. This improves student test scores and overall students' performance during practical time. All interventions cab be considered group learning styles, prior knowledge levels, and specific challenges faced by the target group (Kuo, 2015).

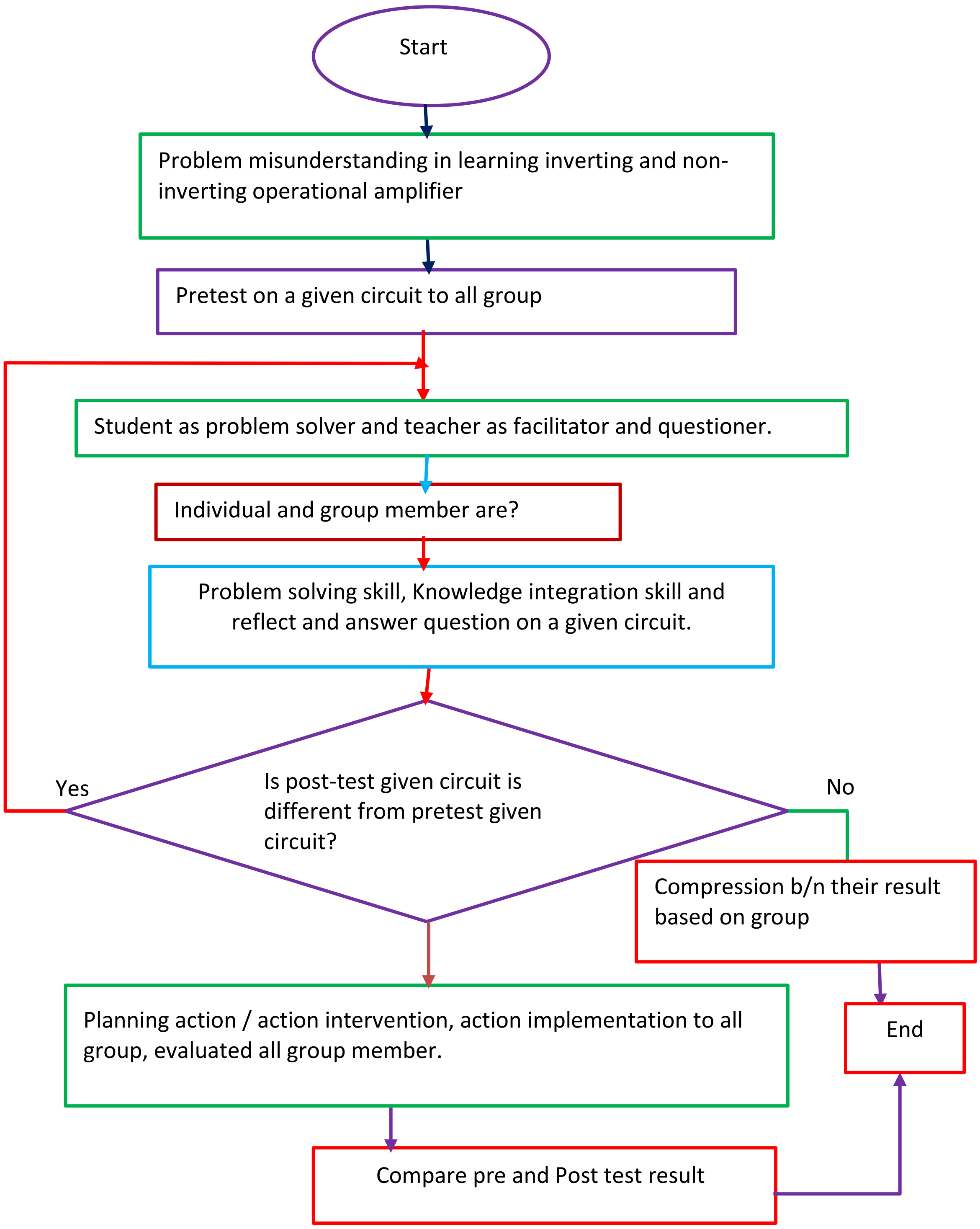

Figure 1: System model for conceptual framework of the study

Designing, implementing, and evaluating an approach to improve selected Electrical Engineering students' abilities with technological lab tools involves a systematic and well-structured process. Some ways of designing approach are technological lab tools, training, integrate real-world applications into the curriculum, continuous feedback, pre-and post-assessment.

The validity and reliability of electronics lab tools improves the characteristics of the selected students. Implementation of the intervention across different sessions and groups, training sessions, use reliability of feedback mechanism and continuous monitoring is described as Figure 1. The designed system was to identify students' misconception regarding inverting and non-inverting operational amplifier using problem-based learning.

This research involves reflection, planning, observation and intervention implementation. Using group discussion method, the students encourage how they are communicating and integrate with each other and find new ideas with existing ideas.

3.1 Sampling and Gathering techniques, and procedures for selecting participants.

The gaps that initiated the current investigation were considered current curricula and instructional strategies, student performance and comments from both teachers and students. This action research was conducted on electronics lab courses within three months. Experimental data can be controlled and managed in the form of data collection, quantitative data, qualitative data, post-intervention assessment, data interpretation and peer review for each group.

Eighteen participants were chosen based on their grade points in all categories, including sex, age and academic field. Pre-and post-tests were administered before and after the intervention. The tests consisted of circuit analysis problems related to inverting and non-inverting operational amplifiers. The considerations to make productive use of electronics lab tools were supposed to support of professional development, technical assistance, access to resources, curriculum development assistance. The questionnaires were prepared in English and the respondents could respond to answer based on the given questions. The survey questionnaire was distributed among the participants to gather their perceptions and experiences regarding the use of technological lab tools. The data collection in this inquiry used is 18 students. The analysis was carried out using assigning labels, group discussions, pre- and post-intervention assessments and comparative analysis. Time and percentage were utilized by three groups of students to evaluate the characteristics of the responses as shown Table 1. The number of students in a group and the quantity of practice time are two selected input parameters that have a significant impact on how well students complete their practical skills.

Table 1: Input parameters and Levels

Input parameters	Levels
Time elapsed on practice (hr.)	2
Number of students in a group	4
	6
	8

3.2 Intervention plan and implementation of the designed project

Conducting an intervention to improve 3rd year Electrical Engineering students' abilities by using electronics lab tools involves a systematic approach. Designing and implementing an intervention can in the form of select electronics lab tools, implement training sessions for each group, group collaboration, continuous feedback and evaluation (Mustapha *et al*., 2014). Data analysis for this study was conducted through both qualitative and quantitative approaches. The combination of both in a study on Electrical Engineering students' abilities with technological tools provides a comprehensive understanding of the research questions. The analyses were carried out using conducting one to one or group interviews with selected students, questionnaires and direct observations of students during intervention activities.

Qualitative study uses face-to-face interviews as electronics lab tool to collect students' narratives on how they improve their knowledge using practical teaching methods. The three scenarios and main strategies in the class can be considered based number of groups. The first scenario was four students in one group, the second scenario was six students in one group and the last scenario was eight students in one group. Some of the conducting intervention implementation issues are to control and identify a group of students for the practical work. The interventions involved incorporating inverting and non-inverting operational amplifiers under electronics lab course. Each group member chooses one student to participate in a thorough lab practice. Individuals were responsible for reporting training-related feedback and transferring information to a group member. The distribution of respondents was based on time used. Total number of participants can be considered as input parameters to create a variety of groups. Analysis of the effects of time and number of students in three respondents' group can be tested as shown in Table 2.

Table 2: **Distribution of Respondents**

Time (hr.)	2	2	2
Number of students	4	6	8

4 Results

As the first part of analysis, the data of participants' performance was collected and number of descriptive results can be expressed as poor, good, very good and excellent. The simulation result was collected based on closed ending questions particularly from students. The result was plotted based on the questioner's answer which is illustrated in Table 3.

Table 3: Students response on the Likert Scale result in count

S/No	Issue	Strongly Agree	Agree	Disagree	Strongly Disagree
1	I would benefit from additional training on electronics lab practical skills.	10	6	2	0
2	I believe that practical learning will promote my further employment opportunities.	16	2	0	0
3	There are necessary electronics lab tools and equipment for studies.	12	4	2	0
4	I struggle to apply the theoretical knowledge I learn in class to practical experiments.	8	6	2	2
5	The time allocated for practical learning is appropriate.	0	4	10	4
6	I am confident in my ability to complete practical tasks.	2	3	8	5

7	I knew what I was supposed to learn during the practical learning period.	8	7	3	0
8	My practical learning period helped me to improve my learning achievement.	10	6	2	0
9	I was satisfied with my practical learning period	3	8	5	2
10	I received sufficient guidance at the workplace for my practical learning difficulties.	3	9	6	0
11	I am able to work effectively in a team when performing laboratory experiments.	8	6	2	2
12	I am motivated and engaged when completing practical assignments	10	5	3	0
13	I believe that number of students in a group limit my practical performance.	12	5	0	0
14	I believe that student group formation based on their grade is important	11	6	1	0

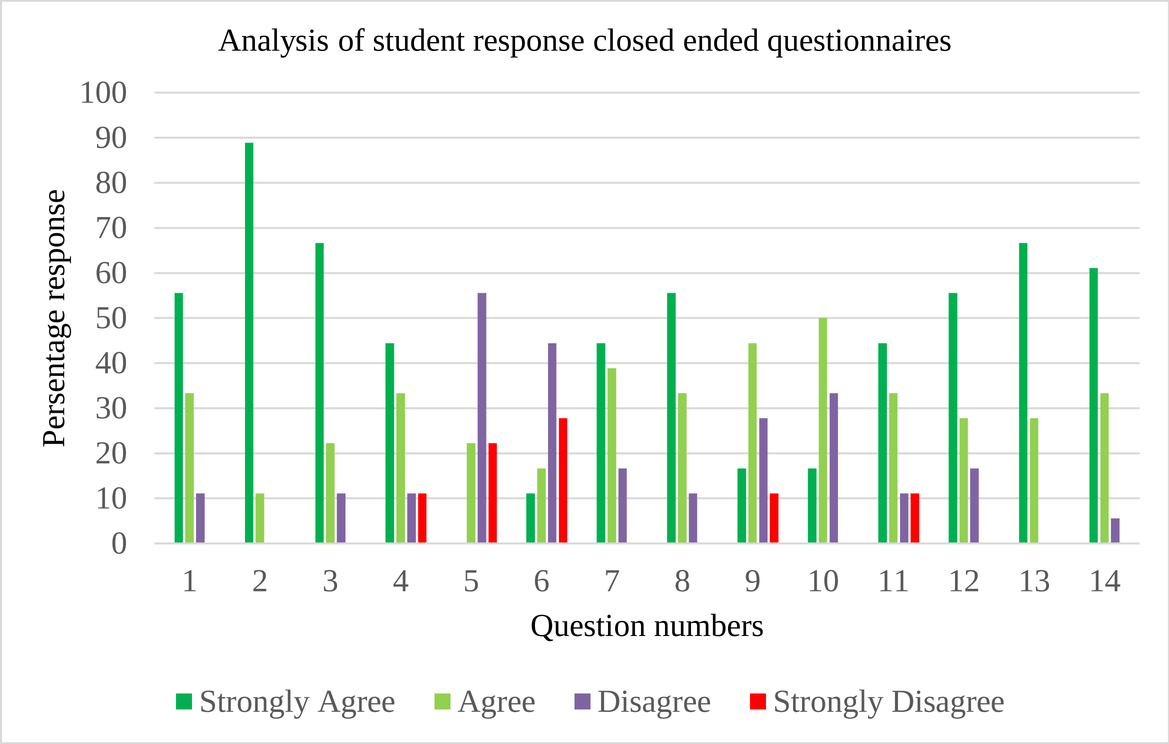

***Figure 2*: Student response closed ended questionnaires**

Figure 2 illustrates that 88.89% of the respondents strongly agree and 11.11 % of student respondents agreed that practical learning will promote their further employment opportunities. This helps improve their knowledge of practical skills and improve their productivity in their workplace during practical time. 66.67% of the respondents is strongly agree and 27.78% of s students is agree. The number of students in a group limits my practical performance. It is concluded that there are electronic lab tools and equipment for studies, time allocated for practical learning is inappropriate.

This implies that the number of students in a one group is higher and lack confidence during practical work. Table 4 shows that analysis of data can be interpreted as interims of poor, good, very good and excellent results. This result can obtain based on questionnaire as they filled from appendix part instruction II. As shown in Figure 3 below, the result describes the judgment of students on their own practical skill and the redness of the obtained result is low.

Table 4: Interpretation and analysis of data obtains from instruction II

Q no.1	Poor	Good	Very good	Excellent
Count	8	7	2	1
100 %	44.44	38.89	11.11	5.56
Q no.2	Poor	Good	Very good	Excellent
Count	7	6	3	2
100 %	38.89	33.33	16.67	11.11

Table 4 can be illustrated, just alternatively, as follows:

In addition, the forthcoming figures (Figure 4 and Figure 5) show electronic lab circuit which is given to students before and after intervention respectively for practical purpose. Ensuring the validity and reliability of an assessment tool is crucial to obtaining meaningful and accurate results. Evaluating Electrical Engineering students' abilities can be in the form of content validity, subject matter experts, pre and post test and continuous review and revision. The evaluation of study in each group takes a project to find the output values of practical skills based on given input parameters. Implementing inverting and non-inverting operational amplifiers before and after intervention is given to same circuit to all group. The students can be contributing existing body of knowledge with integration of theory and practice.

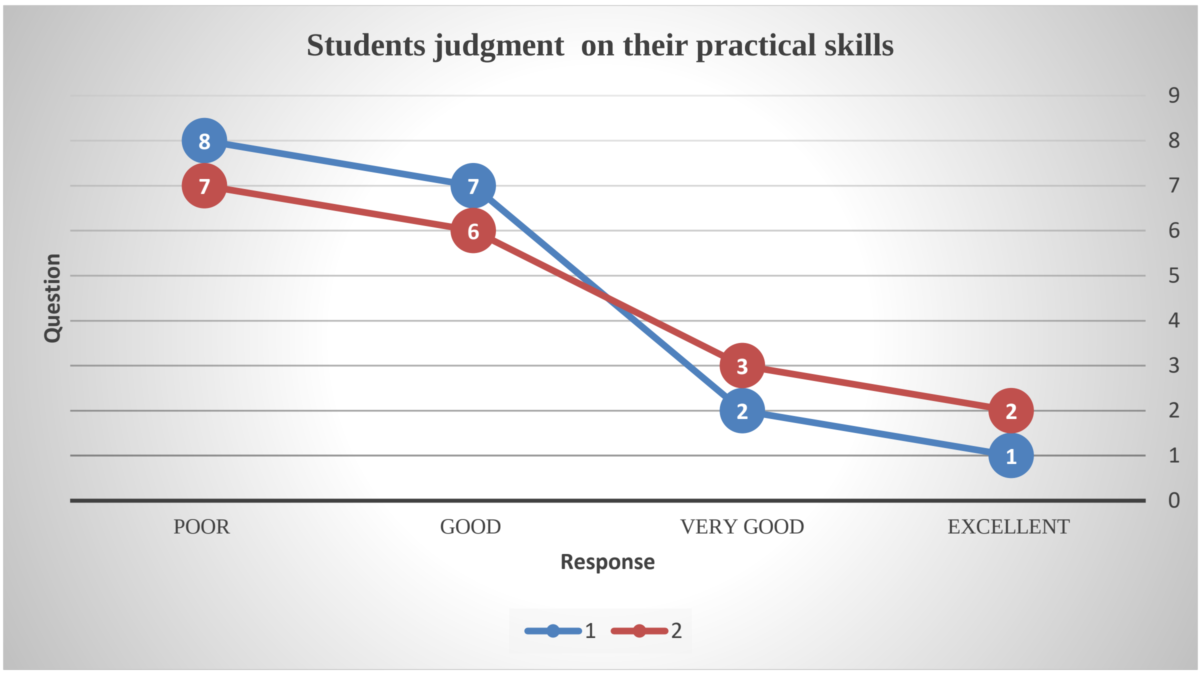

***Figure 3*: Students judgment on their own practical performance**

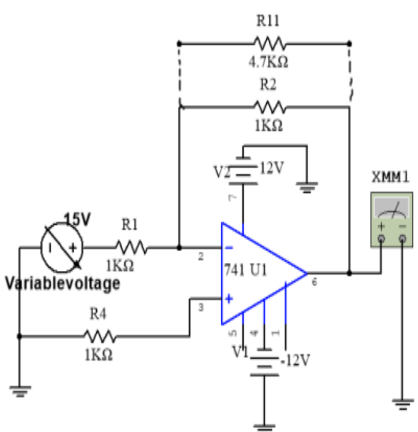

***Figure 4*: Given circuit before intervention**

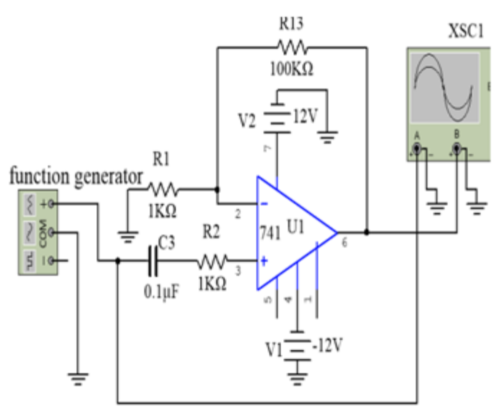

***Figure 5*: Given circuit after intervention**

Below are reports on strategy-based groups of students in from of three scenarios. The first scenario was eight students in one group. Hence, the group of students gave a poor performance. The second scenario was six students in one group which medium result they obtained, and the last scenario was four students in one group, which is highest score they obtained.

Scenario One: Poor Performance

According to evaluation criteria, a group of eight students can get a poor result during their practical work. This is due to insufficient measurements, quick operations, lack of confidence, and poor communication between measurements. A single student may have an excellent suggestion, but many students cannot pay attention. This implies interaction and misunderstanding of their work. The evaluation and supplied data are assembled as shown in Table 5 below.

Table 5: The evaluation and supplied data for group 3

Evaluating characteristics	Expected result for inverting and) data	Student's data (For inverting)	Expected result for non-inverting and) data	Student's data (For non-inverting)	Reasons to failure
Output (V) before intervention	-3	-2	3	2	Poor measurement.
Output (V) after intervention	-3	-2.7	3	2.7	

Scenario Two: Medium Performance

In this scenario as shown in Table 6, a group of six students produces their practical work and hence the success of fishing and answering questions was considered as medium level and good. This shows the number of students one group is minimum compared scenario one. This is because different students contributing ideas during practical time and construction of the circuit becomes better than the scenario one.

Table 6: **The evaluation and supplied data for group 2**

Evaluating characteristics	Expected result for inverting and) data	Student's data (For inverting)	Expected result for non-inverting and) data	Student's data (For non-inverting)	Reasons to failure
Output (V) before intervention	-3	-2.4	3	2.4	Poor measurement and equipment usage
Output (V) after intervention	-3	-2.8	3	-2.8	

Scenario Three: Best Performance

The last scenario as shown Table 7, illustrates that how a group of four students perform the best output voltage measurement and they achieve maximum result. The best result is each group member having access to operate and communicating easily. Even though it is against the rules of this course to work alone, this group makes progress and works well together. One member takes measurements, and the other members offer a straightforward evaluation from various angles. Feedback and ideas were openly exchanged, and there was sufficient time to decide on an adjustment to the measure of output compared to scenario one and two.

Table 7: The evaluation and supplied data for group 1

Evaluating characteristics	Expected result for inverting and) data	Student's data (For inverting)	Expected result for non-inverting and) data	Student's data (For non-inverting)	Reasons
Output (V) before intervention	-3	-2.7	3	2.7	Good usage of steps to

Output (V) after intervention	-3	-2.97	3	2.97	measure the outputs.

Table 8 below shows the test result before and after implementation of the circuit. There was a significant difference of students' achievements between the first, second and third group and the results reached their saturation point in the third group.

Table 8: Test result before and after implementation

Time (hr.)	2	2	2
Number of students	4	6	8
Test (15%) before intervention	8	7	5
Test (15%) after intervention	14.5	13	11

The Figure has shown that pre and post-test results. The students' result in group one, two and three had a basic understanding of inverting and non-inverting operational amplifiers, with an average score of 53.33%, 46.67% and 33.33 % respectively. After the implementation of inverting and non-inverting operational amplifiers circuit during practical time, the post-test result shows a significant improvement, with an average score of 96.67%, 86.67% and 73.33% for group one, two and three respectively. This demonstrated the effectiveness of using inverting and non-inverting operational amplifiers in enhancing students' ability.

The analysis of pre- and post-test scores revealed a significant improvement in students' academic performance after the intervention. This means post-test scores were noticeably higher than pre-test scores. This means to enhance understanding and application of concepts related to inverting and non-inverting operational amplifiers. Finally, the survey responses indicated that the majority of students found the use of electronics lab tools beneficial in understanding complex circuit configurations. They expressed increased confidence, better visualization of concepts, and improved problem-solving abilities when utilizing these tools. Table 10 shows results before and after intervention of 15%.

Table 9: Average result before and after intervention

	G_1	G_2	G_3	AVG
Test (15%) before intervention	53.33	46.67	33.33	44.44
Test (15%) after intervention	96.67	86.67	73.33	85.56

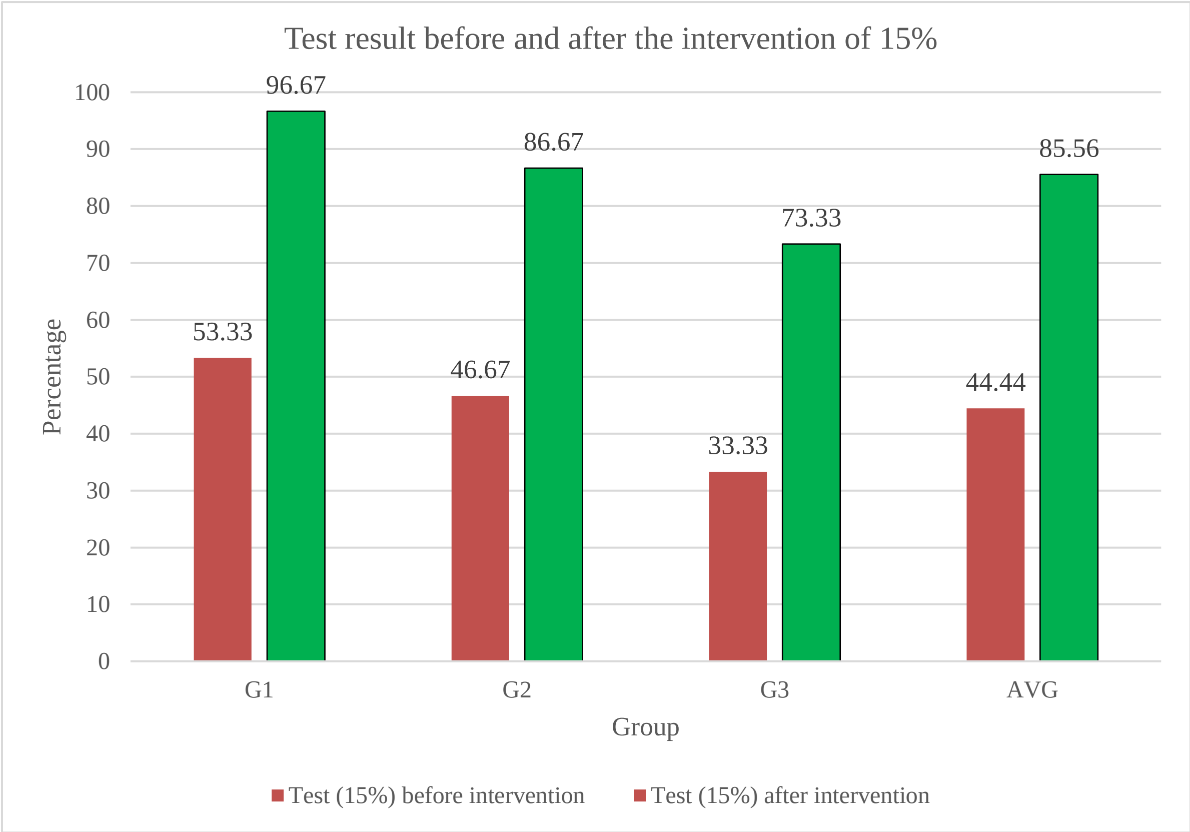

Figure 6: Test Result Before and After Intervention

5. Discussion

This study has found several main findings. The implementation of this research is to enhance the abilities of selected electrical engineering students using technological lab tools. Open-ended questions show that cooperative and problem solution aspects were the most preferred aspects in the problem solving. Some challenges arose during the research was students who refused to participate during the group presentation and time constraint. In this case, the teacher had to ask the students to continue group discussion after class end.

Findings and outcomes of this study are enhanced proficiency, engagement and motivation, enhanced problem-solving skills, collaborative learning culture and continuous improvement. There was a significant difference of students' achievements between the first, second and group and the results reached their saturation point in the third round. The implementation of inverting and non-inverting operational amplifier improves the test score of the student by 41.11%. However, there are different challenges to implementing a technology-aided education system, especially the light randomly going off at particular time. This needs research to assess its impact and related limiting factor. The performance of the four, six and eight students respectively in one group is arranged. Finally, based on their performance, four groups of students have maximum points scores compared to the other group.

6. Conclusion

The findings indicated a significant improvement in students' comprehension and performance when utilizing technological tools during electronics lab training periods. The overall outcome was evaluated and measured based on the implementation of the circuit, and they were determined as having poor, medium, and best performance of the project. The implementation of Inverting and Non-Inverting operational amplifier improves the test score of the student by 41.11%. These findings indicate significant increases in both technical proficiency and problem-solving skills among the participants. Yet, there were some common limitations of traditional methods are lack of hands-on experience, limited practical relevance, inadequate collaboration opportunities and lack of proper space for having group discussion. In the future, exploring the effectiveness of specific instructional strategies, investigating the long-term impact of self-directed learning on technological proficiency, and conducting cross-institutional studies for broader generalizability could be demanded. The teachers, educational leaders and policy makers may arrange and facilitate were minimize group members for teaching method's implementation in future teachers' education.

Declaration of Conflicting Interests

The author declares that no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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