Utilising oscillatory teaching and learning practices to enhance active learning in Higher Education Institutes

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Abstract

In this modern era, there is an unsustainable relationship between teachers and students. Since, students have become passive and disobedient in classes, as their primary motivation for attending classes is to fulfil attendance requirements for end-semester examinations in Higher Education Institutes (HEIs). Unfortunately, even some academics support this practice by justifying that students can acquire knowledge independently through the abundant resources available on the Internet.

However, higher education institutes should not only aim to produce knowledgeable graduates but also responsible citizens with positive attitudes and mind-sets for a better future and society. The students can gain knowledge and skills through the Internet, but developing a good attitude can only be achieved under the guidance of a skilled teacher.

This study focuses on suggesting and examining effective solutions to enhance active learning in higher education institutes. Various modern teaching and learning activities (TLAs), along with oscillatory practices, were utilized to ensure active learning occurs in the classroom. The intervention was implemented in a class of 72 fresh undergraduates pursuing a B.Sc. in Applied Physics and Electronics degree at a higher education institute in Sri Lanka.

Data was collected through feedback from both students and peer teachers, as well as an assessment of the students' achievement in the course's intended learning outcomes. The results revealed that students were highly motivated and actively engaged during the lectures.

Keywords: Brain-based learning; L2L; Object Based Learning; Oscillatory; Student-Centred Learning; TLAs; VARK model

1. Introduction

In this information era, most students in higher education sectors think that they can learn everything from The Internet without the guidance of teachers. As a result, they become less active and ignorant during lectures. Regrettably, some teachers also promote this type of learning environment for their personal benefits. Unfortunately, these practices make students irresponsible citizens with bad attitudes in society.

Due to the rapid evolution of the world, most young teachers prioritise giving subject-related knowledge and skills to students, neglecting their attitude and mind-set. They fail to focus on the importance of students' attitudes, which is well identified in Bloom's taxonomy in the domains of learning: Cognitive (knowledge),

Psychomotor (skills), and Affective (attitudes). A good teacher should be able to engage students in all domains of learning and create an active learning environment for the betterment of the future.

The goal of this research study is to fill the aforementioned gap and create a more effective teaching and learning environment for the students in HEIs. The effective teaching and learning environment was established by incorporating selective TLAs that corresponded to the type of learners with oscillatory practices.

This research was conducted with 72 fresh undergraduates who are pursuing a B.Sc. in Applied Physics and Electronics degree at a HEI in Sri Lanka. It specifically focused on the course Analog Electronics - I which was offered in the first semester.

1.1. Teaching for Active Learning

Teaching for active learning is an instructional approach that places students at the centre of the learning process, actively engaging them in the acquisition of knowledge and skills. Rather than being passive recipients of information, students become active participants who explore, question, analyse, and apply what they learn. This approach involves a shift from traditional teacher-centred instruction to Student-Centred Learning (SCL) environments where students collaborate, problem-solve, and think critically. The seven principles of SCL is shown in Fig. 1.

Fig. 1. Principle of SCL [1]

From the Dale's cone of learning [2] shown in Fig. 2, it is crystal clear that learners learn more when they are actively engaged or doing the learning activity, also known as active learning strategies.

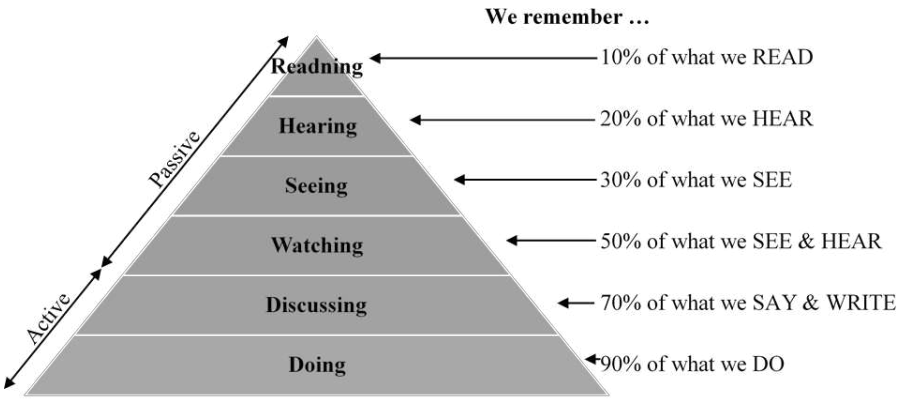

Fig. 2. Dale's Cone of Learning

1.2. Types of Learners

Learners are unique, so it is not possible to engage them with a single active learning activity. A good teacher must be aware of the types of learners and the appropriate teaching methodologies that enable active learning in his/her class.

Since each learner is unique as an individual and can have diverse learning preferences and strategies, categorizing them into well-defined types or styles is not easy. However, various models have been proposed to categorize learners based on their dominant learning styles or preferences.

Some common models are as follows:

- VARK Model: This model, developed by Neil Fleming, categorizes learners into four types based on their preferences for Visual, Auditory, Reading/Writing, or Kinaesthetic learning. According to this model, individuals may have a primary preference or a combination of preferences [3].
- Kolb's Experiential Learning Model: Developed by David Kolb, this model proposes four learning styles: Converging (active experimentation and abstract conceptualization), Diverging (concrete experience and reflective observation), Assimilating (abstract conceptualization and reflective observation), and Accommodating (active experimentation and concrete experience). Individuals may exhibit characteristics of one or more learning styles [4].
- Honey and Mumford's Learning Styles: This model categorizes learners into four styles: Activists (learn by doing and experiencing), Reflectors (learn by observing and reflecting), Theorists (learn through logical and systematic thinking), and Pragmatists (learn through practical application). Individuals may exhibit a dominant style or a combination of styles [5].

It's important to note that these models are theoretical frameworks and that learners often exhibit a range of preferences and strategies depending on the context and the nature of the learning task. Additionally, recent research suggests that focusing on learning strategies and metacognition may be more beneficial than categorizing individuals into fixed learning styles [5].

1.3. Oscillatory Teaching and Learning

Students' attention or concentration time is very important for active learning. Oscillatory practice is playing a vital role in the retention period.

Oscillatory practice, also known as spaced practice or distributed practice, is a teaching and learning strategy that involves spacing out practice sessions over time rather than cramming all practice into one intense session. It refers to the deliberate spacing of study or practice sessions with intervals of time in between to enhance long-term retention and mastery of the material [6].

The oscillatory practice is collaborated with Learning to Learn (L2L) approach. The benefits of oscillatory practice include:

- Improved retention: Research suggests that oscillatory practice over time enhances long-term retention of information and skills. By revisiting the material periodically, students have the opportunity to reinforce their learning and consolidate it into their long-term memory.
- Enhanced retrieval and transfer: Oscillatory practice promotes better retrieval of information from memory. Retrieval practice involves actively recalling information, which strengthens memory retrieval pathways and improves the ability to transfer knowledge and skills to new contexts.
- Long-term mastery: By oscillatory practice, students have more opportunities for repeated exposure and practice, which leads to deeper understanding and long-term mastery of the subject matter. It allows for the identification and correction of misconceptions or gaps in knowledge over time.
- Efficient use of study time: Oscillatory practice is more efficient and effective. Rather than dedicating extended periods of time to studying in a single session, students can allocate shorter, regular study sessions that are spread out over time. This approach helps optimize learning while reducing the risk of cognitive overload and fatigue.

2. Research Elaboration

In the course Analog Electronics – I, the modern TLAs, and effective lecture breaks for blended teaching mode were brought into the lesson plan for promoting Brain-based learning. The traditional lesson plans were designed and developed only for physical lectures, which could not be adapted to the blended sessions directly.

There are numerous of active learning strategies available such as cooperative learning, problem-based learning, role-playing, and etc [7]. The following active learning activities were utilised in this research to facilitate the students to achieve the Lower Order Thinking Skills (LOTS) and Higher Order Thinking Skills (HOTS) in the Bloom's Domains of Knowledge (DoK) of the courses.

1. Known to unknown: At the beginning of every lecturer, students were asked what they already knew related to the lesson objectives and what they would like to know. Then, they were explained how the lesson was going to link the unknowns and achieve the lesson objectives. This activity motivated the students and prepared them for active learning.
2. Think-Pair-Share: The students were given real-world problem, and asked to think individually first (think), then they were allowed to discuss with a partner (pair), and finally the partners were asked to share their collective idea to the whole class (share). This activity encouraged the students for active participation, collaboration, and exchange of diverse perspectives.
3. Jigsaw Method: The students were divided into small groups. Each group was assigned to a specific topic related to the lesson. They were asked to discuss and gather knowledge on their allocated topic. Once they became an "expert" on their assigned topic, one member from each group was swapped with

other groups to share and collect the whole knowledge in the lesson objective. This activity helped the students in fostering collaborative learning and a holistic understanding of the subject matter

4. Case Studies: Students were given real-life electronic circuit design scenarios with small challenges to get the interconnection between the ILOs to achieve the metacognitive level as defined in SOLO taxonomy. This enabled the problem based learning, and encouraged critical thinking, problem-solving, and the application of knowledge to practical situations.
5. Simulation: Since the course was related to electronic circuits, The NI Multisim simulation software was used extensively to encourage students to use simulation and to get some hands-on experiments. Occasionally, the students were allowed to do Gallery Walk activity, like go and explore other students' simulation works to increase the opportunities to observe, analyse data, draw conclusions, and make connections between theory and practice.
6. Peer Teaching: Most of the freshers are facing difficulties in understanding English language during their 1st semester. Not only that, but also hesitate to ask questions from the lecturers. So the students were asked to work with the given problem individually. Then some of the students were asked to present their work to the class in their native language. Even though, this activity consumed more time, its effectiveness was very high, also it promoted active learning, peer collaboration, and the development of communication and presentation skills.

The current blended teaching mode brought even newer issues to the students related to their physical and mental health which severely effecting their brain-based learning negatively. Students were forced to stay sit and stare at the computer screens throughout the day. It was observed that it significantly reduces the retention period, weakens the connection in the brain, and ultimately poor learning environment. For better brain-based learning bodies and brains need to be in gear.

To keep the bodies and brains of the students in gear, the following activities were included to the new lesson plan with oscillatory. (i) The virtual tour using Google Map, because naturally human brain get stimulated and new connections were made while travelling. Arranging field visits and showing real world applications to the students during COVID 19 were not possible and too expensive, these issues could be tackled by this virtual tour activities. (ii) Giving screen break: In order to reduce the eye pressure, students were given a gamified scavenger hunt activity during the screen break, which allowed the students to get away from sitting and gave physical movement. (iii) Graphical conceptualisation: Summarising and concluding the lesson with graphical progressing rather than just put it in words. The incorporated teaching strategies for active learning based on the type of learners have been tabulated in Table 1.

Table 1. Recommended teaching strategies for different type of learners

Type of learners	Teaching strategy for active learning
Visual Learners	• Use visual aids such as charts, diagrams, and illustrations to present information. • Encourage note-taking and the use of colour-coded highlighting or underlining. • Incorporate multimedia presentations to reinforce concepts. • Provide visual organizers or mind maps to help with organizing information.

Auditory Learners	• Incorporate discussions and group activities that encourage verbal interaction. • Provide opportunities for students to present information or teach concepts to their peers. • Use verbal explanations and storytelling techniques to convey information. • Provide audio recordings or podcasts as supplementary learning materials.
Kinesthetic Learners	• Incorporate hands-on experiments and simulations. • Encourage physical movement during learning, such as acting out scenarios or using manipulatives. • Provide opportunities for students to engage in projects, experiments, or practical applications of knowledge. • Offer kinesthetic learning aids, such as fidget tools or tactile materials.
Read/Write Learners	• Provide written materials, textbooks, and handouts. • Encourage note-taking and written summaries or reflections. • Assign reading assignments and provide opportunities for written responses or essays. • Utilize online resources, websites, and digital text for independent reading.

The effectiveness of the new teaching and learning practices were monitored and evaluated using numerous student feedbacks and their performance in the formative assessments.

3. Results

The effectiveness of the practiced TLAs with oscillatory were monitored and evaluated using numerous student feedback and their performance in the formative assessments. In this study, the effectiveness of gamified scavenger hunt activity, virtual tour, simulation-based teaching, pre-class activities, and the oscillatory practices of teaching were investigated.

3.1. Evaluation on the effectiveness of scavenger hunt activity

During the lectures, the students were asked to identify the applications of LEDs in the household devices. Since application of LEDs was a part of that particular lesson. Fig.3 shows the screenshot of the devices that were shared by the students during the scavenger hunt activity. This activity gave screen break and physical movement to the students, which enhanced the brain based education. Not only that, but also it is evident that this activity helped the students to apply their subject knowledge to real-world situations.

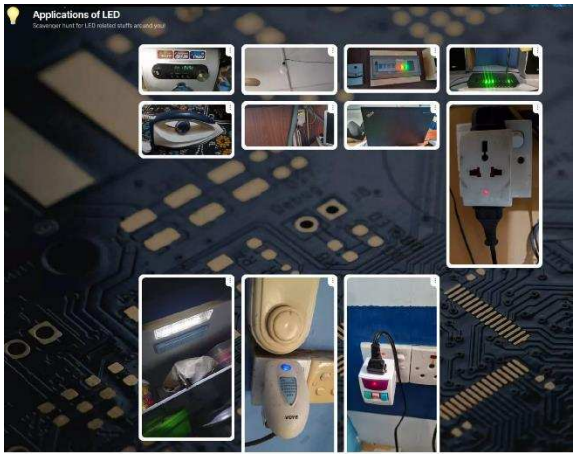

Fig. 3. Screenshot of a scavenger hunt activity

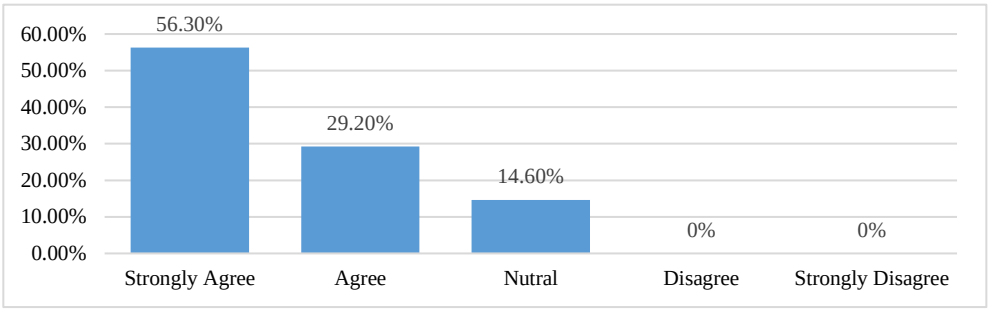

Fig. 4. Results for improvement in knowledge of the topics by doing scavenger hunt activity

The feedback on the improvement of knowledge through the scavenger hunt activity was collected from the responses to the statement - “The scavenger hunt activity helped you to improve your knowledge in the topics”. The results are shown in Fig.4 as bar chart. Approximately 85 % of the students agreed that the gamified scavenger hunt activity helped them improve their knowledge in the relevant topics, while about 15 % of them gave a neutral response.

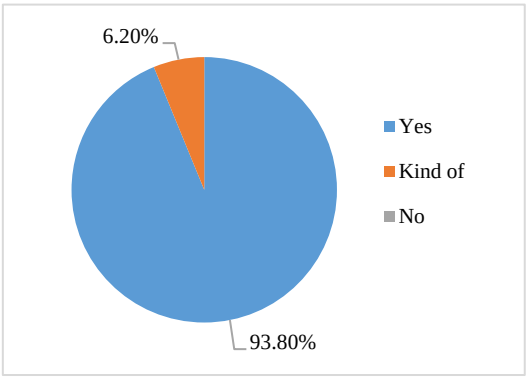

Fig. 5. Results from scavenger hunt activity provide mental and physical refreshment

The impact on physical and mental refreshment was evaluated by collecting feedback from the question - “Did the scavenger hunt activity give you mental and physical refreshment?”. The results are expressed as a pie-chat in Fig.5. About 94 % of the students were responded positively, with only 6 % of them gaving a neutral response, and none of them provided a negative response to this question.

3.2. Evaluation on effectiveness of virtual tour

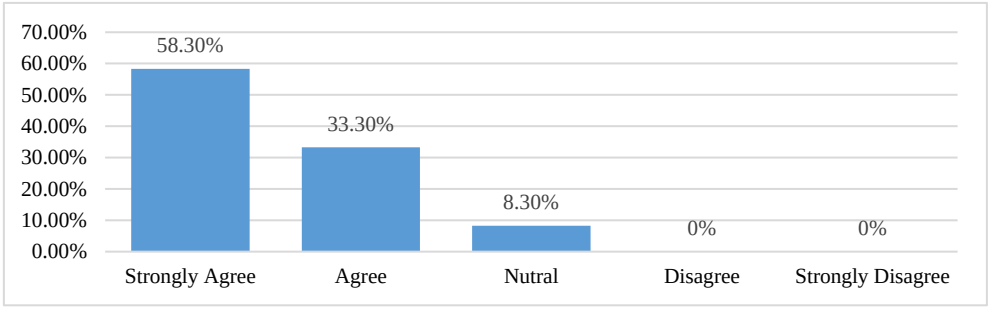

Fig. 6. Results for informative and enjoyable virtual tour

Feedback on the virtual tour session was collected through the statement, “The virtual tour was informative and enjoyable”. The students’ responses were analyzed and presented as a bar chat in Fig.6. About 8.30 % of the students gave neutral response, showing that they had mixed feeling about the virtual tour. On the other hand, all the other students expressed agreement with this statement, implying that they found the virtual tour to be both informative and enjoyable.

3.3. Evaluation on simulation based teaching method

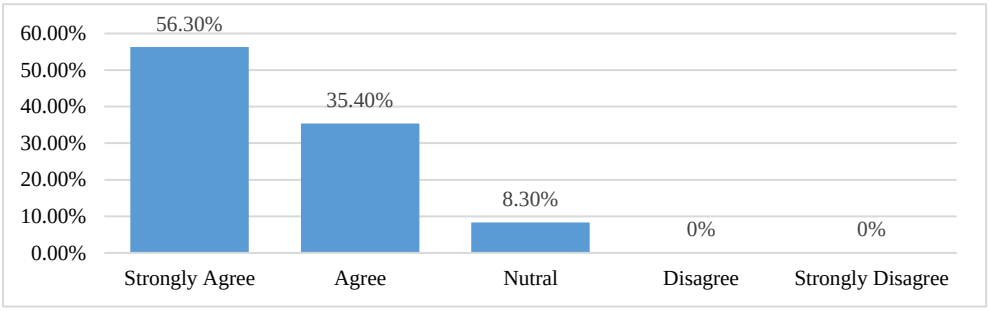

Fig. 7. Results for the statement, ‘motivation and confident level increased by simulation based teaching method’

The improvement in motivation and confidence levels of the students in the subject was evaluated through the feedback on the statement, “The simulation based teaching method motivated and gave you more confidence on the electronic circuits”. The results were summarized and presented as a bar chat in Fig.7. About 8.30 % of the students provided neutral response, suggesting that they had mixed feelings about the impact of the simulation based teaching method. However, an overwhelming 91.70 % of the students agreed that the simulation based teaching method significantly enhanced their motivation and level of confidence in understanding electronics circuits.

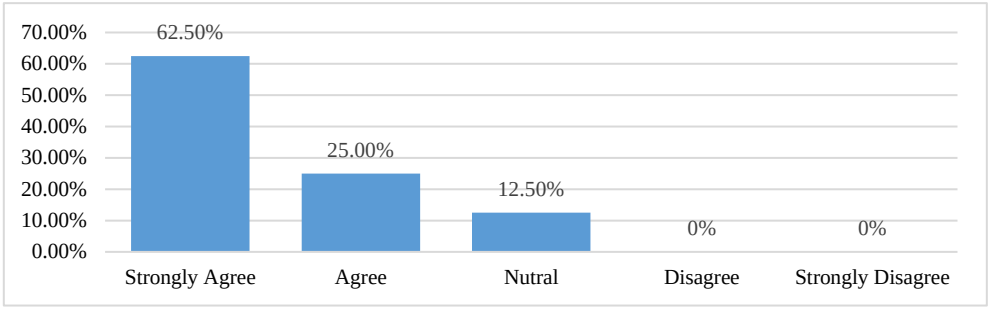

Fig. 8. Results for the improvement of curiosity in designing and developing electronic circuits through simulation based teaching

The level of improvement in curiosity on designing and developing electronic circuits was evaluated through feedback on the statement, “designing and developing electronic circuits using simulation increased your curiosity”. The results were summarized and presented as a bar-chat in Fig.8. Impressively, about 87.50 % of students agreed that their curiosity in designing and developing electronic circuits were increased significantly due to the simulation based teaching method. The remaining 12.50 % of the students provided neutral responses, indicating that they had mixed feelings about the impact on their curiosity.

3.4. Evaluation on effectiveness of pre-class activity

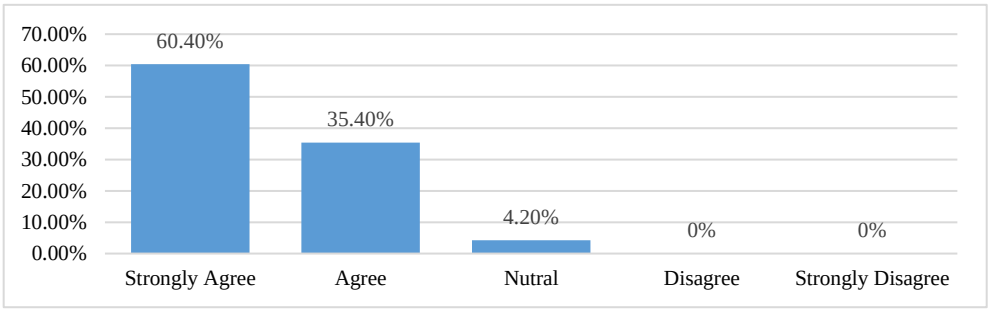

Fig. 9. Results for the statement, ‘overburdens in the subject were reduced by pre-class activity’

The evaluation on helpfulness of pre-class activity was conducted through feedback on the statement, “Having choices for picking pre-class activity helped you to reduce the overburdens in the subject”. The results were summarized and presented as a bar chat in Fig.9. An overwhelming 95.80 % of students agreed that the pre-class activity choices provided to them effectively reduce the burdens they experienced in the subject. In contrast, only 4.20 % of students gave neutral responses, suggesting that they had mixed feelings about the impact of the choices.

The motivation for active learning, which was gained through the group discussion on the pre-class activities, was evaluated by gathering feedback on the statement, “The group discussion on the pre-class activities motivated you to learn more”. The results of this evaluation were summarized and presented in a bar chart in Fig.10. According to the data survey, approximately 97.90 % of the students agreed with this statement, indicating that the group discussion significantly contributed to their motivation to learn. A small portion about 2.10 %, of the students gave a neutral response, suggesting that they neither strongly agreed nor disagree with the statement. Notably, none of the students provided negative responses, indicating that the group discussion had a positive impact on all the participants.

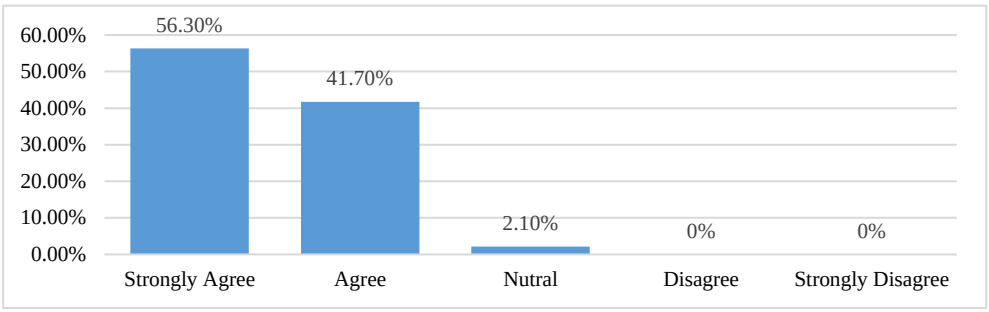

Fig. 10. Results for group discussion on the pre-class activities helps to gaining motivation to learn subjects

3.5. Evaluation on effectiveness of oscillatory teaching style

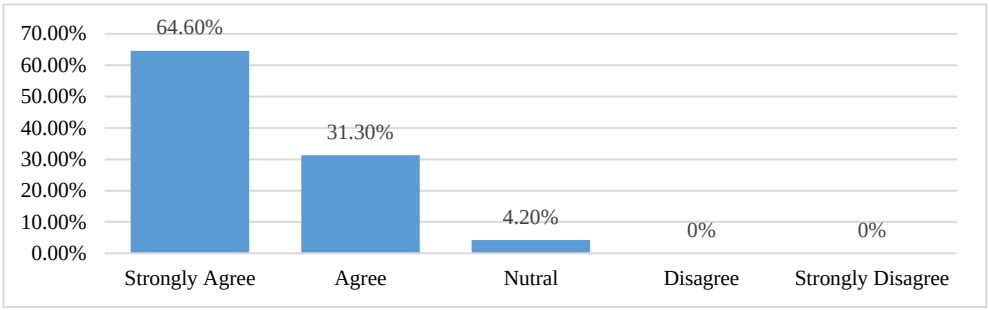

Fig. 11. Feedback on gaining knowledge by the oscillatory teaching style

The ability to gain knowledge through oscillatory teaching method was evaluated based on the responses to the statement, “The new way of teaching style helped to gain more knowledge”. The responses were then represented in a bar chart (Fig.11). The results indicated that approximately 95 % of the students agreed that the new way of teaching style facilitated a better understanding and acquisition of knowledge. The evaluation sought to gauge the effectiveness of the innovative teaching approach in enhancing students' learning experiences. By analyzing the data and feedback received, it was evident that the majority of the students found the new teaching method to be beneficial in expanding their knowledge and comprehension of the subject matter.

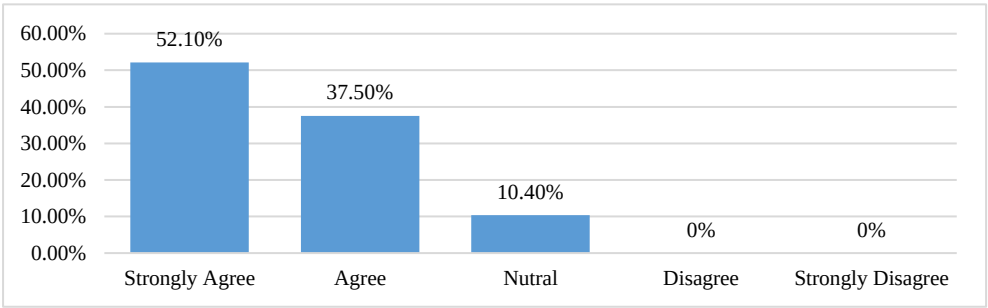

Fig. 12. Results on the statement that the oscillatory teaching reducing stress and eye pressure

Feedback on the statement “The new way of teaching style helped to reduce your stress and eye pressure” was collected and expressed as a bar chart in Fig.12. The results show that more than 50 % of the students strongly agreed and approximately 37.50 % agreed with this statement. It should be noted that no students disagreed with this statement. This indicating that a significant majority found the new teaching style to be beneficial in reducing their stress and eye pressure.

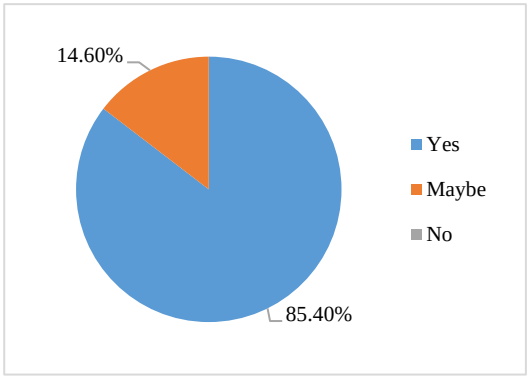

Fig. 13. Students’ preferences for the new way of teaching over the existing (traditional) way of teaching

The effectiveness of the new way of teaching was evaluated based on the feedback received from the question “Do you prefer the new way of teaching over the previous way of teaching?”. Approximately 85 % of the students recommended the new way of teaching over the existing method. This suggests that a significant portion of the student body found the new approach to be beneficial, enjoyable, or more effective than the traditional method. Such a high percentage of positive recommendations indicates that the new teaching style resonated well with a large majority of the students. On the other hand, around 15 % of the students provided a neutral response, this indicate that they neither strongly preferred nor disapproved of the new approach, indicating a mixed or indifferent perception of the changes.

4. Conclusion

In conclusion, the feedback from the students, with the majority expressing agreement, highlights the effectiveness of the virtual tour as a valuable tool in teaching and learning process. It demonstrates its potential to create an immersive and enjoyable learning environment that positively impacts students' understanding and engagement. The feedback-based evaluation of the simulation-based teaching method confirms its effectiveness in enhancing students’ motivation and confidence in understanding electronic circuits. Moreover, it shows the students' curiosity in designing and developing electronic circuits. The feedback-based evaluation affirms the positive impact of offering choices in the pre-class activity. The reduction in perceived burdens and the increase in motivation and engagement indicate that this approach is well-received by the students and contributes to a more effective and enjoyable learning journey.

The Fig. 11 demonstrates the overwhelming agreement among students that the oscillatory teaching style positively impacted their ability to gain knowledge with less stress and eye pressure. This positive response from the students highlights the importance of innovative TLAs that maximize students' learning potential. This feedback is valuable for educators and researchers to understand the impact and acceptance of the new teaching approach and to continually enhance the learning experience for all students.

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