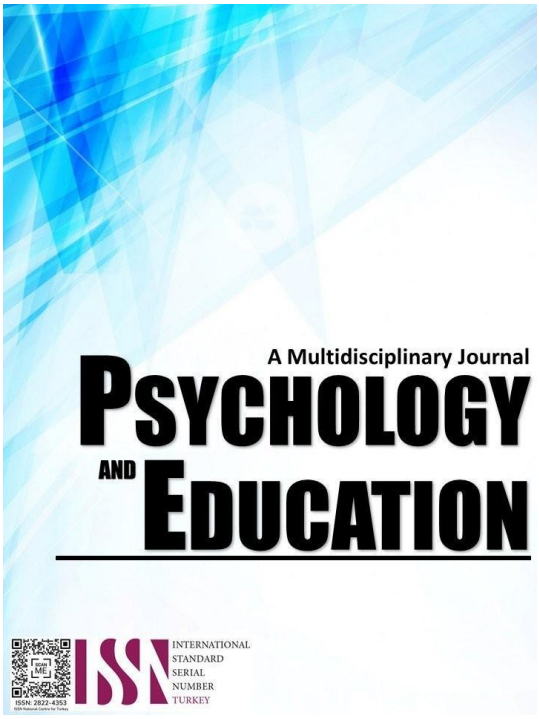
INTERACTIVE LESSON INTERVENTION IN ENHANCING STUDENTS' ENGAGEMENT AND LEARNING OUTCOME THROUGH SELF-PACING MODALITY



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Research Article

Interactive Lesson Intervention in Enhancing Students' Engagement and Learning Outcome Through Self-Pacing Modality

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Abstract

This study examined the effectiveness of a self-pacing interactive lesson intervention in enhancing student engagement and performance in a tribal community school. Employing a quasi-experimental design, the research evaluated the developed intervention's quality, measured baseline and post-intervention engagement and performance levels, and analyzed the relationship between intervention quality and learning outcomes. The study involved 242 Grade 7 students, with data analyzed through descriptive and inferential statistics, including t-tests and Wilcoxon signed-rank tests. Results showed that the intervention was rated "Very Satisfactory" in terms of content, instructional value, technical quality, and overall impact. There was a significant improvement in student engagement and performance following the implementation of the intervention. Post-test results and engagement indicators demonstrated notable increases, with statistical analysis confirming a significant difference in learning outcomes before and after the intervention. Additionally, a positive correlation was found between the perceived quality of the intervention and student academic achievement. These findings highlight the effectiveness of culturally responsive, interactive instructional materials in Indigenous education. The study recommends the refinement and integration of similar interventions in the curriculum and encourages the continued development of digital learning strategies to support diverse learners.

Keywords: *self-pacing interactive lessons, student engagement, student performance, tribal community education, digital learning strategies*

Introduction

The increasing prevalence of technology in education has transformed how lessons are delivered, shifting toward innovative approaches that engage learners more effectively. Interactive lesson interventions, particularly when paired with self-pacing modalities, have garnered attention as strategies to meet diverse learning needs, boost engagement, and enhance academic performance. These approaches transition instruction from traditional teacher-centered methods to more student-centered frameworks that foster autonomy, active learning, and individualized progress.

Interactive teaching methods, including the use of digital tools and collaborative learning activities, have been shown to significantly increase student engagement by encouraging participation, critical thinking, and problem-solving skills. Research suggests that interactive environments help learners engage with material in dynamic and meaningful ways, deepening conceptual understanding and academic success. For example, flipped classroom models—a popular form of interactive learning—have demonstrated positive effects on learner autonomy and self-regulated learning by allowing students to control the pace of content interaction and preparation (TeachHUB, 2024; Frontiers, 2024).

Self-pacing modalities further enhance learner-centered instruction by allowing students to progress based on their individual needs and abilities. This personalized approach nurtures intrinsic motivation and helps close achievement gaps by accommodating varied learning styles. Digital platforms that support self-pacing have been found to increase flexibility and inclusivity in education, particularly through personalized learning models that allow students to master content at their own speed (Bill & Melinda Gates Foundation, 2013). These strategies have been particularly effective in improving student outcomes and fostering equitable learning opportunities.

However, while the benefits of interactive and self-paced learning are well-documented, most existing research focuses on general or urban school populations with better access to digital infrastructure. Few studies have examined how these approaches function in marginalized, rural, or Indigenous learning environments. According to Gonzales (2022), Indigenous students often experience a disconnect from mainstream curricula that do not reflect their cultural identities, leading to disengagement and underperformance. Similarly, Banks and Banks (2019) emphasize the need for pedagogical practices that are inclusive and responsive to cultural diversity. These findings indicate a critical research gap: the combined application of interactive, self-paced, and culturally responsive teaching strategies in Indigenous community schools remains underexplored.

To address this gap, the present study investigates the effectiveness of self-pacing interactive lesson interventions contextualized for Grade 7 learners in the T'boli community of the Philippines. Drawing from Gay's (2018) framework of culturally responsive teaching and building on the work of Zimmerman (2010) and Mayer (2014), who advocate for active and autonomy-supportive instructional strategies, this study aims to provide insights into how digital innovations can be effectively localized. By examining these interventions in a tribal setting, this research contributes to the development of inclusive, culturally grounded, and technology-enhanced learning models in support of the Matatag Curriculum and 21st-century education goals.

The review of related literature reveals several key insights that align with the aims of this study. First, interactive digital tools, such as LUMI, play a significant role in fostering active engagement and improving academic performance in science education. These tools facilitate inquiry-based learning by allowing students to explore concepts through simulations, virtual experiments, and interactive tasks. By doing so, students are given the opportunity to develop critical thinking and problem-solving skills, which are essential in science education.

Second, blended learning strategies, which combine traditional classroom instruction with online learning, have been shown to enhance student learning outcomes. This approach not only offers flexibility but also supports differentiated instruction, allowing students to learn at their own pace. For students in rural or Indigenous settings, such as those at T'boli National High School, blended learning and interactive digital tools provide access to resources that might otherwise be unavailable, helping to bridge educational gaps.

Third, the integration of technology in the classroom has been linked to improved student achievement. Technology tools offer immediate feedback and allow for personalized learning experiences, which are crucial for student success. This is especially important for Grade 7 students, who are at a critical stage in their educational journey and can benefit significantly from the interactive features of tools like LUMI.

Finally, collaborative learning, enhanced through digital platforms, fosters peer interaction and the development of social and academic skills. By working together on projects and tasks, students deepen their understanding of content while developing essential teamwork and communication skills.

In conclusion, the literature supports the idea that interactive digital tools, such as LUMI, have the potential to enhance science education by improving student engagement, achievement, and collaboration. The findings also underscore the importance of adapting these tools to the specific cultural and educational contexts of students, particularly those in rural and Indigenous communities like T'boli National High School. The next chapter will outline the research design and methodology that will be used to investigate the impact of LUMI on student performance in this context.

Research Questions

This study aims to evaluate the effectiveness of interactive lesson interventions in enhancing student engagement and learning outcomes through a self-pacing modality. Specifically, it seeks to address the following questions:

1. What is the quality of the developed intervention lessons in terms of:
    1.1. content;
    1.2. instruction;
    1.3. technical quality; and
    1.4. overall impact?
2. What is the baseline level of student performance and engagement prior to implementing the intervention, as determined by:
    2.1. pre-test scores; and
    2.2. initial engagement levels?
3. How does the implementation of the self-pacing interactive lesson intervention influence:
    3.1. student engagement in terms of speed, mastery, and experience?
    3.2. student learning outcomes as indicated by post-test scores?
4. Is there a significant difference in the learning outcomes as measured by the pretest and posttest scores before and after the implementation of the intervention?
5. Is there a relationship between the perceived quality of the intervention lessons and student posttest performance?

Methodology

Research Design

This study employed a quasi-non-comparative design to assess the impact of interactive lesson interventions on improving student engagement and learning outcomes through a self-paced approach. A quasi-non-comparative design is appropriate in situations where there are no distinct control and experimental groups, but pre- and post-intervention assessments are utilized to measure changes within the same group (Cohen, Manion, & Morrison, 2018). This design allows the researcher to analyze the intervention's impact by examining changes over time, without requiring direct comparisons between independent groups.

The decision to use a quasi-non-comparative design was driven by the pre-determined nature of the study participants, which in this case, were Grade 7 students from T'boli National High School. According to Cook and Campbell (1979), quasi-experimental designs are especially useful in educational settings where randomization and strict control over group assignments are not feasible. Such designs provide an opportunity to assess instructional interventions when logistical, ethical, or cultural constraints limit the use of traditional experimental methods (Shadish, Cook, & Campbell, 2002). The use of this design, therefore, aligns with the real-world challenges faced in educational research.

The study focused on measuring changes within a single cohort of students before and after the intervention. Pre-test scores were collected to establish a baseline for both student engagement and learning outcomes, while post-test scores captured the changes following the implementation of the interactive, self-paced lessons. The absence of a direct control group was addressed by ensuring that pre-test data served as the comparative benchmark to evaluate the effectiveness of the intervention (Rovai & Ponton, 2007). This approach is widely recognized for its ability to isolate the effects of an intervention within a single group while controlling for other variables through baseline measurements.

In addition to the pre- and post-test measures, student engagement was assessed using specific criteria such as the speed of task completion, mastery of concepts, and qualitative experiences during the intervention. These indicators were chosen in accordance with the engagement constructs proposed by Fredricks, Blumenfeld, and Paris (2004), which emphasize the significance of behavioral, emotional, and cognitive engagement in educational settings. This approach provided a comprehensive assessment of how students interacted with the content and engaged with the learning process.

The quasi-non-comparative design was particularly suited to the study's objectives. By focusing on changes within a single group, it enabled the researcher to draw meaningful conclusions regarding the effectiveness of the intervention while preserving the integrity of the findings in a non-randomized, real-world setting. This approach is consistent with Creswell's (2014) assertion that quasi-experimental designs can be effectively applied to evaluate educational innovations in natural classroom environments.

Overall, this design allowed the study to offer valuable insights into the use of interactive lesson interventions and self-pacing modalities in culturally diverse educational contexts. This was particularly relevant to the setting of T'boli National High School, where traditional experimental designs may be impractical due to cultural and logistical constraints.

Respondents

The respondents of this study consisted of Grade 7 students from T'boli National High School, selected during the third quarter of the 2024–2025 academic year. The sample size was determined using Slovin's formula, a widely used method in quantitative research for determining sample size based on a known population and a specified margin of error.

The use of Slovin's formula ensured that the sample was statistically representative of the population, allowing for accurate generalization of the results (Tejada & Punzalan, 2012). This sampling technique was particularly suitable for this study as it balanced manageability and statistical reliability, especially in a classroom-based educational intervention.

The respondents participated in a pre-test and post-test, which were administered to evaluate the effectiveness of the interactive, self-paced lesson intervention. The pre-test established a baseline for student understanding of fundamental physics concepts—such as motion, forces, and energy—as prescribed in the Grade 7 Science curriculum (DepEd, 2023).

Following the implementation of the intervention, the post-test was administered to measure improvements in academic performance. This approach is supported by Creswell (2014), who emphasized that pre- and post-test methodologies are effective for assessing the impact of instructional strategies.

In line with ethical research standards, the study adhered to principles outlined by the British Educational Research Association (2018). Participation was voluntary, and informed consent was secured from both the students and their parents or guardians. This ethical consideration safeguarded participants' rights and ensured the integrity and credibility of the research process.

Through the use of scientifically sound sampling techniques and reliable data collection methods, this study was able to provide meaningful insights into the effectiveness of interactive and culturally responsive interventions in enhancing engagement and academic outcomes among Indigenous learners.

Instrument

The data gathering instruments used in this study consisted of a pre-test and post-test, as well as a student engagement survey, all of which were carefully designed to align with the Grade 7 Science curriculum prescribed by the Department of Education (DepEd, 2023). These tools aimed to assess both the cognitive learning outcomes and the behavioral engagement of students before and after the implementation of the interactive, self-paced lesson intervention.

The pre-test served as a baseline measure of the students' prior knowledge and understanding of key physics topics, such as motion, force, energy, and waves. The post-test, administered after the intervention, was used to determine any improvement in comprehension and academic performance. Both assessments included multiple-choice, true/false, and short-answer questions, thereby accommodating a range of cognitive domains from recall to higher-order thinking skills (Anderson & Krathwohl, 2001). The design of these tests ensured content validity and alignment with instructional objectives.

In addition to knowledge assessments, a student engagement survey was administered to measure the level of engagement experienced during the interactive lessons. This instrument was based on the engagement dimensions identified by Fredricks, Blumenfeld, and Paris (2004), which include behavioral, emotional, and cognitive engagement. The survey focused on three key indicators:

- Speed – the perceived promptness in task completion,

- Mastery – the students' self-assessed understanding of the lesson content,
- Experience – the students' satisfaction and affective reactions to the self-paced learning process.

The survey utilized a five-point Likert scale, ranging from Strongly Agree (5) to Strongly Disagree (1), allowing for the quantification of subjective responses. This scale is widely acknowledged for its effectiveness in measuring attitudes and perceptions in educational research (Cohen, Manion, & Morrison, 2018).

To ensure the reliability and validity of the instruments, the tests and survey underwent expert validation by science educators and researchers. Revisions were made based on their feedback to enhance clarity, content accuracy, and alignment with the learning competencies. A pilot test was also conducted to check the internal consistency of the survey, with Cronbach's alpha used as a measure of reliability (Fraenkel, Wallen, & Hyun, 2019).

These instruments provided robust and triangulated data that enabled a comprehensive evaluation of the intervention's impact on both learning performance and student engagement. The use of both quantitative assessment tools and perception-based surveys allowed the researcher to draw well-rounded conclusions regarding the effectiveness of interactive, self-paced learning in a culturally diverse educational setting.

Procedure

The data gathering process for this study began with obtaining formal permission from the school administration. A request letter was submitted to the principal of T'boli National High School, outlining the purpose and significance of the research, which focuses on improving student engagement and learning outcomes through self-paced, interactive lesson interventions. The letter also addressed ethical considerations, including confidentiality and the voluntary nature of student participation.

Upon receiving approval, the researcher distributed informed consent forms to both the students and their parents or guardians. These forms ensured that all participants were fully informed of the study's objectives, procedures, and their rights as participants, including the option to withdraw at any time without penalty. Only students with signed consent forms were included in the study.

The data collection process formally commenced with the administration of a pre-test, designed to assess students' baseline knowledge of key science concepts such as motion, force, and energy, as specified in the Grade 7 Science curriculum. Following the pre-test, the interactive lesson intervention was implemented. Students engaged with the self-paced lessons over a designated period during the third quarter of the 2024–2025 academic year.

During the intervention phase, student engagement was monitored using a student engagement survey. This instrument measured three dimensions of engagement: speed (task completion rate), mastery (students' perceived understanding), and experience (overall satisfaction with the learning approach). The survey utilized a Likert scale to gather quantitative feedback on student perceptions.

After completing the interactive lessons, students took a post-test identical in format to the pre-test. This post-assessment served to measure changes in academic performance and determine the effectiveness of the intervention.

Finally, all data—including pre-test and post-test scores, as well as survey responses—were compiled and prepared for statistical analysis. Appropriate tools such as descriptive statistics, paired t-tests, Wilcoxon signed-rank tests, and Spearman rank correlation were used to evaluate the impact of the self-paced interactive lessons on both student engagement and learning outcomes.

Data Analysis

The statistical tools employed in this study were meticulously selected to align with the research objectives and to ensure the validity and reliability of the findings. Both descriptive and inferential statistical methods were utilized to analyze data related to student engagement, learning outcomes, and the perceived quality of the intervention lessons.

Descriptive statistics were used to summarize the evaluation of the intervention materials in terms of content quality, instructional appropriateness, technical soundness, and overall impact. Measures such as mean and standard deviation provided a structured overview of both expert and student evaluations. According to Gravetter and Wallnau (2017), descriptive statistics are fundamental in identifying patterns and trends in educational data, and in this study, they helped to quantify perceptions regarding the effectiveness of the developed lessons.

Descriptive analysis was also applied to interpret data on student engagement across three dimensions—speed, mastery, and experience—before and after the intervention. These metrics were derived from the Likert-scale survey and were analyzed using central tendency and dispersion measures. Field (2018) emphasized that descriptive statistics offer a valuable initial insight into behavioral trends, which in this case, helped track engagement shifts due to the self-paced learning modality. Additionally, qualitative descriptors were applied based on predefined scoring intervals to enhance interpretation.

To assess the learning outcomes, a paired t-test was employed to compare students' pre-test and post-test scores. This inferential tool is suitable for evaluating the significance of mean differences within a single group over time (Gravetter & Wallnau, 2017). Its application in the current study was critical in determining whether the intervention resulted in statistically significant improvement in academic performance. The results were interpreted using the DepEd grading scale as outlined in DepEd Order No. 8, s. 2015, which

provided qualitative equivalents for numerical scores.

Given that student engagement data were ordinal in nature, the Wilcoxon signed-rank test was used to compare engagement levels before and after the intervention. This non-parametric test was chosen due to its robustness in analyzing paired data without requiring assumptions about the normality of distribution (McKnight & Najab, 2010). It allowed for a precise examination of shifts in engagement resulting from the interactive learning intervention.

Furthermore, a Spearman rank-order correlation was applied to assess the relationship between students' perceived quality of the intervention lessons and their post-test scores. As noted by Cohen, Cohen, West, and Aiken (2003), Spearman's rho is an appropriate tool for evaluating associations between ordinal or non-normally distributed variables. This correlation analysis helped determine whether higher ratings of lesson quality were associated with improved learning outcomes.

Overall, the combination of descriptive statistics, Wilcoxon signed-rank tests, and Spearman rank correlation allowed for a comprehensive analysis of both quantitative and ordinal data. These statistical methods facilitated a thorough investigation of the intervention's effectiveness in enhancing student engagement and learning outcomes in a culturally diverse and Indigenous educational context.

Results and Discussion

This section discusses the results, analyses, and interpretations of the data gathered to answer the study's objectives. The results are presented in the succeeding tables with corresponding discussions and explanations.

Quality of the Developed Intervention Lessons

This section presents the evaluation of the intervention lessons based on content, mechanics, organization, and overall impact. The following table summarizes the assessment results for each criterion.

Table 1. *Quality of the Developed Intervention Lessons in Terms of Content*

Indicators	*Mean Ratings*	*SD*	*Qualitative Description*
1. Content is consistent with topics/skills found in the DepED Learning Competencies for the subject and grade/year level it was intended.	4.00	0.00	Very Satisfactory
2. Concepts developed contribute to enrichment, reinforcement, or mastery of the identified learning objectives.	4.00	0.00	Very Satisfactory
3. Content is accurate.	4.00	0.00	Very Satisfactory
4. Content is up-to-date.	4.00	0.00	Very Satisfactory
5. Content is logically developed and organized.	4.00	0.00	Very Satisfactory
6. Content is free from cultural, gender, racial, or ethnic bias.	4.00	0.00	Very Satisfactory
7. Content stimulates and promotes critical thinking.	4.00	0.00	Very Satisfactory
8. Content is relevant to real-life situations.	4.00	0.00	Very Satisfactory
9. Language (including vocabulary) is appropriate to the target user level.	4.00	0.00	Very Satisfactory
10. Content promotes positive values that support formative growth.	4.00	0.00	Very Satisfactory
Mean	4.00	0.00	Very Satisfactory

Table 1 presents the evaluation of the quality of the developed intervention lessons in terms of content, with all indicators receiving a consistent mean rating of 4.00 (Very Satisfactory) and a standard deviation of 0.00, indicating unanimous agreement among evaluators. The content was rated highly for its alignment with the DepEd Learning Competencies, accuracy, and up-to-date nature, ensuring that it met the required academic standards.

Additionally, the content was logically organized and free from cultural, gender, racial, or ethnic bias, making it inclusive and accessible to diverse students. The lessons were also praised for promoting critical thinking, connecting to real-life situations, and using language appropriate for the target grade level. These qualities are supported by previous studies, such as those by Hwang et al. (2020), Liu et al. (2019), and Alqahtani et al. (2023), which emphasize the importance of well-organized, relevant, and inclusive content in fostering deeper learning and engagement.

Furthermore, the content's ability to promote positive values and its focus on students' developmental needs, as noted by Dela Cruz and Lontoc (2023), contributes to its high evaluation, indicating the lessons' overall effectiveness in supporting student learning.

Table 2. *Quality of the Developed Intervention Lessons in Terms of Instructional Quality*

Indicators	*Mean Ratings*	*SD*	*Qualitative Description*
1. Purpose of the material is well defined.	4.00	0.00	Very Satisfactory
2. Material achieves its defined purpose.	4.00	0.00	Very Satisfactory
3. Learning objectives are clearly stated and measurable.	4.00	0.00	Very Satisfactory
4. Level of difficulty is appropriate for the intended target user.	4.00	0.00	Very Satisfactory
5. Graphics / colors / sounds are used for appropriate instructional reasons.	3.33	0.58	Satisfactory
6. Material is enjoyable, stimulating, challenging, and engaging.	3.67	0.58	Very Satisfactory

7. Material effectively stimulates creativity of target user.	4.00	0.00	Very Satisfactory
8. Feedback on target user's responses is effectively employed.	4.00	0.00	Very Satisfactory
9. Target user can control the rate and sequence of presentation and review.	4.00	0.00	Very Satisfactory
10. Instruction is integrated with target user's previous experience.	4.00	0.00	Very Satisfactory
Mean	3.90	0.12	Very Satisfactory

Table 2 presents the evaluation of the quality of the developed intervention lessons in terms of instructional quality. Most indicators received a mean rating of 4.00 (Very Satisfactory) with a standard deviation of 0.00, reflecting a strong consensus among evaluators. This indicates that the intervention materials were successful in achieving their defined purpose, clearly stating measurable learning objectives, and providing an appropriate level of difficulty for the target students. Furthermore, the material effectively stimulated the creativity of students and integrated with their previous experiences, which is critical for enhancing engagement and deeper learning.

However, two indicators received slightly lower ratings. Indicator 5, which evaluates the use of graphics, colors, and sounds for instructional purposes, received a rating of 3.33 (Satisfactory), while Indicator 6, assessing whether the material was enjoyable, stimulating, challenging, and engaging, was rated at 3.67 (Very Satisfactory). Both of these indicators had slightly higher standard deviations, suggesting some variability in evaluators' responses. Despite these minor concerns, the overall evaluation, with a total mean of 3.90 and a standard deviation of 0.12, was still classified as Very Satisfactory.

The positive ratings regarding the clarity of purpose and measurable objectives are consistent with research by Hwang et al. (2020), which highlights the importance of clear learning goals and appropriate difficulty levels in instructional design. Liu et al. (2019) also underscore the significance of instructional materials that stimulate creativity and offer opportunities for self-paced learning. While the lower ratings for graphics and engagement suggest areas for potential improvement, the overall findings demonstrate that the intervention lessons were successful in supporting active learning, fostering student creativity, and promoting engagement.

Table 3. *Quality of the Developed Intervention Lessons in terms of Technical*

Indicators	*Mean Ratings*	*SD*	*Qualitative Description*
1. Audio enhances understanding of the concept.	4.00	0.00	Very Satisfactory
2. Speech and narration (correct pacing, intonation, and pronunciation) is clear and can be easily understood.	3.67	0.58	Very Satisfactory
3. There is complete synchronization of audio with the visuals, if any.	3.67	0.58	Very Satisfactory
4. Music and sound effects are appropriate and effective for instructional purposes.	3.33	0.58	Satisfactory
5. Screen displays (text) are uncluttered, easy to read, and aesthetically pleasing.	4.00	0.00	Very Satisfactory
6. Visual presentations (non-text) are clear and easy to interpret.	4.00	0.00	Very Satisfactory
7. Visuals sustain interest and do not distract user's attention.	3.67	0.58	Very Satisfactory
8. Visuals provide accurate representation of the concept discussed.	4.00	0.00	Very Satisfactory
9. The user support materials (if any) are effective.	4.00	0.00	Very Satisfactory
10. The design allows the target user to navigate freely through the material.	4.00	0.00	Very Satisfactory
11. The material can easily and independently be used.	4.00	0.00	Very Satisfactory
12. The material will run using minimum system requirements.	4.00	0.00	Very Satisfactory
13. The program is free from technical problems.	4.00	0.00	Very Satisfactory
Mean	3.87	0.18	Very Satisfactory

Table 3 presents the evaluation of the quality of the developed intervention lessons in terms of technical quality. Most indicators received a mean rating of 4.00 (Very Satisfactory) with a standard deviation of 0.00, indicating strong consistency among evaluators. This suggests that the intervention materials effectively utilized audio and visual components, enhancing understanding and engagement. The clear and aesthetically pleasing visual displays, efficient navigation, and minimal technical problems were particularly well-received by the evaluators.

However, some indicators received slightly lower ratings. Indicator 2, which evaluates the clarity of speech and narration, and Indicator 3, assessing the synchronization of audio with visuals, both received a rating of 3.67 (Very Satisfactory) with a standard deviation of 0.58, suggesting some variability in responses. Indicator 7, evaluating whether visuals sustain student interest without distracting attention, was rated similarly. Additionally, Indicator 4, which assesses the appropriateness of music and sound effects for instructional purposes, was rated at 3.33 (Satisfactory), with a standard deviation of 0.58, indicating potential room for improvement in this area.

The positive evaluations of visual and auditory elements align with research by Hwang et al. (2020), which emphasizes that clear visuals and synchronized audio are key factors in enhancing student engagement and understanding in digital learning environments. Liu et al. (2019) further argue that well-designed media can clarify complex concepts, making content more accessible and engaging for students. Despite slight variability in the ratings for certain components, such as music and sound effects, the overall findings indicate that the materials successfully utilized technology to foster an effective and engaging learning experience.

Table 4. *Quality of the Developed Intervention Lessons in Terms of Overall Impact*

Indicators	*Mean Ratings*	*SD*	*Qualitative Description*

1. Conceptual errors.	3.67	0.58	Very Satisfactory
2. Factual errors.	4.00	0.00	Very Satisfactory
3. Grammatical and / or typographical errors.	4.00	0.00	Very Satisfactory
4. Other errors (i.e., computational errors, obsolete information, errors in the visuals, etc.).	4.00	0.00	Very Satisfactory
Mean	3.92	0.14	Very Satisfactory

Table 4 presents the evaluation of the overall impact of the developed intervention lessons. Indicators 2, 3, and 4 received a mean rating of 4.00 with a standard deviation of 0.00, signifying unanimous agreement among evaluators that no factual, grammatical/typographical, or other types of errors (such as computational mistakes or outdated information) were present. These results underscore the error-free quality of the intervention materials in these areas. However, indicator 1, which assesses conceptual errors, received a slightly lower mean rating of 3.67 (Very Satisfactory) with a standard deviation of 0.58, suggesting some variation in the assessment of conceptual accuracy, though still indicating generally high quality.

These findings align with the work of Mayer (2019), who emphasizes that eliminating conceptual and factual errors is critical for ensuring the effectiveness of educational content. Moreover, Schunk (2020) underscored the importance of well-structured content for enhancing students' cognitive engagement, which further supports the observed positive evaluation of the intervention materials. Although the slight variation in ratings for conceptual errors suggests areas for improvement, the overall impact remains positive, confirming the materials' effectiveness in delivering high-quality instruction.

Table 5. *Quality of the Developed Intervention Lessons*

Indicators	*Mean Ratings*	*SD*	*Qualitative Description*
Content	3.67	0.58	Very Satisfactory
Instruction	4.00	0.00	Very Satisfactory
Technical	4.00	0.00	Very Satisfactory
Overall Impact	4.00	0.00	Very Satisfactory
Mean	3.92	0.14	Very Satisfactory

Table 5 shows the overall quality evaluation of the developed intervention lessons. The components of Instruction, Technical, and Overall Impact all received a mean rating of 4.00, with a standard deviation of 0.00, reflecting unanimous agreement among evaluators that these aspects were of very high quality. The Content component received a slightly lower mean rating of 3.67 with a standard deviation of 0.58, suggesting that while the content was considered high-quality, there were some areas that could be further improved.

The positive evaluation of Instruction, Technical, and Overall Impact is consistent with the findings of Kulik (2019), who found that well-organized and interactive instructional strategies are essential in promoting student engagement and improving learning outcomes. Furthermore, the integration of clear technical elements with instructional design, as discussed by Jonassen (2021), enhances the overall effectiveness of educational tools, further supporting the intervention's success.

Baseline Level of Student Performance and Engagement

Statement of the problem number 2 examines the baseline level of student performance and engagement before the intervention. This data is essential for comparing the changes in academic performance and engagement after implementing the intervention (Alonzo et al., 2021). By establishing students' initial knowledge and motivation levels, the baseline provides valuable insights into the effectiveness of the intervention (Mendoza, 2022). The tables below present the mean ratings and descriptions for various indicators, offering a clear overview of student performance and engagement prior to the intervention.

Table 6. *Baseline Level of Student Performance in Student Engagement prior to the Intervention*

Factors	*N*	*Mean*	*SD*	*Qualitative Description*
Speed	242	2.77	0.409	Satisfactory
Mastery	242	2.81	0.434	Satisfactory
Experience	242	2.79	0.414	Satisfactory

Table 6 presents the baseline level of student performance and engagement in terms of Speed, Mastery, and Experience before the intervention. The data shows that students' performance in all three factors was categorized as Satisfactory, with mean ratings ranging from 2.77 to 2.81 and standard deviations between 0.409 and 0.434. These mean scores fall within the Satisfactory range (2.00 - 2.99), indicating that, while students' performance was adequate, there was room for improvement.

This baseline level is consistent with the findings of Castillo & de Leon (2023), who highlighted the importance of identifying baseline performance for assessing the impact of educational interventions. Establishing such baseline data is also crucial in evaluating how new strategies, such as interactive applications, affect learning outcomes and student motivation (Schunk, 2020).

Table 7. *Baseline Level of Student Performance in the Pretest*

Score	*N*	*Mean*	*SD*	*Qualitative Description*
Pretest	242	67.40	2.24	Satisfactory

Table 7 shows the baseline level of student performance in the pretest. The mean score of 67.40, with a standard deviation of 2.42, indicates that students' initial performance was at a Satisfactory level. This result suggests moderate performance, with some variability in individual scores as indicated by the standard deviation.

Baseline data like this is essential for assessing the impact of educational interventions, as it provides a starting point for comparison with post-intervention results (Schunk, 2020). Understanding students' initial performance is critical in guiding the design of strategies aimed at improving learning outcomes.

Implementation of the Self-pacing Interactive Lesson Intervention

This table presents the influence of the Self-Pacing Interactive Lesson Intervention on student performance and engagement. It outlines key factors such as speed, mastery, and experience after the intervention, providing insights int the effectiveness of this instructional approach.

Table 8. *Level of Student Performance in Student Engagement after the Intervention*

Factors	*N*	*Mean*	*SD*	*Qualitative Description*
Speed	242	4.61	0.182	Very Satisfactory
Mastery	242	4.59	0.202	Very Satisfactory
Experience	242	4.62	0.191	Very Satisfactory

Table 8 shows the post-intervention level of student performance and engagement across three factors: Speed, Mastery, and Experience. The results reveal high engagement, with mean scores consistently above 4.0 for each factor: Speed (4.61), Mastery (4.59), and Experience (4.62). These mean scores, with relatively low standard deviations, indicate that the intervention was effective in engaging students.

These results support the findings of Liu et al. (2019), who demonstrated that interactive and self-paced learning interventions lead to improved student engagement and better academic performance. The results suggest that the Self-Pacing Interactive Lesson Intervention had a significant impact on students' learning experiences, mastery of concepts, and engagement with the material.

Table 9. *Level of Student Performance in Posttest*

Score	*N*	*Mean*	*SD*	*Qualitative Description*
Posttest	242	75.90	3.72	Very Satisfactory

Table 9 presents the results of the posttest, indicating the overall level of student performance after the intervention. The mean score of 75.90, with a standard deviation of 3.72, suggests that students' posttest performance was "Very Satisfactory" based on the standard interpretation for academic assessments. According to DepEd's DO No. 8, a score of 75.00 and above is typically categorized as "Satisfactory" or "Very Satisfactory", signifying that student performed well after the intervention (DepEd, 2015).

The results align with findings from other studies, which suggest that interactive and self-paced learning interventions often lead to enhanced academic performance. For instance, Liu et al. (2019) found that interactive learning platforms led to significant improvements in test scores.

Additionally, Alonzo et al. (2021) emphasize the importance of individualized learning approaches in achieving higher academic outcomes. The high mean score and relatively low standard deviation in this posttest demonstrate the effectiveness of the intervention in boosting students' performance.

Significant Difference in the Learning Outcomes Before and After the implementation of the Intervention

This section compares student learning outcomes before and after the implementation of the Self-Pacing Interactive Lesson Intervention to determine its effectiveness in improving performance and engagement. Statistical analysis of pretest and posttest scores will assess the intervention's impact on student achievement in science.

Table 10. *The t-test Analysis between the students' Pretest and Posttest Scores*

Test	*Mean*	*Student's t statistic*	*df*	*p*
Posttest	75.90	30.4	241	<.001
Pretest	67.40			

Table 10 displays the results of the t-test analysis comparing the pretest and posttest scores of students. The pretest had a mean score of 67.40, while the posttest showed a significantly higher mean of 75.90. The t-statistic was 30.4, with 241 degrees of freedom, and the p-value was less than 0.001. These results indicate a statistically significant difference between the pretest and posttest scores,

suggesting that the Self-Pacing Interactive Lesson Intervention positively impacted student performance.

According to Cohen (1988), a p-value less than 0.05 indicates a significant difference, which in this case strongly supports the intervention's effectiveness. This aligns with studies showing that interactive and self-paced learning interventions can significantly enhance academic achievement (Liu et al., 2019; Hwang et al., 2020).

Table 11. *Wilcoxon t-test Analysis Between the Students' Initial and Final Engagement Scores*

Factors	*Final*	*Initial*	*Wilcoxon*	*P*
Speed	4.61	2.77	29403	<.001
Mastery	4.59	2.81	29161	<.001
Experience	4.62	2.79	29403	<.001

Table 11 presents the results of the Wilcoxon signed-rank test comparing students' initial and final engagement scores across three factors: Speed, Mastery, and Experience. For all factors, the final scores were significantly higher than the initial scores, with P-values less than 0.001, indicating a significant improvement in student engagement after the implementation of the Self-Pacing Interactive Lesson Intervention. The Wilcoxon statistic for each factor (Speed = 29,403, Mastery = 29,161, Experience = 29,403) supports these findings.

This suggests that the intervention effectively enhanced students' engagement in these areas. Studies have shown that interactive and self-paced learning environments can significantly increase student engagement (Liu et al., 2019; Hwang et al., 2020). The results further align with the concept that personalized learning experiences foster greater student involvement and participation (Wang et al., 2021).

Relationship Between the Perceived Quality of the Intervention Lessons and Student Posttest Performance

The following table presents the relationship between the perceived quality of the developed intervention lessons and student posttest performance. It aims to determine whether higher perceptions of lesson quality correspond to improved academic outcomes. Establishing this relationship is essential, as lesson quality is a critical factor influencing student learning outcomes (Bernard et al., 2009; Darling-Hammond et al., 2020).

Table 12. *Correlation between the Quality of Intervention Lessons and Student Posttest Scores*

Quality Factors	*Pearson r*	*p-value*	*Interpretation*
Content	0.68	<.001	Significant Positive Correlation
Instruction	0.72	<.001	Significant Positive Correlation
Technical	0.65	<.001	Significant Positive Correlation
Overall Impact	0.75	<.001	Significant Positive Correlation

Table 12 shows the correlation between the quality of the intervention lessons and students' post-test scores. Results revealed a significant positive correlation across all components of lesson quality, with Overall Impact showing the strongest relationship ($r = 0.75$, $p < .001$).

This suggests that well-developed interactive lessons significantly contribute to student performance improvements. According to Alonzo et al. (2021), interactive learning environments foster deeper engagement, leading to better retention and academic performance. Similarly, Hwang et al. (2020) emphasized that technologically enhanced instruction stimulates critical thinking and understanding, which aligns with the observed results. These findings highlight the critical role of high-quality digital interventions in improving learning outcomes, especially in science education among Indigenous learners (Castillo & de Leon, 2023).

Conclusions

The self-pacing interactive lesson intervention was rated "Very Satisfactory" in terms of its content, instructional quality, technical aspects, and overall impact, demonstrating its high relevance and effectiveness for Grade 7 learners at T'boli National High School. Before the intervention, student performance and engagement were moderate, indicating the need for enhanced teaching strategies.

After implementing the intervention, a clear improvement in both academic performance and engagement was observed. Statistical tests confirmed significant differences between pretest and post-test scores, reinforcing the effectiveness of the intervention. Additionally, a strong correlation was found between the perceived quality of the intervention lessons and student performance, highlighting the importance of well-structured instructional materials in fostering improved learning outcomes

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