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Improving Grade 5 Learners' Reading Comprehension Skills through TechPlay Fusion Strategy

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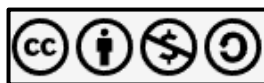
Abstract

The Grade 5 Philippine Informal Reading Inventory Assessment conducted in 2023 revealed that out of a population of 204 learners, 61 were categorized as experiencing frustration, as they showed withdrawal from reading situations by refusing to read. These results clearly demonstrate the extent to which learners in the Philippines struggle with reading comprehension. Through this, the researchers conducted this research to be part of the solution regarding reading comprehension of Grade 5 learners. The present study employed quasi-experimental quantitative research design to improve the reading comprehension skills of Grade 5 learners in an elementary school through the TechPlay Fusion strategy - a dynamic teaching approach that blends technology and interactive games to make reading more engaging, and help students improve comprehension, vocabulary, and retention. The respondents were two regular sections of the Grade 5 learners who agreed to attend the face-to-face classes during the third quarter of the school year 2023-2024. Based on the findings, Grade 5 learners attained satisfactory pre-test scores with a difference mean of 1.83, while the post test score went one step higher, from "Satisfactory" to "Very Satisfactory" ratings with a mean difference of 2.41. Based on the significant findings of the study, the strategy is an effective, useful and relevant strategy in improving the Grade 5 learners' reading comprehension. The TechPlay Fusion Strategy assists not only the learners' comprehension but also the learners' vocabulary and retention.

Keywords: *Grade 5 Learners, Phil-IRI Assessment, Quasi-Experimental Research, Reading Comprehension, TechPlay Fusion Strategy*

Introduction

Reading comprehension is the ability to understand and make sense of what you read. It involves going beyond just reading the words rather it involves understanding the meaning, connecting ideas, and analyzing the text. In addition, reading comprehension plays a vital role in academic success, closely tied to overall performance. It enables learners to grasp concepts, enhance their vocabulary, and foster critical thinking skills (Suson et. al., 2020). Thus, it forms the foundation for future learning across the curriculum, and without it, learners may struggle academically in various subjects, including English studies, Sciences, Mathematics, and even Social Studies (Requiso-Jimenez & Bascos-Ocampo, 2022).



The recent 2023 Programme for International Student Assessment (PISA) results found that in the Philippines, only 24% of learners achieved Level 2 or higher proficiency in reading. At this level, learners can identify main ideas, look at data based on factual evidence, and reflect on the given text as presented. This result may be significantly lower than the OECD average of 74%. In the Philippines, notably no recorded learner scored higher than level 5 in reading based on the OECD result average of 7%, indicating a lack of proficiency in comprehending lengthy texts, dealing with abstract concepts, and distinguishing between proper ideas and opinionated assumptions.

The Grade 5 Philippine Informal Reading Inventory (Phil-IRI) Assessment conducted at Pinaod Central School in 2023 revealed significant insights into the reading capabilities of its 204 learners. Specifically, 61 students were identified as experiencing frustration, as evidenced by their withdrawal from reading activities and refusal to engage in reading tasks. Conversely, 89% of the learners were classified at the instructional level, suggesting that they could benefit from targeted instructional support. Only 54 students were categorized as independent readers, capable of reading without assistance. These assessment findings underscore the challenges faced by learners in the Philippines regarding reading comprehension.

Reading comprehension challenges have persisted despite various teaching methods and strategies being employed. Recent studies reveal that, even with government initiatives aimed at improving literacy in the Philippines, Filipino learners continue to face difficulties in reading comprehension (Idulog et al., 2023). Evidence suggests that learners' reading comprehension skills are indeed low and require significant improvement, which is a serious concern. Compe (2018) noted that while many learners struggle with English reading comprehension, their overall academic performance is improving. This highlights a strong correlation between reading comprehension abilities and success in other academic areas. A deficiency in reading comprehension adversely affects academic achievement in English and other subjects. Additionally, Nanda (2020) pointed out that low reading comprehension skills can lead to negative consequences, such as diminished learning outcomes, impaired problem-solving abilities, and limitations in future educational and career opportunities.

The TechPlay Fusion Strategy is a unique strategy that combines Technology-Based Learning and Game-Based Learning as it utilizes the power of technology and the engaging nature of games simultaneously in aiming to enhance the reading comprehension abilities of Grade 5 learners. With "Tech" representing Technology-Based Learning and "play" representing Game-Based Learning, this fusion strategy aims to create a dynamic and effective learning experience for the learners. According to the study of Iyake, James, and Amonde (2018), they found that indeed there are positive effects of technology-based strategy for addressing reading comprehension. Meanwhile, Villacres and Rodriguez (2023) also discovered in their study that Game-based learning is advantageous for learners in enhancing their reading comprehension skills.

The researchers selected the TechPlay Fusion Strategy because it addresses a gap in conventional reading approaches by integrating technology and interactive games to enhance the learning experience. Many existing methods fail to fully engage students, particularly those who face challenges with reading. Evidence suggests that combining technology with gaming can increase student participation and improve performance. This study is distinctive in its innovative fusion of these elements specifically tailored for Grade 5 students at Pinaod Central School. Unlike other techniques that utilize either technology or games independently, TechPlay Fusion merges both to create a more captivating and effective means of enhancing reading comprehension.

Through this initiative, the researchers aimed to contribute to the improvement of reading comprehension among Grade 5 English learners. Consequently, the study concentrated on the TechPlay

Fusion Strategy as a classroom approach to bolster the reading comprehension abilities of these students at Pinaod Central School. The research sought to evaluate whether this proposed strategy would enhance the reading comprehension skills of Grade 5 learners. It specifically aimed to describe the reading comprehension abilities of these learners prior to the implementation of the strategy, assess their skills following the strategy's implementation, and determine if there was a significant difference between the pre-test and post-test scores of both the control and experimental groups.

Materials and Methods

In this study, the researchers employed a quasi-experimental design to investigate the efficacy of a specific instructional strategy aimed at enhancing reading comprehension among Grade 5 learners. Unlike true experimental designs, which involve random assignment of participants to different groups (Harris et al., 2006), quasi-experimental designs compare outcomes between pre-existing or non-randomly assigned groups. This approach seeks to identify potential causal effects of the intervention.

The participants were divided into two groups: one group received the TechPlay Fusion strategy, which integrates technology and game-based learning, while the other group did not receive this intervention. The primary objective was to ascertain whether this innovative strategy would significantly influence learners' reading comprehension abilities. However, the researchers did not specify the activities or instructional methods employed by the control group, which is critical for understanding the comparative effectiveness of the TechPlay Fusion strategy. A detailed account of the control group's experiences would provide a clearer context for interpreting the impact of the intervention and allow for more precise conclusions.

During the implementation of the TechPlay Fusion strategy, the learners were observed for any improvements in engagement and participation. The researchers aimed to assess the extent of these improvements, indicating that the collected information was essential for measuring the quantitative outcomes of the intervention. The results of the quantitative data were presented in tabular format, accompanied by descriptive statistics and annotations to facilitate comprehension and interpretation of the findings.

The Grade 5 learners of Pinaod Central School, Division of Bulacan, served as the subjects of the study. In Grade 5, there are six sections: Special Science Class, and four regular sections. In conducting this study, the researchers identified the sections that required improvement in reading comprehension skills in English, and based on the observation and evidence (academic performance from their class advisers' class records), it implied that the sections that showed a low level of reading comprehension served as participants in this study are the learners among the two regular heterogeneous sections of Grade 5, which are 5-Mariano Llanera (the experimental group) and 5-Diego Silang (the control group). A total of 72 learners participated in the study.

The legal basis of this matter is pursuant to DepEd Order No. 16 s. 2017 and Republic Act No. 10173 that brought springboards to the ethical considerations of this study to exhibit fairness and confidentiality. The right to privacy of communication is being considered by virtue of ensuring the spread of information is hereby exercised, as the researchers sought parental permission to the guardians of the learners involved in this study. Moreover, researchers also provided a request form to be given to the school used in conducting their action research.

The researchers chose these two groups based on the outcomes of the Philippine Informal Reading Inventory (Phil-IRI) Assessment 2023. In order to avoid any bias in this study, the researchers decided to collect data from all five regular sections. The researchers found that the Mariano Llanera section had the lowest percentage with 58% or below and categorized as "Frustration" in reading

comprehension. Out of 36 learners in this section, 25 were classified as frustrated. The Diego Silang section had a similar pattern, with 21 out of 36 learners falling into the frustration category. On the other hand, the Pio Del Pilar section had the highest percentage, with only one out of 38 learners classified as having frustration in reading comprehension in English.

It was evident that the selected groups were facing challenges in comprehending certain questions related to English. The Grade 5 Mariano Llanera chosen as the experimental group was based on the observation that this particular section demonstrated a slightly lower average score compared to Grade 5 Diego Silang, which was consequently assigned as the control group.

This selection was made with the intention of investigating and implementing strategy to the experimental group, aiming to address the identified challenges or lower reading comprehension in English compared to the control group. The experimental group served as the focus for implementing the strategy, while the control group provided a baseline for comparison, allowing researchers to assess the effectiveness of the strategy employed.

The sampling method involved in the study is a type of non-probability sampling, which is the Purposive Sampling Method. This involves intentionally selecting informants based on their specific qualities. It is a nonrandom method that does not require any underlying theories or a predetermined number of informants. In essence, the researcher identified what information was needed and actively sought out individuals who possessed the knowledge or experience to provide that information (Klimova & Zamborova, 2020). Therefore, in this study, the researcher selected a sample from the population based on the Philippine Informal Reading Inventory (Phil-IRI) Assessment 2023 of Grade 5 in Pinaod Central School. The first two sections that had higher numbers of learners categorized as "Frustration" and scored 58% below in terms of their reading comprehension skills were the criteria applied in selecting respondents.

The TechPlay Fusion Strategy is an integrated approach inspired by two key innovators: Sweller's Cognitive Load Theory, which emphasizes the effective use of educational technology, and the principles of Game-Based Learning proposed by Piaget and Vygotsky. This strategy is grounded in the understanding that both technology-based and game-based learning can significantly enhance learners' reading comprehension skills. To implement this strategy, the researchers developed innovative and interactive games known as the "TechPlay Fusion Games." These games resemble a unique twist on a wheel of fortune, incorporating engaging elements designed to captivate learners. Features such as prizes, a TikTok dance, and customizable designs tailored to learners' interests were included to foster excitement, physical engagement, and personalization, ultimately aiming to improve reading comprehension skills in English (Hashemi, 2021).

The game commenced with the implementer spinning a small spinner to select a student for participation. The chosen student performed a brief TikTok dance before spinning the "TechPlay Wheel." This wheel featured a variety of superhero characters and celebrities. When the wheel came to a stop, a cartoon or celebrity was displayed on the screen along with its corresponding word. The learner had to articulate the word associated with the character they landed on and would then receive a prize. Afterward, the implementer prompted the rest of the class to repeat the word in a specific sequence. Finally, the spinner took another turn, spinning the TechPlay Wheel to determine who would participate next.

Additionally, pre-tests and post-tests were administered to the learners before and after the strategy was implemented. The following outlines the details of the strategy's implementation over one month during the third quarter of the academic year 2023-2024 at Pinaod Central School in San Ildefonso,

Bulacan. Initially, the researchers intended to test the TechPlay Fusion strategy over both the third and fourth quarters of the school year. However, due to various factors, the focus was narrowed to the third quarter, covering just one month. During this period, the experimental group engaged with the TechPlay Fusion strategy—a combination of technology and game-based learning—aimed at enhancing their reading comprehension skills. In contrast, the control group adhered to traditional instructional methods throughout the same timeframe.

While the initial plan was broader, focusing on just one grading period provided a snapshot of the strategy's impact. This approach helped with resource and time management, but it also limited the understanding of the strategy's long-term effects and how it measured up against the control group's approach.

This study used a validated 3rd Quarter periodical Assessment Test in English 5 SY. 2022-2023 that is adopted from the official website of DepEd teacher Club to gather data from the learners. This consisted of 50 items. The test is used to determine the level of reading comprehension of grade 5 learners in English in the cooperating school at Pinaod Central School. The result of the pre-test and post-test is graded using grading scale.

At Pinaod Central School, the researchers obtained the necessary permission and consent to conduct their study. Before commencing the discussion, they administered a pre-test that assessed students' prior knowledge of the topic. The proposed strategy was implemented over one month and consisted of four weekly lessons incorporating the TechPlay Fusion strategy:

- **Week 1:** "Distinguish among Various Types Based on Elements"
- **Week 2:** "Summarize Various Text Types Based on Elements"
- **Week 3:** "Make a Stand"
- **Week 4:** "Provide Evidence to Support Opinion/Fact"

Following each lesson, the teacher conducted a weekly assessment to determine improvements in the students' reading comprehension skills.

After the implementation of the proposed strategy, a post-test was administered. The researchers collected data throughout the four weeks, recording the participants' scores based on their pre-test and post-test results.

To ensure fairness and adhere to ethical considerations, the researchers followed the Department of Education (DepEd) Order No. 16, s. 2017, which outlines the Research Management Guidelines (RMG) for basic education research. These guidelines support the management of research initiatives and enhance mechanisms such as funding and partnerships.

Once all data were collected, appropriate analysis techniques were employed for interpretation and presentation. The data from the pre-test and post-test were subjected to a paired t-test, a parametric statistical tool used to determine whether there is a statistically significant difference between the two sets of data. This test effectively compares the differences between the pre-test and post-test scores, measuring the efficacy of the strategy. Each Grade 5 section's pre-test and post-test scores were compared individually. The researchers selected Grade 5 for its relevance to the study and the availability of the students during the research period. To ensure the effectiveness of the tools used, a small pilot run was conducted, followed by expert reviews to confirm that the instruments accurately measured the intended outcomes.

For data analysis, Microsoft Excel was utilized as the statistical software for analyzing the quantitative data. A line graph was created to visually represent whether the learners gained knowledge and improved their reading comprehension skills in English after implementing the strategy. The pre-test assessed the learners' prior knowledge and understanding of the lesson, while the post-test items indicated how the integration of the TechPlay Fusion strategy enhanced Grade 5 learners' reading comprehension skills and interest in the subject. All collected data were analyzed and securely maintained for the study.

Additionally, the study employed the following scoring system based on DepEd Guidelines:

- A score from 0 to 15 was categorized as "Did Not Meet Expectations."
- A score from 16 to 25 was labeled "Satisfactory."
- A score from 26 to 35 was considered "Very Satisfactory."
- A score from 36 to 50 was classified as "Outstanding."

Results and Discussion

Pre-test Results of the Control Group and Experimental Group

Table 1 presents the pre-test results for both the control and experimental groups, providing a snapshot of their reading comprehension levels before the intervention began. This comparison helps establish a baseline for evaluating the impact of the TechPlay Fusion strategy on the experimental group.

Table 1

Pre-test Results of the Control Group and Experimental Group

Range	Control Group		Experimental Group	
	Frequency	Percentage	Frequency	Percentage
36-50	4	11.12%	4	11.12%
26-35	9	25%	6	16.67%
16-25	14	38.89%	14	38.89%
0-15	9	25%	12	33.33%
Mean	18.72		16.89	
Verbal Interpretation	Satisfactory		Satisfactory	

Legend: Outstanding (36-50); Very Satisfactory (26-35); Satisfactory (16-25); Did Not Meet Expectation (0-15)

As exhibited in Table 1, the pre-test of the control group's results has a mean of 18.72 with a verbal interpretation of "Satisfactory" while the mean for the Experimental is 16.89 with a verbal interpretation of "Satisfactory". Moreover, based on the result, it went constant, from "Satisfactory" ratings with a mean difference of 1.83.

Based on the pre-test findings, it is implied that both groups started at relatively similar proficiency level and any disparities in the pre-test outcomes were attributed to inherent difference of the learners rather than instructional methodologies employed. The pre-test results showed that both groups started with similar reading skills, which means any differences that the researchers see later are more likely due to the individual learners rather than the teaching methods. This initial balance helps the researchers be more confident that any improvements observed are because of the TechPlay Fusion strategy itself, not just differences in the learners. So, if the researchers find significant gains in the experimental group, it would strongly suggest that the new strategy made a real difference (Alqahtani, 2020).

Post-test Results of the Control Group and Experimental Group

Table 2 shows the post-test results for the control and experimental groups, highlighting the changes in reading comprehension scores after the intervention. This table illustrates the effectiveness of the TechPlay Fusion strategy by comparing the final performance levels of both groups.

Table 2

Post-test Results of the Control Group and Experimental Group

Range	Control Group		Experimental Group	
	Frequency	Percentage	Frequency	Percentage
36-50	4	11.11%	9	25%
26-35	14	38.89%	12	33.33%
16-25	13	36.11%	15	41.67%
0-15	5	13.89%	0	0%
Mean	24.67		27.08	
Verbal Interpretation	Satisfactory		Very satisfactory	

Legend: Outstanding (36-50); Very Satisfactory (26-35); Satisfactory (16-25); Did Not Meet Expectation (0-15)

As exhibited in Table 2, the post-test results have a mean of 24.67 for the Control Group with a verbal interpretation of "Satisfactory" while the mean for the Experimental Group is 27.08 with a verbal interpretation of "Very Satisfactory." For the pre-test of the control group, the following percentages were generated: 13.89% (0-15), 36.11% (15-25), 38.89% (25-35) and 11.11% (35-50). Meanwhile, the experimental group recorded 41.67% (15-25), 33.33% (25-35), 25% (35-50) and no learners scored in the range of 0-15.

Moreover, based on the result, it went one step higher, from "Satisfactory" to "Very Satisfactory" ratings with a mean difference of 2.41. This implies that the TechPlay Fusion strategy implemented for the experimental group contributed to the improvement of learners' reading comprehension skills in comparison to the control group. There was a substantial improvement to the experimental group after the implementation of the proposed strategy. The TechPlay Fusion strategy led to a clear improvement in the experimental group's reading skills, moving their ratings from "Satisfactory" to "Very Satisfactory" with a mean difference of 2.41. This significant boost suggests that the strategy effectively enhanced their reading comprehension more than the control group's experience.

Likewise, Bondaug (2021) affirmed that learners could improve their reading comprehension skills through playing the games. Qualitative data from the student-users further described how the instructional material motivated them to take part in their learning as well as enable them to use different comprehension skills to achieve a high level of understanding in the selections they read.

This matches the findings of Nitiasih and Budiarta (2020), who found that using games based on Balinese local stories as a teaching method greatly improved Grade 5 students' reading skills. Their study also showed that adding games to the learning process helped boost the students' reading performance.

Meanwhile, based on the study of Alqahtani (2020), technology-based strategies have been applicable in improving learners' reading comprehension. While the study primarily focused on children facing reading challenges, the implications suggest potential benefits for Grade 5 learners in enhancing their reading comprehension abilities.

Significant Difference in Pre-test Results of the Control Group and Experimental Group

Table 3 displays the analysis of significant differences in pre-test results between the control and experimental groups. This table assesses whether there were any initial differences in reading comprehension levels before the intervention started.

Table 3

Significant Difference on Pre-test between 5 – Mariano Llanera (Control group) and 5- Diego Silang (Experimental Group)

	Mean	P-Value	Decision	Verbal Interpretation
Control Group	18.72			
Experimental Group	16.89	0.13	Accepted Ho	There is no significant difference

Legend: <0.05

As shown in Table 3, the test of significant difference on the pre-test between two groups (control and experimental) resulted in a p-value of 0.13, which is greater than the level of significance at 0.05. Therefore, the null hypothesis was not rejected. There is no significant difference between the pre-tests of the control and experimental groups. Since this p-value is greater than the 0.05 significance level, it failed to reject the null hypothesis. This means that, initially, both groups had similar reading comprehension levels before the intervention began.

The implication of this finding is that any changes observed later in the study can be more confidently attributed to the interventions applied rather than pre-existing differences between the groups. This helps us ensure that the improvements seen in the experimental group are likely due to the TechPlay Fusion strategy, rather than differences in skill levels that were present from the start.

Significant Difference on Post-test Results of the Control Group and Experimental Group

Table 4 presents the analysis of significant differences in post-test results between the control and experimental groups, evaluating the impact of the intervention on reading comprehension scores. This comparison helps determine the effectiveness of the TechPlay Fusion strategy.

Table 4

Test of Significant Difference on Post-test between 5- Mariano Llanera (Control group) and 5- Diego Silang (Experimental Group)

	Mean	P-Value	Decision	Verbal Interpretation
Control Group	26.67			
Experimental Group	27.08	0.042	Rejected Ho	There is significant difference

Legend: <0.05

Table 4 reveals that the test has a significant difference on post-test between the control and experimental groups. Since the computed p-value was 0.042, which is less than the level of significance of 0.05, the null hypothesis was rejected. There is a significant difference between the post-test scores of the control group and experimental group. The significant difference in post-test scores (p-value=0.042) reveals that the TechPlay Fusion Strategy led to substantial improvements in the experimental group compared to the control group.

This baseline equivalence ensures that any significant improvements in the post test scores of the experimental group can be attributed to the TechPlay Fusion Strategy rather than pre-existing proficiency differences. In simpler terms, this result suggests that the TechPlay Fusion Strategy made a

meaningful impact, as the experimental group's reading comprehension scores improved more significantly compared to the control group. This significant difference highlights that the strategy effectively enhanced learning outcomes for the experimental group.

Diallo (2023) emphasized the significant role of technology in influencing learners' reading experiences. The widespread acceptance of technologies by learners, teachers, and parents highlights their potential as beneficial tools for educators and parents in supporting learners with their reading skills. Moreover, according to the study of Capodieci, Cornoldi, Doerr, Bertolo, and Carretti (2020), they provide evidence that supporting the effectiveness of game-based and technology-based learning helps enhance reading comprehension.

Conclusion

Based on the significant findings of the study, the researchers concluded that using the TechPlay Fusion Strategy—combining technology and games—greatly improved reading comprehension for Grade 5 learners. Initially, both groups were on the same level, but after the intervention, the experimental group scored significantly higher. This suggests that modern, interactive teaching methods can make a big difference in student learning and boost educational quality.

Recommendations

In light of the findings and conclusions of the study and to boost reading skills and support Sustainable Development Goals 4 (Quality Education), schools should start using engaging methods like the TechPlay Fusion Strategy. Schools Division Offices should back these efforts with training and resources. On a larger scale, national policies and funding should focus on supporting interactive learning tools and ensuring all schools have access to them, making quality education more effective and inclusive. Future researchers may conduct similar study with more conclusive number of samples involved or be conducted with more than one school.

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Mobile Application in Developing Reading Skills Among Kindergarten Learners

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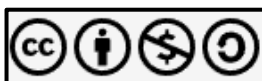
Abstract

The study used the CVC 3-Letter Words and Phonics application to enhance reading skills among kindergarten learners. Using a pretest-posttest quasi-experimental design, the study was conducted at Nalsian Elementary School in Bayambang, Pangasinan, Philippines. Specifically, it involved 21 kindergarten learners enrolled at this school during the 2023-2024 school year. The research examined 21 kindergarten students in the Philippines. A questionnaire was used to gather data on learners' profiles, while a researcher-made reading test assessed reading levels before and after exposure to interactive applications. The study revealed that interactive applications had a statistically significant positive impact on learners' reading skills, as evidenced by a Wilcoxon signed-rank test ($Z = -4.019, p < 0.001$). Before the intervention, 81% of learners were assessed as "full refresher," while after, 81% were "grade ready." The gain in reading levels was not significantly associated with learners' demographic and home environment variables, suggesting that interactive applications can benefit all learners regardless of factors such as gender, availability of reading materials at home, parents' educational attainment, internet connection status, and electronic gadgets used in the household. The gain in reading levels was not significantly associated with learners' profile variables, suggesting that interactive applications can benefit all learners regardless of background. Mean scores increased from 8.81 (SD=4.96) before intervention to 18.57 (SD=2.68) after intervention. Interactive applications offer engaging, multimodal experiences. The study's limitations include a small sample size and the use of an intact class from a single school. Future research should explicitly state in the abstract the inclusion of control groups and larger sample sizes to validate the effectiveness of interactive applications in developing reading skills among young learners. The results can inform the design and implementation of reading interventions that leverage these applications to support kindergarteners' success.

Keywords: *digital interactive literacy, digital learning, early childhood education, early literacy, educational technology, kindergarten learners, phonics, sight words*

Introduction

Reading proficiency, which encompasses various components including phonics and letter recognition, is fundamental for academic success and lifelong learning (Solari, 2014; Schmitt et al., 2015). Phonics, the understanding of letter-sound relationships, and letter recognition, the ability to identify and name letters, are crucial early literacy skills that form the foundation for more advanced reading abilities.



Early childhood is critical for developing reading skills as children grasp phonics, letter recognition, and word formation (Dickinson & Porche, 2011). However, many children enter kindergarten with gaps in reading readiness (Wood, 2019), which can lead to long-term academic challenges if not addressed promptly.

Recent years have seen growing interest in using interactive applications to enhance early literacy instruction. These digital tools offer engaging, multimodal learning experiences tailored to individual needs and learning styles (Outhwaite et al., 2019). Studies have shown promising results for using such applications to improve young children's letter knowledge, phonological awareness, and word recognition skills (Neumann, 2018; Fokides & Zachristou, 2019).

However, research focusing on the effectiveness of interactive applications for developing reading skills among kindergarten learners remains limited. These tools, particularly in resource-constrained environments, can bridge learning gaps. Most existing studies have examined older children or broader age ranges, leaving a gap in our understanding of how these tools impact the earliest stages of formal reading instruction. Additionally, few studies have explored how learners' characteristics may influence the impact of interactive applications on reading outcomes, particularly in diverse educational contexts like the Philippines.

This study aims to address these gaps by investigating the effectiveness of interactive applications in developing reading skills among kindergarten learners in the Philippines. By focusing on this specific age group and context, the research will contribute valuable insights into the potential of interactive applications to enhance early reading instruction in settings with limited resources or diverse learner populations. The findings may have broader implications for early literacy instruction in various cultural and socioeconomic contexts and could inform evidence-based practices for integrating technology into early childhood education (Hirvonen et al., 2015; Tupas, 2015).

To achieve these aims and address the research questions, a carefully designed methodology was implemented, taking into account the unique linguistic and educational landscape of the Philippines (Bautista & Gonzalez, 2006; Bernardo, 2004). The following section details the research design, participant selection, data collection instruments, and procedures used to investigate the impact of interactive applications on kindergarten learners' reading skills, considering the multilingual context of Philippine education (Dekker & Young, 2005; Padilla, 2018).

Materials and Methods

Research Design

This study employed a one-group pretest-posttest quasi-experimental design to determine the effectiveness of interactive applications in developing reading skills among kindergarten learners. This design was chosen for its ability to capture changes in reading performance over time within a single group of participants, an approach that aligns with recent educational research trends in the Philippines (Cruz, 2010; Vizconde, 2006). By comparing learners' reading levels before and after exposure to the intervention, researchers could assess the impact of interactive applications on early literacy skills, while considering the unique challenges of English language instruction in the Philippine context (Ocampo, 2002).

The one-group pretest-posttest design offers several advantages in this context. It allows for a focused examination of the intervention's effects within a naturalistic classroom setting, maintaining the ecological validity of the study. This approach is particularly suitable for exploratory research in educational technology, where the primary aim is to establish the potential efficacy of a novel intervention (Shadish et al., 2002). However, it is essential to note the limitations of this design, including the lack of

a control group and potential threats to internal validity, such as maturation effects or history effects. While effective for assessing within-group changes, the lack of a control group limits the ability to establish causality. Despite these limitations, the design provides valuable preliminary evidence of the effectiveness of interactive applications in developing reading skills among kindergarten learners, laying the groundwork for more rigorous experimental studies in the future.

Subjects and Sampling

The study subjects consisted of 21 kindergarten learners enrolled at Nalsian Elementary School in Bayambang, Pangasinan, Philippines, during the school year 2023-2024. This sample comprised nine male and 12 female students, reflecting a relatively balanced gender distribution. Selecting participants from a single school in a specific geographic location provides a focused snapshot of early literacy development within this educational context. Nalsian Elementary School, as a public institution in the Philippines, represents a typical learning environment for many young Filipino students, potentially enhancing the generalizability of the study's findings to similar settings within the country.

An intact class was utilized for this research, employing a convenience sampling approach. This methodological decision was made to maintain the natural classroom dynamics and avoid disrupting established educational routines. While convenience sampling has limitations in terms of representativeness and potential bias, it offers practical advantages in educational research, particularly when working with young children. By preserving the existing class structure, the study aimed to capture the effects of the intervention within a realistic classroom environment, thus enhancing its ecological validity. However, it is important to acknowledge that using an intact class and the relatively small sample size ($n=21$) may limit the generalizability of the findings to broader populations, necessitating cautious interpretation and further research with larger, more diverse samples.

Setting

The study was conducted at Nalsian Elementary School, a public educational institution in Bayambang, Pangasinan, Philippines. The study was conducted at Nalsian Elementary School, a public educational institution in Bayambang, Pangasinan, Philippines. This setting is significant as it represents a typical learning environment for many Filipino children, particularly those in rural or semi-urban areas. Public schools in the Philippines often face challenges such as limited resources and large class sizes, making them an essential context for researching innovative educational interventions. Nalsian Elementary School, like many of its counterparts, serves a diverse student population from various socioeconomic backgrounds, providing a rich environment for examining the effectiveness of interactive applications across different learner profiles.

The intervention occurred in a kindergarten classroom that was specially equipped with tablets for student use. This setup represented a notable investment in technology integration at the early childhood education level, which was not yet commonplace in many Philippine public schools. The provision of tablets for each student in the classroom created a unique learning environment, allowing individualized, hands-on interaction with the interactive applications. This technological enhancement of the traditional kindergarten classroom setting allowed us to explore how digital tools could be effectively incorporated into early literacy instruction in a resource-constrained public school context. The contrast between the traditional classroom setting and the introduction of tablets for learning offered valuable insights into the feasibility and impact of technology-enhanced instruction in similar educational contexts.

Data Gathering Instruments

Two researcher-made instruments were developed and utilized in this study to collect comprehensive data on the kindergarten learners' backgrounds and reading skills. The first instrument

was a questionnaire checklist to establish the learners' profiles. This questionnaire gathered crucial demographic and contextual information, including the learners' sex, availability of reading materials at home, parents' educational attainment, internet connection status, and electronic gadgets used in the household. These variables were selected based on their potential influence on early literacy development, as identified in previous research (e.g., Neuman & Celano, 2001; Bradley & Corwyn, 2002). By collecting this information, the researchers aimed to explore potential relationships between these background factors and the effectiveness of the interactive applications in developing reading skills.

The second instrument was a 20-item reading test, carefully structured to assess critical components of early literacy. This test was divided into two tasks: Task 1 focused on letter recognition and comprised ten items. In contrast, Task 2 assessed the learners' ability to read CVC (Consonant-Vowel-Consonant) patterns and basic sight words, consisting of 10 items. These specific tasks align with established frameworks of early reading development, which emphasize the importance of letter knowledge, phonological awareness, and sight word recognition as foundational skills for reading proficiency (Ehri, 2005; National et al., 2008). Using the same test as both a pretest and posttest, the researchers ensured a consistent measure of reading skills before and after the intervention, allowing for a direct comparison of learner progress.

To ensure the reliability and validity of these instruments, rigorous validation procedures were employed. The content validity of the questionnaire checklist and the reading test was established through expert review. Five experts in early childhood education, literacy instruction, and educational assessment evaluated the instruments. These experts evaluated the relevance, clarity, and comprehensiveness of the items in relation to the study's objectives and the target age group.

The experts provided detailed feedback on each item, suggesting modifications to improve clarity and age-appropriateness. For instance, in the reading test, one expert recommended simplifying the instructions for Task 1 to ensure better comprehension by kindergarten learners. Another expert suggested including more commonly encountered sight words in Task 2 to better reflect the typical vocabulary of Filipino kindergarteners.

The researchers carefully reviewed all expert feedback and made necessary revisions to the instruments. This iterative process involved multiple rounds of refinement until a consensus was reached among the experts. The final versions of the instruments incorporated all key recommendations from the expert panel.

The validation process yielded an average rating of 5.00 on a 5-point scale, indicating high content validity. This high rating suggests that the instruments were deemed appropriate and effective for measuring the intended constructs in the context of kindergarten learners in the Philippines. The involvement of multiple experts and the high validity rating strengthen the credibility of the data gathered using these instruments, providing a solid foundation for the study's findings and conclusions.

Data Gathering Procedure

The data-gathering procedure for this study was carefully designed and executed to ensure ethical compliance, participant engagement, and accurate assessment of reading skills. The process began with securing the necessary permissions from key educational authorities. The researchers first obtained approval from the school division Superintendent, recognizing the importance of aligning the study with broader educational policies and objectives. Subsequently, permission was sought from the Public Schools District Supervisor, ensuring that the study adhered to district-level guidelines and priorities. Finally, the School Principal's approval was secured, acknowledging the school's autonomy and the importance of their support in facilitating the research within the school environment. This

hierarchical approach to obtaining permissions ensured compliance with administrative protocols and helped build a supportive network for the study's implementation.

Following the acquisition of official permissions, the researchers engaged with the parents of the kindergarten learners. A comprehensive briefing session was conducted to explain the study's purpose, potential benefits, and implications for their children's education. This step was crucial in ensuring transparency and building trust with the families involved. The researchers provided detailed information about the nature of the interactive applications, the duration of the intervention, and the types of assessments that would be conducted. Parents were encouraged to ask questions and voice any concerns they might have. After this thorough explanation, informed consent was obtained from each parent, ensuring their children's participation in the study was voluntary and based on a clear understanding of the research process.

The next phase involved the administration of the pretest to the learners. This initial assessment was crucial in establishing a baseline measure of the children's reading skills before the intervention. The 20-item reading test, covering letter recognition, CVC patterns, and basic sight words, was administered individually to each learner to ensure accurate assessment. The scores from this pretest were meticulously recorded and then interpreted using the Comprehensive Rapid Literacy Assessment (CRLA) grading scale and descriptors. The CRLA is a standardized tool designed to provide a nuanced understanding of early literacy skills, allowing for detailed categorization of learners' reading abilities. This interpretation provided a clear picture of each child's initial reading level as a crucial reference point for measuring post-intervention progress.

The intervention phase of the study was implemented over four weeks and strategically divided to focus on different aspects of early reading skills. The interactive applications concentrated on letter recognition activities during the first two weeks. This initial focus aligns with research indicating the fundamental importance of letter knowledge in early reading development (Piasta & Wagner, 2010). The applications likely included games and exercises designed to help children identify and differentiate between various alphabet letters in isolation and simple words, and the latter two weeks shifted focus to reading CVC patterns and basic sight words. This progression follows a logical sequence in early reading instruction, building upon the letter recognition skills to form simple words and recognize common sight words. Throughout these four weeks, learners engaged with the interactive applications under the supervision of their teachers, ensuring consistent and appropriate use of the technology.

Following the four-week intervention, the posttest was administered to the learners. This posttest was identical to the pretest, directly comparing reading skills before and after exposure to the interactive applications. As with the pretest, scores were carefully recorded for each learner. The interpretation of these scores again utilized the CRLA grading scale and descriptors, maintaining consistency in the assessment approach. This final step in the data-gathering procedure provided the crucial data needed to evaluate the effectiveness of the interactive applications in developing reading skills. By comparing the pretest and posttest scores and interpretations, the researchers were able to quantify the progress made by each learner and assess the overall impact of the intervention on the class.

To ensure the ethical conduct of this research, several protocols were implemented. Institutional Review Board (IRB) approval was obtained before commencing the study. Detailed information about the study's purpose, procedures, potential risks, and benefits was provided to parents/guardians of all participating children, and written informed consent was obtained. Importantly, an age-appropriate assent process was conducted with the kindergarten learners. The researchers used simple language and visual aids to explain the study activities, emphasizing that participation was voluntary. Children were asked to verbally agree before participating. This process was conducted in the presence of their teachers to

ensure comfort and understanding. If a child showed any signs of reluctance or discomfort, they were not included in the study, even if parental consent had been obtained. All personal information and research data were kept confidential and stored securely, with only anonymized data used in analysis and reporting. It was made clear to both parents and children that participation was entirely voluntary and that they could withdraw from the study at any time without any negative consequences. These ethical protocols were rigorously followed throughout the research process to protect the rights and well-being of the young participants and to maintain the integrity of the study.

Intervention

The intervention utilized ABC Mouse® (Age of Learning, Inc., Glendale, CA, USA), an interactive learning application installed on tablets. For four weeks, learners engaged with the application for 30 minutes daily, five days a week.

Statistical Treatment

Data analysis was performed using IBM SPSS Statistics version 26 (IBM Corp., Armonk, NY, USA). The following statistical tests were employed:

1. Descriptive statistics (frequency, percentage, mean, standard deviation) to describe learners' profiles and reading levels.
2. Wilcoxon Matched-Pair Signed Rank Test to determine the significance of the difference in reading levels before and after the intervention.
3. Kendall's Tau-b and Point-Biserial Correlation Coefficients determine the relationship between reading level gains and learners' profile variables.

The significance level was set at $\alpha = 0.05$ for all statistical tests.

This methodology allowed for a comprehensive investigation of the effectiveness of interactive applications in developing reading skills among kindergarten learners while considering the influence of learners' background characteristics.

Ethical Considerations

To ensure the ethical conduct of this research, several protocols were implemented:

1. Institutional Review Board (IRB) Approval: Before commencing the study, approval was obtained from the relevant institutional review board or ethics committee.
2. Informed Consent: Detailed information about the study's purpose, procedures, potential risks, and benefits was provided to parents/guardians of all participating children. Written informed consent was obtained from parents/guardians before any data collection or intervention activities began.
3. Child Assent: Age-appropriate, simple explanations of the study activities were provided to the kindergarten learners. The children were then asked if they would like to participate, and their verbal assent was obtained before proceeding with any research activities.
4. Data Protection: All personal information and research data were kept confidential and stored securely. Only anonymized data was used in the analysis and reporting of results.
5. Voluntary Participation: Parents and children were clearly informed that participation was entirely voluntary and that they could withdraw from the study at any time without any negative consequences.

6. **Minimizing Disruption:** The research activities were designed to minimize disruption to the children's regular educational activities.
7. **Equitable Access:** After the study, the interactive application was made available to all children in the class, including those who may not have participated in the study, to ensure equitable access to educational resources.
8. **Reporting of Results:** Commitments were made to share the study's findings with the school and parents in an accessible format.

These ethical protocols were rigorously followed throughout the research process to protect the rights and well-being of the young participants and to maintain the integrity of the study.

Results and Discussion

This section presents and interprets the study's findings about the research questions and existing literature.

3.1 Profile of Kindergarten Learners

Table 1.

Profile of Kindergarten Learners

Characteristics	Percentage (%)
Gender	
Female	57.1
Male	42.9
Activity Books at home	81.00
Smart cellphone usage	100.0
Parents' Education (High School Graduates)	
Fathers	42.9
Mothers	38.1
Internet connection (Mobile data)	45.0

Source: Processed by researchers (2024)

These findings provide context for understanding the learners' backgrounds and access to resources that may support reading development.

3.2 Reading Levels Before and After Exposure to Interactive Applications

Table 2.

Descriptive Statistics and Assessment Levels of Kindergarten Learners' Reading Performance

Component	Before Intervention	After Intervention
Mean ± SD	Mean ± SD	
Letter Recognition	6.00 ± 3.39	9.62 ± 0.80
CVC Pattern	0.22 ± 1.09	3.76 ± 1.09
Basic Sight Words	1.40 ± 0.65	4.24 ± 1.00
Overall Score	8.81 ± 4.96	18.57 ± 2.68
Assessment Level	Before (%)	After (%)
Full Refresher	81	-
Grade Ready	-	81

Source: Processed by researchers (2024)

The results show a substantial improvement in all aspects of reading performance after the intervention. The shift from 81% of learners assessed as "full refresher" before the intervention to 81% assessed as "grade ready" after the intervention indicates the effectiveness of the interactive applications in developing reading skills. These findings align with previous research, such as that of Neumann (2018), who also noted significant improvements in early literacy skills using interactive applications. Similarly, Fokides and Zachristou (2019) observed the positive effects of tablet use on kindergarteners' letter knowledge and phonological awareness. The consistency between our results and these prior studies strengthens the evidence for the potential of interactive applications in enhancing early reading skills.

3.3 Difference in Reading Levels Before and After Exposure to Interactive Applications

Table 3.

Difference in Reading Levels Before and After Exposure to Interactive Applications

Performance	MS	SD	MD (Pre-Post)	Wilcoxon Matched-Pair Signed Rank Test	
Pretest	8.81	4.96	-9.76	Z	p-value
Posttest	18.57	2.68		-4.019	<.001

Source: Processed by researchers (2024)

The significant difference ($Z=-4.019$, $p<.001$) in reading levels before and after the intervention provides strong evidence of interactive applications' effectiveness in developing reading skills among kindergarten learners. This aligns with previous studies demonstrating the positive impact of technology-enhanced instruction on early literacy skills (Neumann, 2018; Fokides & Zachristou, 2019).

3.4 Relationship Between Gain in Reading Levels and Learners' Profile Variables

Kendall's Tau-b and Point-Biserial Correlation Coefficients showed no significant relationship between the gain in reading levels and learners' profile variables ($p>.05$). This suggests that the interactive applications were practical across diverse learner backgrounds, potentially serving as an equalizing tool in early literacy instruction.

Discussion

This study's significant improvement in reading levels across all components (letter recognition, CVC patterns, and essential sight words) highlights the potential of interactive applications to provide engaging, multimodal learning experiences that support early literacy development (Outhwaite et al., 2019). This comprehensive enhancement of reading skills suggests that well-designed interactive applications can effectively target multiple aspects of early literacy. The multimodal nature of these applications, which often combine visual, auditory, and kinesthetic elements, may be particularly beneficial for young learners still developing their cognitive and sensory processing abilities. This aligns with theories of multiple intelligences and diverse learning styles, suggesting that interactive applications can cater to a wide range of learner needs and preferences.

A particularly noteworthy finding is the lack of a significant relationship between the gain in reading levels and learners' profile variables. This result indicates that interactive applications may help bridge the gap in reading readiness among children from diverse backgrounds (Wood, 2019). In the context of the Philippines, where socioeconomic disparities can significantly impact educational outcomes, this finding is especially promising. Interactive applications could serve as an equalizing force in early literacy education, providing high-quality learning experiences to children regardless of their home environment, parental education level, or access to traditional reading materials. This potential for reducing educational

inequalities aligns with global efforts to promote inclusive and equitable quality education, as outlined in the United Nations Sustainable Development Goals.

These findings address a critical gap in research on the effectiveness of interactive applications specifically for kindergarten learners. Much of the existing literature on educational technology focuses on older students or broader age ranges, leaving a need for more information on how these tools impact the earliest stages of formal education. This study contributes valuable insights into early literacy instruction by demonstrating the efficacy of interactive applications for kindergarten-aged children. It provides empirical support for integrating technology into early childhood education curricula, a topic that has been debated among educators and policymakers.

The results suggest that integrating such applications into kindergarten classrooms could be a promising strategy for enhancing reading skills development. This has important implications for educational practice and policy. For educators, it suggests the need for professional development in effectively using interactive applications as part of a comprehensive literacy instruction approach. For policymakers and school administrators, it highlights the potential value of investing in technology infrastructure and digital resources for early childhood education. However, it is crucial to note that interactive applications should be seen as a complement to, rather than a replacement for, traditional teaching methods and human interaction in the learning process.

However, the study's limitations must be carefully considered when interpreting these results. The small sample size ($n=21$) and the use of an intact class from a single school limit the generalizability of the findings to broader populations. This restricted sample may not fully represent the diversity of kindergarten learners across different socioeconomic backgrounds, cultural contexts, or educational settings.

The lack of a control group is another significant limitation. Without a comparison group that did not receive the intervention, it becomes difficult to attribute the observed improvements solely to the interactive applications. Other factors such as natural maturation, general classroom instruction, or even the novelty effect of using technology could have contributed to the gains in reading skills.

Additionally, the study's focus on short-term outcomes leaves questions about the long-term retention and transfer of the acquired reading skills. It remains unclear whether the improvements observed immediately after the intervention would be sustained over time or translate into better overall academic performance.

Future research should address these limitations by:

1. Exploring larger, more diverse samples that better represent the target population.
2. Incorporating control groups to isolate the effects of interactive applications from other potential influencing factors.
3. Conducting longitudinal studies to assess the sustained impact of interactive applications on reading development over extended periods.
4. Investigating potential moderating factors such as prior exposure to technology, learning styles, or specific learning difficulties.

Such expanded research efforts would further validate these findings and provide a more comprehensive understanding of the role of interactive applications in early literacy instruction across various educational contexts.

Conclusion

This study sought to investigate the effectiveness of interactive applications in developing reading skills among kindergarten learners and examine the relationship between reading improvement and learners' profile variables. Based on the findings, we can conclude:

1. Interactive applications efficiently develop developing reading skills among kindergarten learners. The significant improvement in reading levels across all components (letter recognition, CVC patterns, and basic sight words) demonstrates the potential of these tools to enhance early literacy instruction.
2. The intervention's impact was substantial, transforming most learners from "full refresher" to "grade ready" status. This suggests that interactive applications can rapidly accelerate reading skill development in a relatively short period.
3. The effectiveness of interactive applications is consistent across diverse learner backgrounds. The lack of significant relationships between reading gains and profile variables indicates that these tools may serve as equalizers in early literacy education, potentially helping to bridge achievement gaps.
4. The study reveals the potential of technology-enhanced instruction to create engaging, multimodal learning experiences that cater to the needs of young learners. This aligns with contemporary educational theories emphasizing the importance of interactive and personalized learning environments.

These conclusions have important implications for early childhood education:

- Educators and policymakers should consider integrating interactive applications into kindergarten reading curricula as complementary to traditional instruction.
- The design of early literacy interventions should leverage the engaging nature of interactive applications to maximize learner engagement and reading skill development outcomes.
- The potential of these applications to benefit learners regardless of background suggests they could be precious in diverse or resource-limited educational settings.

While these findings are promising, it is essential to note the study's limitations, including its small sample size and single-school setting. Future research should:

- Explore the long-term impacts of interactive application use on reading achievement.
- Investigate the specific features of these applications that contribute most to reading skill development.
- Examine how interactive applications can be most effectively integrated with traditional teaching methods.

In conclusion, this study provides strong evidence for the potential of interactive applications to enhance early reading instruction in kindergarten classrooms. By embracing these tools, educators can create more inclusive, engaging, and effective learning environments that foster a strong foundation in literacy for all learners.

Recommendations

Based on the findings and conclusions of this study, we offer the following recommendations for future research, educational practice, and policy:

For Researchers:

1. Conduct longitudinal studies to examine the long-term effects of interactive applications on reading achievement beyond kindergarten.
2. Investigate the optimal duration and frequency of interactive application use for maximum reading skill development.
3. Explore the effectiveness of interactive applications across different socioeconomic backgrounds and cultural contexts.
4. To further validate the effectiveness of interactive applications in developing reading skills, design studies with larger sample sizes and include control groups.
5. Examine the specific features of interactive applications (e.g., gamification elements, personalized learning paths) that contribute most significantly to reading skill development.

For Educators:

1. Integrate interactive applications into kindergarten reading curricula to complement traditional instruction methods. This integration should be thoughtful and purposeful, ensuring that technology enhances rather than replaces effective teaching practices.
2. Participate in comprehensive professional development opportunities focused on effectively implementing and leveraging interactive applications in classrooms. This training should cover:
 - Best practices for blending digital and traditional literacy instruction
 - Strategies for differentiating instruction using interactive applications
 - Techniques for facilitating student engagement with digital learning tools
 - Methods for troubleshooting common technical issues
3. Regularly monitor and assess students' progress using interactive applications to ensure they meet individual learning needs. Use the data generated by these applications to inform instructional decisions and provide targeted support.
4. Develop lesson plans incorporating interactive applications and hands-on activities to reinforce reading skills. For example, follow up a digital letter recognition game with a tactile alphabet activity.
5. Explore ways to involve parents in supporting their children's use of interactive applications at home, extending the learning beyond the classroom. This could include providing guidance on recommended applications, suggesting home literacy activities that complement digital learning, and sharing progress updates.
6. Create a classroom environment that supports seamless transitions between digital and traditional learning experiences. This might involve setting up dedicated tech stations alongside traditional reading corners.
7. Collaborate with colleagues to share best practices, troubleshoot challenges, and develop innovative approaches to integrating interactive applications in early literacy instruction.

For Policymakers and School Administrators:

1. Allocate dedicated funding for acquiring and implementing quality interactive applications in kindergarten classrooms. Prioritize this funding for rural and under-resourced areas to help bridge the digital divide in early childhood education.
2. Develop comprehensive guidelines for selecting and using interactive applications in early literacy instruction. These guidelines should:
 - Outline criteria for evaluating the educational value and age-appropriateness of applications
 - Provide benchmarks for time spent on digital learning activities
 - Offer strategies for integrating applications with existing curriculum standards
3. Create policies that support integrating technology-enhanced learning in early childhood education curricula. This could include:
 - Updating curriculum frameworks to incorporate digital literacy skills explicitly
 - Establishing standards for teacher proficiency in educational technology use
 - Implementing regular technology audits to ensure equitable access across schools
4. Initiate partnerships between educational institutions, technology companies, and research organizations to:
 - Develop locally relevant and culturally appropriate interactive applications
 - Conduct large-scale studies on the long-term impact of these applications
 - Create professional development programs for educators on effective tech integration
5. Establish a task force to monitor and evaluate the implementation of interactive applications in early childhood education. This group should regularly report on outcomes, challenges, and best practices.
6. Implement a grant program to support innovative projects that combine interactive applications with traditional teaching methods in early literacy instruction.
7. Develop a centralized resource hub for educators and administrators to access vetted interactive applications, implementation guides, and success stories from other schools.

For App Developers:

1. Collaborate with early childhood education experts to ensure that interactive applications align with current best practices in literacy instruction.
2. Develop features allowing easy progress monitoring and data collection to support ongoing research and assessment.
3. Create culturally responsive and adaptable applications to diverse learning contexts.

For Future Research Directions:

1. Investigate the combined effects of interactive applications and traditional teaching methods on reading skill development.

2. Explore the potential of interactive applications to support reading skill development for children with learning disabilities or those learning a second language.
3. Conduct comparative studies of different types of interactive applications to identify the most compelling features and approaches for kindergarten learners.
4. Examine the impact of interactive applications on other aspects of child development, such as digital literacy, fine motor skills, and social-emotional learning.

Addressing these recommendations, future research and educational practices can build upon this study's findings to further enhance early literacy instruction and support the reading development of young learners in an increasingly technology-rich educational environment.

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Utilizing Nearpod Application to Enhance Grade 8 Learners' Integrated Science Process Skills

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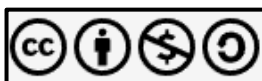
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Abstract

In recent years, the pressing issue of the low performance of learners in science has addressed the need for innovative teaching strategies to motivate and help them intrinsically embrace essential scientific concepts. The demands of 21st-century education continuously challenge science teachers to explore more technology-driven solutions. This action research explored the effectiveness of the implementation of the Nearpod application in improving the Integrated Science Process Skills (ISPS) of grade 8 learners during the school year 2023-2024. The research employed a quantitative approach in processing all the data gathered. Nearpod was systematically integrated into Science 8 classes, with features like Collaborative Board and Immersive Reader being used regularly in weekly lessons. Learners participated in interactive activities, such as using the Collaborative Board for group discussions and engaging with immersive virtual reality experiences to elicit prior knowledge. Formative assessments were conducted through Nearpod's Poll and Draw It features, providing immediate feedback to learners and the Time to Climb feature was used to gamify review sessions. Findings indicate a significant improvement in learners' performance after exposure to the application. The mean score in the post-test of the experimental group is higher ($M=16.5$, $SD=1.48$) than the post-test of the control group ($M=11.78$, $SD=1.34$) $t=8.97$ ($p=0.000$). This finding was further supported by the quantitative data from questionnaires using a Likert scale elaborating on positive experiences and perceptions of learners regarding the integration of Nearpod. Learners appreciate well the structured approach of the Nearpod including focused instruction, guided practice, collaborative learning, and independent application. Using interactive tools in the classrooms improves the learners' overall performance. As digital natives, the learners can relate well to the lessons through the regulated use of gadgets as supplementary materials that enrich their learning environment. As suggested, it would be beneficial to look into how this technology integration strategy can also be applied in different schools that value the inevitable advancement of technology that, in turn, influences the teaching and learning process with an extended study timeframe to gauge its lasting impacts.

Keywords: *Action Research, Grade 8 Learners, Integrated Science Process Skills, Nearpod Application*



Introduction

In the Philippines, a nation embracing innovation, it is crucial to incorporate modernity with teaching, especially in science. The use of various technologies as tools brought modernity to learning and helped teachers and students cope with the ever-changing curriculum. The rapid and constant pace of change in technology increases the opportunity for students to understand scientific concepts to the extent that it can be carried on to their future years with consistency.

Educational technology (EdTech) plays a significant role in attaining the United Nations Sustainable Development Goal 4 (SDG4) for quality education. A framework for EdTech's contribution to quality education was proposed elaborating its potential to democratize access and improve academic performance (Costa et al., 2023). Although there is limited academic literature linking EdTech and SDG4 so far, increasing research opportunities in these fields are being reported (Jordan, 2020). In fact, Suaco et al. (2024) found that SDG-related competencies are integrated into the secondary science curriculum in the Philippines, with teachers showing a good understanding and positive attitudes toward SDGs. In addition, a pedagogical model for integrating digital technology and SDGs in K-12 education is provided which gained high support from students and teachers (Silva et al., 2023).

Although several interventions, such as Strategic intervention materials (SIM), lesson studies, and teacher mentoring, have been implemented to improve science performance in the Philippines, these approaches are limited by factors like time, budget, and the number of participants that can be accommodated (Villar et al., 2022; Payot and Deloy, 2022; Perdio, 2022). Research has emphasized the need for more ICT-based professional development to support teachers' instructional practices (Bibon, 2022). Thus, a more student-centered approach and technologically-driven classroom is needed to align the instruction to the current needs of the learners and their prior knowledge based on the Constructivist learning theory (Alam, 2016). This theory promotes authentic learning principles in the classroom that ultimately provide a positive and more conducive learning environment for the learners' academic success.

Traditional science teaching often involves teacher-centered approaches, characterized by standard lectures that lead to passive learning and low student achievement. Classroom observations revealed that didactic methods are still being widely used, leading to a decline in students' interest and participation in the subject (Oliveira and Lathrop, 2022). The learners have minimal opportunities to actively develop their scientific inquiry, problem-solving, and collaborative learning. To address this issue, there has been a shift towards incorporating ICT in science education that can increase student motivation. An inquiry-based approach utilizing ICT tools can enhance visual, intuitive, and collaborative work, leading to greater student involvement (Palomarez-Ruiz et al., 2020).

Nearpod, an interactive digital learning application, has been found to positively impact teaching and learning processes in terms of improving students' attitudes, learning outcomes, and teaching efficiency (Prasetyo, 2024; Putra et al., 2021). While it offers a free version, additional storage and premium features are available through a paid subscription (Kidder, 2021). This application promotes socio-emotional learning, critical thinking, and collaboration, and caters to learners' diverse learning styles (Caroy, 2023; Rios-Zaruma et al., 2019; Naik et al., 2022).

Nearpod allows for video-conferencing during the conduct of a flexible learning system and supports BYOD (Bring Your Own Device) environments promoting flexibility and accessibility (Hakami, 2020; Ryan, 2017). Lastly, it allows for diverse content creation, including 3D models, simulations, and virtual field trips (Naik et al., 2022). Studies in chemistry and language education have shown that Nearpod-based activities increased learners' motivation and engagement (Naumoska et al., 2022;

Salvador-Cisneros and Conza-Armijos, 2022). However, poor internet connectivity has been reported as a limitation to the effectiveness of this platform (Caroy, 2023). Nearpod can be used in schools even without a developed Learning Management System (LMS) as it is made available online with free trials.

Nearpod-based interactive science learning media are found to be beneficial to the learners' creative thinking abilities and metacognitive skills (Siswati et al., 2023). Recent studies relatively found the effectiveness of other digital technologies in enhancing science process skills and related competencies. Simple computer simulations are found to improve various basic science process skills such as observing, summarizing, predicting, communicating, and classifying (Siahaan et al., 2017). Similarly, mobile-based interactive learning multimedia enhances the learners' science process skills better than the traditional approach (Nugroho and Surjono, 2019).

Science process skills refer to using logical reasoning to critically understand scientific knowledge, principles, concepts, and methods. Integrated science process skills, on the other hand, include skills in data interpreting, formulating hypotheses, making inferences skills, and controlling variables. Thus, Baharom et al. (2020) conducted a study to assess the impact of Inquiry-Based Science Education (IBSE) through an application to improving the learners' mastery and achievement in Science Process Skills (SPS). Relatively, Ekici and Erdem (2020) found mobile applications and technology-enhanced scientific inquiry to affect the development of both basic and integrated SPS positively. These approaches enhance students' ability to design experiments, state hypotheses, interpret data, and improve their critical thinking and problem-solving skills (Del Rosario and Chua, 2023).

Despite the prevalent use of technology worldwide, its integration into teaching methodologies remains limited, especially in science education. Most teachers understand the benefits and importance of ICT for learning, but its usage in the classroom is less common than for lesson preparation (Ferrari et al., 2011). This gap may be attributed to different factors, including teachers' lack of awareness of available resources, insufficient training, and challenges integrating new tools into existing curricula. There is still a gap between technological breakthroughs and their implementation in education addressing the need for more effective collaboration between technology developers and educators (Garyfallidou and Ioannidis, 2007).

On the other hand, the Philippines still finds it difficult to perform well in the Program for International Student Assessment (PISA), which assesses the learners' performance in math, reading, and science. The OECD conducts PISA and has been evaluating the literacy of 15-year-olds every three years since 2000 (OECD, 2023). Along with these challenges, grade 8 learners in one public secondary school in San Miguel, Bulacan, struggled to process their ISPS, which could be associated with developing their higher-order thinking skills (HOTs) in science.

With these surfacing challenges in science education, the study integrated an educational application in instruction to enhance the Integrate Science Process Skills and, in general, the science performance of the learners, which would greatly contribute to satisfying the learners' needs to acquire meaningful learning experiences. The researchers aimed to determine the impact of Nearpod application on enhancing the ISPS of grade 8 learners. Specifically, the study sought to examine the students' ISPS before and after using the Nearpod application, investigate the significant difference in the scores of learners in the control and experimental groups, as well as the pre-test and post-test of the experimental group, and explore the learners' feedback regarding the use of Nearpod.

Materials and Methods

Research Design

By employing a quasi-experimental design, the researchers evaluated the impact of the Nearpod application on Grade 8 learners' Integrated Science Process Skills (ISPS). Pre-test and post-test scores from the experimental and control groups were compared to assess learning outcomes. The experimental group used Nearpod, while the control group followed traditional instructions.

Diagnostic tests identified sections with ISPS difficulties, and a survey ensured learners had access to necessary devices and the internet. Statistical analysis, including paired and independent t-tests, was conducted to determine the significance of the results. A satisfaction survey gathered feedback from the experimental group on Nearpod's effectiveness.

Sampling Method

The required sample size was measured using purposive sampling. The researchers administered a diagnostic test to determine the learners' current level of knowledge and identified which sections needed help processing their integrated science process skills. In addition, the researchers surveyed how many students have access to gadgets and the Internet. The 50-item diagnostic test revealed that learners' scores ranged from 9, the lowest score, to 28, the highest. Subsequently, the survey showed that 100% of Grade 8 – cacao learners have access to gadgets and the Internet. Thus, they qualified from the set criteria and were chosen to be the experimental group.

Respondents

The respondents of this study were grade 8 students. These students enrolled in the grade 8 heterogeneous class have been identified as the group that was having difficulties in processing their integrated science process skills in science 8. The respondents of this study were selected based on the survey on how many students have and can access gadgets and the internet. The use of diagnostic test results checked the student's level of knowledge. One heterogeneous class section served as the control group and another heterogeneous class section was the experimental group. The table below shows the distribution of respondents.

Table 1

Distribution of the Respondents

SECTION	POPULATION
Grade 8 - Aratiles	30
Grade 8 - Cacao	30
Total	60

Instruments

The study utilized several instruments to gather data including a diagnostic test, a pre-test, a post-test, and a questionnaire. The 50-item diagnostic test, a teacher-made test, was used to identify the current level of knowledge of the learners and determine which sections needed help with their integrated science process skills (ISPS). Some modifications were made to align the items with the ISPS test. The researchers conducted a simple survey to determine learners' availability of gadgets and access to the internet. The survey consisted of different types of questions related to the various devices the learners use and their typical internet usage pattern. This was done to ensure that the technological requirements for using the Nearpod application were met.

A set of 20 multiple-choice questions was constructed for the pre-test and post-test to assess the learners' Integrated Science Process Skills. Science teachers reviewed and validated these tests to ensure content validity. However, due to time and resource constraints, the tests were not pilot-tested before implementation.

The content of the test includes some topics in Matter covered in the 3rd Quarter of Science 8 during the 3-week implementation of the Nearpod application. For the skill target, the researchers applied the ISPS levels instead of Bloom's taxonomy to match the test items from the ISPS, such as data interpretation, formulating hypotheses, making inferences, and controlling variables. The ISPS also starts from lower-order thinking skills to higher-order thinking skills. The table below shows the modified Table of Specifications.

Table 2

Modified Table of Specifications (TOS)

Topics	No. of Hours Taught	No. of Items	Integrated Science Process Skills (ISPS)				Percentage
			Interpreting Data	Formulating Hypothesis	Making Inferences	Controlling Variables	
Week 1							
Atomic Structure	4 hours	7	9	8, 6	1, 4	17, 18	33.3
Proton							
Neutron							
Electron							
Week 2							
Atomic Structure	4 hours	7	7, 10	3	11	19, 20	33.3
Isotopes							
Ions							
Week 3							
The Periodic Table of Elements	4 hours	6	14, 15	5, 12	2, 13	6	33.3
Proponents of the Periodic Table							
Arrangement of the Periodic Table							
Reactivity Series							
Total	12	20	5	5	5	5	100

A 10-item questionnaire was adopted from Kovalskys (2015) to gather feedback from the experimental group on their perceptions and experiences of using the Nearpod application. It was used to capture constructs related to learners' collaboration, creativity, performance, and overall learning experiences.

Integration of Nearpod

Nearpod is an educational technology platform designed for the learners' dynamic and diverse learning experiences. It provides various tools such as real-time polls, quizzes, collaborative boards, and multimedia presentations, allowing teachers to transform rote and isolated learning into progressive learning. In this study, Nearpod was systematically integrated into the K to 12 Science 8 Curriculum as a key tool for delivering interactive lessons to improve learners' Integrated Science Process Skills (ISPS).

Table 3*Integration of Nearpod Activities in Science 8 Lessons*

WEEK	TOPIC	LEARNING COMPETENCY	NEARPOD ACTIVITY
1.1	Atomic Structure	Identify a substance based on its atomic structure;	Students identified the parts of an atom using information from the periodic table related to protons.
1.2	Protons	Find the number of protons, neutrons, and electrons in a given atom	The students answered activities on the collaborative board of the Nearpod application, where they shared their insights.
1.3	Neutrons	Determine the number of neutrons in a particular atom;	The students were given an activity called Draw It using the Nearpod. It served as an interactive whiteboard for the students.
1.4	Electrons	Determine the number of electrons in a particular atom;	The students were given an activity called Matching Pairs. The students clicked the cards they believed contained the correct match.
2.1	Isotopes	Explain what is an isotope	Atoms: Vocabulary The students strengthened their understanding of atoms by completing a vocabulary challenge matching key terms with their definitions.
2.2	Ions	Identify the no. of protons, neutrons, electrons, isotopes, and ion charge in an atom	Activity: Game to Climb The students reviewed ions and molecules using Nearpod's interactive quiz game, Time to Climb.
3.1	The Periodic Table	Use the periodic table to predict the chemical behavior of an element;	The Periodic Table: Draw-It The students interpreted the arrangement of elements on the periodic table with a Draw-It activity.
3.2	Proponent of the Periodic Table	Differentiate the contribution of each scientist to the development of the periodic table;	Atoms: Bohr Model In this practice activity, the students strengthened their understanding of atoms by completing a challenge matching element.
3.3	Arrangement of Periodic Table	Create a timeline for the development of the periodic table as per the similarities in properties of elements	Activity: Drag and Drop The students completed diagrams of the atoms of different elements by placing icons for protons, neutrons, and electrons in the correct locations.
3.4	Reactivity	Arrange the different elements based on their reactivity	Periodic Table: Matching Pairs In this activity, the students strengthened their understanding of chemical reactions by completing a challenge i.e. matching elements with the correct group

Nearpod was employed weekly in the experimental group (grade 8 – cacao) to transform traditional science lessons into interactive sessions that actively involved the learners. Specific features of the application such as Collaborative Board, Immersive Reader, and various assessment tools were combined to create an engaging and supportive learning environment. The Collaborate Board was frequently used as a bell-ringer exercise where the learners were asked to answer open-ended questions related to the lesson. This feature not only encouraged participation but also facilitated peer-to-peer learning to maximize interaction. The Immersive Reader feature allowed the learners to access the content more easily. This was used to enable the learners to interact with the materials independently because it has text-to-speech, translation, and picture dictionary functionalities. The learners were given enough time to practice this feature to ensure that they were comfortable and confident using it during sessions.

Nearpod was not merely an add-on but was fully integrated into the lesson structure. Each Science 8 module included activities that used Nearpod's interactive elements to reinforce key concepts. Virtual reality (VR) experiences were used as lesson hooks to stimulate learners' interest and activate prior knowledge by allowing them to explore environments related to the topic, such as underwater ecosystems and distant planets. Formative assessments were guided by Nearpod's Poll and Draw It features which served as exit tickets to test learners' understanding and provide immediate feedback. These assessments helped teachers to immediately identify and address misconceptions leading to a more responsive and adaptive learning environment. Furthermore, as Nearpod became a part of the daily classroom routine, the Time to Climb feature of Nearpod was used to gamify review sessions making the learning both entertaining and educational at the same time. This regular integration helped the learners to get more accustomed to the application ensuring also that they could fully grasp the content being taught. Table 3 shows how the Nearpod activities were integrated into different lessons in Matter during the 3-week implementation.

In Week 1, Nearpod activities focused on identifying the parts of an atom and determining the number of protons, neutrons, and electrons using the Collaborative Board and Interactive Whiteboard features as motivational activities where learners answered open-ended questions related to the lesson content. The Immersive Reader was used to logically present the details of the lesson in order to support learners' understanding of atomic structures and models. In week 2, the Nearpod activities centered around strengthening learners' conception of isotopes and ions, including a vocabulary challenge and an interactive quiz game, such as the "Game to Climb" activity. Moving to Week 3, the Nearpod activities were used to help learners interpret the periodic table, differentiate the contributions of scientists to its development, and complete diagrams of different atomic structures. The formative features of Nearpod, such as the Poll and Draw It tools, were used to assess learners' understanding, corresponding with the activities mentioned in Weeks 1.3 and 1.4.

Research Ethics Consideration

The researchers adhered to the guidelines outlined in DepEd Order (DO) No. 16, s. 2017, under the Research Management Guidelines. They sought and obtained the necessary permission from the school head as part of the process. The purpose of the study was explained to the student respondents and informed of their right to withdraw from the study. At the same, all confidential matters were secured. The parents or guardians of the student-respondents were informed about the conditions of the research and were provided a permission slip to allow their children to participate in the study. The student-respondents were informed about the study before the implementation of the research. Furthermore, the goal of the research was discussed both with the students and the parents/guardians with utmost clarity and transparency.

Data Collection

To measure the effectiveness of the intervention, data were collected using pre-test and post-test. The pre-test and post-test were both composed of a 20-item validated test used to measure integrated science process skills that assessed the level of ISPS of the grade 8 learners. After the pre-test, the intervention was introduced to the participants and applied to the third-quarter topics and discussion in the Science 8 module. The pre-test was conducted at the start of the lesson to measure the level of ISPS of the grade 8 students before the integration of the intervention. The experimental group received the intervention with the integration of the Nearpod application. For the logistics consideration, the researchers provided prepaid WiFi to ensure that all learners could consistently access the Nearpod platform. The learners' access to personal devices was confirmed through a preliminary survey to ensure that the technological requirements for Nearpod were met. No interventions were applied to the control group. Both groups took the post-test after the quarter. The post-test was administered toward the end of the study to determine how much the said intervention contributed to enhancing the level of ISPS of the students in Science 8. After the intervention, the researchers conducted a 10-item validated questionnaire to assess the students' attitude toward their feedback using the Nearpod application.

Data Analysis

The weighted mean of the pre-test and post-test was computed using paired and independent sample t-tests that determined the effectiveness of the Nearpod application in enhancing the integrated science process skills of grade 8 students in science. A questionnaire was used to know the student's feedback and satisfaction with using the application in their learning. The data that were gathered with this questionnaire was presented through descriptive statistics.

An independent sample t-test with assumed equal variances was used to analyze the significant difference between the scores in the pre-test and post-test of the students in the control and experimental groups. On the other hand, paired sample t-tests were used to measure the significant difference between the student's pre-test and post-test in the experimental group. The researchers used the STATA 12 software to analyze the data. In addition, the questionnaire was presented in descriptive statistics to see the students' perceptions and insights after using the application.

Results and Discussion

Learners' Integrated Science Process Skills with Conventional Teaching

Table 4 shows the pre-test result of the control group (8-Arartiles) with a mean value of 5.4 and a standard deviation of 2.25 which can be expressed verbally as "Fairly Satisfactory" for the respondents. The post-test result revealed a mean of 11.87 and a standard deviation of 1.81 which can be described as "Satisfactory" for the respondents. The mean score of the post-test is comparable to the mean score of the pre-test despite the lack of intervention with this group of learners. This suggests that the integrated science process skills of the learners may have naturally improved over time due to the implementation of the spiral progression approach in the curriculum. While the control group did not receive the Nearpod intervention, the traditional teaching methods employed by the teacher, such as questioning, discussion, and hands-on activities, may have still provided opportunities for the learners to practice and develop their ISPS to a certain extent. However, the lack of a more engaging, interactive, and technology-driven approach likely limited the extent of improvements in the control group's ISPS.

The spiral progression approach allows for the revisiting and reinforcement of concepts across grade levels, which may have contributed to the gradual development of the learners' ISPS (Derilo, 2019). Additionally, factors such as student motivation, prior knowledge, and cognitive development during the

course of the study may have also played a role in the modest improvements observed in the control group's performance (Athuman, 2017).

Table 4

Results of the Pre-test and Post-test of Control Group (8-Aratiles)

Range	Pre-test		Post-test	
	Frequency	%	Frequency	%
17-20	0	0	0	0
13-16	0	0	1	3.33
9-12	3	10.00	21	70.00
5-8	17	56.67	8	26.67
0-4	10	33.33	0	0
Mean	5.4		9.93	
Standard Deviation	2.25		1.78	
Verbal Interpretation	Fairly Satisfactory		Satisfactory	

Outstanding (17-20); Very Satisfactory (13-16); Satisfactory (9-12); Fairly Satisfactory (5-8); Needs Improvement (0-4)

Learners' Integrated Science Process Skills before and after the Utilization of Nearpod

Before implementing the Nearpod among grade 8 learners, the researchers ensured that all participants in the experimental group had access to mobile phones or any gadgets, which is a crucial requirement for the effective use of Nearpod application. This access to technology allowed the learners to familiarize the interactive features and tools provided by Nearpod. Furthermore, the researchers provided the participants with sufficient time to explore and familiarize themselves with the key features of Nearpod, such as collaborative boards, immersive reader, and various assessment tools. This preparatory phase enabled the learners to become comfortable with the platform and its functionalities, allowing them to utilize the tools effectively during the science lessons.

Table 5

Results of the Pre-test and Post-test of the Experimental Group (8-Cacao)

Range	Pre-test		Post-test	
	Frequency	%	Frequency	%
17-20	0	0	13	43.33
13-16	0	0	17	56.67
9-12	2	6.67	0	0
5-8	16	53.33	0	0
0-4	12	40	0	0
Mean	5.23		16.17	
Standard Deviation	2.01		1.29	
Verbal Interpretation	Fairly Satisfactory		Very Satisfactory	

Outstanding (17-20); Very Satisfactory (13-16); Satisfactory (9-12); Fairly Satisfactory (5-8); Needs Improvement (0-4)

As shown in Table 5, the mean score of the pre-test was 5.23 with a standard deviation of 2.01 and can be described as "Fairly Satisfactory". More than half of the learners obtained a score ranging only from 5-8 in the pre-test. Meanwhile, the mean score of the post-test was 16.17 with a standard deviation of 1.29, and can be viewed as "Very Satisfactory". Almost half of the learners were able to obtain scores ranging from 17-20. This implies that the mean score of the post-test surpassed the mean score of the pre-test indicating an observed improvement in the ISPS of the learners after the utilization

of the Nearpod application in science. During the intervention, the researchers systematically outlined Nearpod activities to the lesson structure, incorporating interactive elements such as collaborative boards to reinforce scientific concepts. This application has further enriched the learning environment, making learning more fruitful and productive. The formative assessments and gamification features in Nearpod helped to stimulate the learners' interest, promote active participation, and provide immediate feedback. This structured and interactive approach to teaching and learning facilitated a more engaging and responsive learning environment, ultimately contributing to the imaginable significant improvement in the learners' ISPS.

Several studies reported improvements in students' test scores after implementing Nearpod, with mean scores increasing from 64.7 to 84.8 in one particular study (Pupah and Sholihah, 2022) and from 74.13 to 83.05 in another (Khoirrohmah and Fadhilawati, 2024). Similarly, Nearpod's interactive features were favored by both teachers and students in science classes in high schools even if it did not significantly outperform traditional active learning methods in terms of grades (Lowry-Brock, 2016).

Significant Integrated Science Process Skills Progress

Table 6

Difference in Mean Scores between the Pre-test and Post-Test of the Experimental Group (Cacao)

	N	Mean Score (Mean±SD)	Standard Error	Significance (p<0.05)	T value
Pre-test	30	5.3±2.07	0.38	0.000	-27.14
Post-test	30	16.17±1.29	0.23	0.000	

Table 6 shows the result of the paired samples t-test conducted to statistically determine whether there is a significant difference between the experimental group's pre-test and post-test. A pre-test and post-test were administered to assess the impact of utilizing the Nearpod application. Learners gained an average score of 5.3 out of 20 on the pre-test, which increased to 16.17 on the post-test. This improvement was statistically significant, with post-test scores ($M=16.17, SD= 1.29$) being notably higher than pre-test scores ($M=5.3, SD= 2.07$); $t(-27.14), p=0.000$. Nearpod enabled the experimental group to actively learn the scientific concepts of atoms and the periodic table while practicing their ISPS more meaningfully than in the traditional classroom. As digital natives, the learners could relate well to the lessons through the regulated use of technology, which enriched their overall learning experience. This shift from a most-of-the-time passive, teacher-centered approach to a more interactive, student-centered learning environment facilitated by Nearpod may have contributed significantly to the experimental group's higher scores on the post-test. Utilizing technology-based instruction can be one of the ways teachers can apply the Constructivist approach in their classroom. The Constructivist approach is considered to be the trend nowadays in the 21st-century classroom, allowing learners to meaningfully generate new ideas by using their prior knowledge. It also emphasizes the role of teachers as facilitators of learning and the role of the students as active learners.

In the same way, several studies suggest that Nearpod, as an interactive LMS, has significantly enhanced the teaching and learning process in various educational settings. Different studies argued that Nearpod integration promotes active learning and improves learning outcomes or learners' achievement (Prasetyo, 2024; Hakami, 2020; Ryan, 2017). Regardless of class size or type, the application facilitates real-time interaction between teachers and students and encourages BYOD and flipped classroom strategies (Ryan, 2017). Furthermore, Nearpod has emerged as an effective tool for enhancing engagement, inclusivity, and interactivity in both K-12 and higher education contexts (Buttrey, 2021;

McClellan and Crowe, 2017). On the cognitive aspect, Nearpod-assisted digital daily assessments have been claimed to significantly improve learners' creative thinking abilities and metacognitive skills (Siswati et al., 2023). Relatively, a study on critical thinking skills revealed that Nearpod-assisted learning substantially improved students' performance (Wulandari et al., 2023).

Table 7 presents the result of the independent samples t-test to statistically test the significant difference between the pre-test results of the control group and the experimental group. This means that there is no existing intervention yet in the experimental group and the pre-test was conducted before the utilization of Nearpod. The experimental group registered a 5.3 average score while the control group obtained a slightly higher average score of 5.6 from a 20-item assessment. The results elicited a p-value of 0.58 and 0.29 for the control group and experimental group, respectively, which is higher than the alpha value of .05. Therefore, it can be stated that there is no significant difference between the pre-test of the two groups indicating that both groups started at the same baseline level of knowledge or skill. In addition, it must also be noted that both groups came from heterogeneous classes. It further implies that any observed differences in the post-test scores can be easily attributed to the Nearpod application.

Table 7

Mean Score Difference in the Pre-test of the Control Group (Aratiles) and Experimental Group (Cacao)

	N	Mean Score (Mean±SD)	Standard Error	Significance (p<0.05)	T value
Aratiles	30	5.6±2.11	0.38	0.58	-0.56
Cacao	30	5.3±2.07	0.38	0.29	

Recent studies indicate that Nearpod can significantly improve academic performance in higher education settings (Jiménez Rico and Velázquez Sagahón, 2023). Likewise, Nearpod has demonstrated potential in the field of language acquisition for improving L2 learners' reading comprehension and English grammar proficiency (Salvador-Cisneros and Conza-Armijos, 2022; Mastura et al., 2023). On the contrary, a study by Lowry-Brock (2016) revealed although students and teachers like the active learning opportunities offered by Nearpod, the app does not significantly improve student grades when compared to learning with the teacher's use of PowerPoint.

Table 8 revealed the comparison of the post-test scores of the experimental and control groups after the implementation of Nearpod. The results specified that the mean score of the experimental group (M=16.57, SD=1.48) was higher than the mean score of the control group (M=11.78, SD=1.34). The increase was reported to be highly significant with a p=.000 that is less than the alpha value (0.05), t(8.97). These results imply that implementing Nearpod is useful in teaching and enhancing the integrated science process skills of grade 8 learners. Furthermore, the learners have found a more interactive learning opportunity using their mobile phones which is most commonly restricted by the teachers inside the classroom. One way to develop the new generation of learners into globally competent individuals is by allowing them to explore the full potential of technology, enabling them to maximize their learning. The strategic function of the Nearpod features likely played a crucial role in enhancing the experimental group's ISPS. For instance, the "Time to Climb" feature helped make the review sessions more engaging and enjoyable for the learners. This, in turn, may have positively influenced their motivation, attention, and overall learning experience as they were able to review and consolidate their knowledge in a fun and interactive manner. In contrast, the control group, which received conventional teaching methods without Nearpod application, showed slower improvements in their ISPS. Generally, systematic integration of Nearpod's interactive features, which is tailored to the specific ISPS and topics covered in Science 8,

appears to have been a key factor in the experimental group’s significantly higher performance on the post-test compared to the control group.

Table 8

Mean Score Difference in the Post-test of the Control Group (Aratiles) and Experimental Group (Cacao)

	N	Mean Score (Mean±SD)	Standard Error	Significance (p<0.05)	T value
Aratiles	30	11.78±1.34	0.36	0.000	8.97
Cacao	30	16.57±1.48	0.39	0.000	

More studies using well-known online programs could be a potentially creative way to get teachers and students involved in worthwhile teaching and learning activities. The introduction of Nearpod application provides a variety of options that can help teachers analyze and incorporate the application in daily lessons, activities, and assessments more easily. As discussed by Nisa et al. (2023), Nearpod-based interactive science learning resources can improve junior high school students learning activities and critical thinking skills. Specifically, many studies found that the application of Nearpod and mobile-based interactive learning multimedia is effective in enhancing the science process skills of learners (Ahmed and Elmubark, 2022; Xian, 2022; Nugroho and Surjono, 2019). In undergraduate financial accounting classes, Nearpod has been found to increase student interest and positively influence learning experiences when utilized for in-class multiple-choice exams (Shehata et al., 2019). Furthermore, Nearpod, which offers features such as concept mapping, collaborative boards, and web integration, has been applied to 11th-grade science classes to teach complex topics like global warming. These tools facilitate group discussions, peer feedback, and the development of practical solutions that improve classroom interactions (Qi et al., 2022).

Learners’ Feedback on the Utilization of Nearpod in Integrated Science Process Skills Enhancement

Table 9 shows the learners’ feedback regarding the utilization of Nearpod in enhancing their Integrated Science Process Skills (ISPS). The overall mean obtained was 4.70 with a standard deviation of 0.40 and could be verbally interpreted as “Strongly Agree” for the respondents. This implies that the learners have an overall positive experience and attitude with the Nearpod application as it allows them to participate actively during the discussion, collaborate with co-learners, and express creativity.

These findings are supported by recent studies which also indicate that learners have positive attitudes toward using Nearpod in both classroom and distance learning environments (Musa and Momani, 2022; Gangadharan and Thangavel, 2023). The interactive features as well as the visual aids and simulations of Nearpod improve student participation and comprehension (Paramita, 2023). The integration of Nearpod in teaching has shown positive impacts on learning outcomes and teaching efficiency (Prasetyo, 2024).

Item number 1 obtained the highest mean, which means that the learners strongly agreed with the statement, “*I learn more from the discussion when I use Nearpod.*” This means that the Nearpod application reinforces the knowledge that the learners acquire in science. Since they are allowed to use their mobile phones or other gadgets, it probably increases their motivation for learning as long as the teacher ensures proper regulation. On the other hand. Item number 2 had the second-highest mean, which indicates that the respondents strongly agreed with the statement, “*I participate more in our discussion when I use Nearpod*”. This implies that the application employed in learning has more likely

facilitated understanding and improvement in the learners' class participation in the lesson. Compared to other app presentations, students claimed that Nearpod made their class tasks easier, and this outcome was in line with the findings of other researchers (Gallegos and Nakashima, 2018; Lowry-Brock, 2016; Siani, 2017).

This shift from traditional classroom discussion to blended learning not only enhances students' conceptual understanding of scientific concepts but also integrates their abilities in formulating concepts, solving problems, and thinking critically, which they can transfer to real-world contexts. Nearpod can help teachers engage learners in authentic learning by providing a variety of learning activities and resources, even in big classes (McClellan and Crowe, 2017).

Table 9

Learners' Feedback on the Utilization of Nearpod in Integrated Science Process Skills Enhancement

STATEMENT	N	Frequency (f)					Mean	SD	Verbal Description
		SD (1)	D (2)	N (3)	A (4)	SA (5)			
I learn more from the discussion when I use Nearpod.	30	0	0	0	3	27	4.94	0.24	Strongly Agree
I participate more in our discussion when I use Nearpod.	30	0	0	0	5	25	4.88	0.33	Strongly Agree
I collaborate well with my classmates when I use Nearpod.	30	0	0	0	7	23	4.82	0.39	Strongly Agree
I am freer to create my work when I use Nearpod.	30	0	0	0	10	20	4.76	0.44	Strongly Agree
While using Nearpod, I work with my classmates in a way that can help me learn more.	30	0	0	0	7	23	4.76	0.44	Strongly Agree
While using Nearpod, I feel that I can express my creativity more.	30	0	0	0	9	21	4.71	0.47	Strongly Agree
I am aware that my classmates and teacher can view my work when I use Nearpod.	30	0	0	0	7	23	4.82	0.39	Strongly Agree
I like the challenge in every activity given using Nearpod.	30	0	0	0	9	21	4.82	0.39	Strongly Agree
I became more interested in science after using Nearpod.	30	0	0	0	6	24	4.82	0.39	Strongly Agree
Generally, my work and participation through Nearpod improved my learning in science.	30	0	0	0	13	17	4.59	0.51	Strongly Agree
Grand Mean	30	0	0	0	76	224	4.79	0.40	Strongly Agree

Strongly Disagree (SD) (1.00-1.50); Disagree (D) (1.51-2.50); Neither agree nor disagree (N) (2.51-3.50); Agree (A) (3.51-4.50); and Strongly Agree (SA) (4.51-5.00)

Conclusion

Traditional teaching methods alone are less efficient in enhancing learners' ISPS than the technology-driven, interactive approach facilitated by the Nearpod application. This elaborates on the importance of incorporating engaging, technology-integrated instructional strategies, like Nearpod, to better support the development of essential science process skills among learners. The systematic integration of Nearpod's interactive activities into the lesson structure could be the key factor contributing to the learners' ISPS enhancement. The formative assessments and gamification features help to create

a more engaging, responsive, and structured learning environment. The technology-based classroom is the new trend in the 21st century that teaches learners to become adaptive to change. The days of strictly adhering to the old curriculum and using the behaviorist method in the classroom to manage student behavior and run the class are long gone. Students can relate well if a teacher often uses digital media and different technologies since they are digital natives.

The learners who experienced Nearpod integration were able to thrive and adapt well to the Nearpod-enhanced learning setup. Teachers nowadays need to try new techniques to shift away from passive, lecture-based teaching methods towards more interactive, hands-on learning environments. The learners' ability to actively learn scientific content and practice their ISPs through Nearpod's activities indicates that such technology-integrated strategies can help bridge the gap between rote learning and the development of essential process skills. Nearpod application has the power to transform traditional science learning into technology-driven instruction where it cultivates the critical thinking, problem-solving, and scientific inquiry skills that are essential for learner's success in the 21st century. Furthermore, the positive learners' feedback on the Nearpod application further suggests that technology-based tools can foster greater student motivation, participation, and overall satisfaction with the learning process. This has important implications also for improving learners' performance and nurturing a love for science among students.

Recommendations

School administrators and teachers may consider integrating more interactive educational technologies, such as the Nearpod application, in science teaching as it offers a flexible learning modality. By adopting Nearpod and similar interactive platforms, educators can create a more engaging learning environment that promotes the development of essential science process competencies. Schools may prioritize investing in the use of interactive educational technologies, such as the Nearpod application, not only in science but also in other subject areas. The integration of technology-driven platforms can better align with students' learning preferences and facilitate adaptability to the changing landscape of the 21st century. The School Heads may encourage teachers to attend several training workshops that tackle the utilization of advanced technologies, generative AIs, and different educational applications that promote 21st-century skills as it can be part of their reskilling and upskilling initiatives and professional development of the teachers in the field. The integration of Nearpod into other learning areas and its inclusion for other grade levels are highly recommended. Exploring the transferability of this technology-driven approach to enhance competencies in subjects other than science can yield valuable insights for holistic educational development.

Prospective researchers may investigate the long-term retention of skills acquired through Nearpod utilization. Its effectiveness across different educational contexts, such as its impact on specific groups of learners or on other dimensions of learning like critical thinking and creativity, should be further explored. Future studies on this topic may consider incorporating a pilot testing phase to further validate the research instruments and enhance the quality of the data collected. Other methods like pre-experimental research design may also be employed to include all students in using Nearpod inside the classroom. Also, future studies may consider using a qualitative research method to strongly support the result of the quantitative data.

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Assessment of the Use and Determinants of Adoption of PICS Bag Technology among Grain Merchants in Dawanau Market, Kano State

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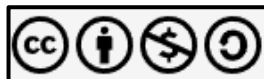
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Abstract

Postharvest management of agricultural produce presents a considerable difficulty in developing countries like Nigeria. Staple crops of economic importance, including rice, wheat, cowpea, maize, and wheat, are prone to losses, primarily owing to insect pests at storage. The current study assessed the use and determinants of adoption of Purdue Improve Crop Storage bag (PICS) Technology among grain merchants in Dawanau market, Kano state. Multi-stage sampling techniques were used for the study. A total of 80 merchants were sampled. Data collected were analyzed using descriptive statistics, logistic model and garrets ranking techniques. The result revealed that the merchants are above economically active age, with household size beyond the national average and quit years of experience. Also, the result shows that majority (95%) are aware of PICS bag. The determinants of PICS bag technology indicated that age, household size, membership and extension contact are statistically significant in the adoption with R-square value of 0.45. The result further indicates that 46% of the merchants had never utilized the PICS bag technology due to the high cost of the technology. Garret ranking indicates inadequate finance and high cost of the PICS bag as the major constrained to the adoption and used of PICS bag technology among the merchants. The study, therefore, recommends that the government at all levels should play an important role by subsidizing or offering financial incentives to lower the cost of PICS bags. Additionally, NSPRI should create a feedback system where merchants can share their experiences, challenges, and suggestions regarding PICS bags. Lastly, targeted awareness campaigns should be initiated to inform merchants about the advantages of using PICS bags, particularly their effectiveness in reducing post-harvest losses.

Keywords: *Assessment, Adoption, Determinants, Food Security, Grains merchants, Garret ranking, PICS Bag Technology, Postharvest Management*



Introduction

Postharvest management of agricultural output presents a substantial difficulty in generating agricultural commodities resistant to deterioration. Staple crops of economic importance, including rice, wheat, cowpea, maize, and wheat, are prone to losses, primarily owing to insect pests at storage. Several storage methods exist for legumes and cereal grains, including traditional/local methods, insecticides, and hermetic systems. The most significant attribute of storage systems is maintaining grain integrity for a specific amount of time while minimizing quantity and quality loss.

Hermetic storage technologies, as an alternative to chemical control and traditional approaches, have sparked substantial interest among various actors, including farmers, the commercial sector, governments, and other development agencies. Hermetic storage technologies are useful because of the airtight conditions that are established during storage. Biological processes like respiration and metabolism, fueled by insects and other organisms, deplete oxygen and release carbon dioxide within hermetic containers (Murdock et al., 2012). The Purdue Improved Crop Storage (PICS) bag is a hermetic storage solution originally designed for cowpeas in Western Africa, now expanded to maize, Bambara nuts, and rice (Sudini et al., 2015). The system features two inner high-density polyethylene layers for hermetic sealing and an outer woven plastic layer for protection (Williams, Murdock & Baributsa, 2017).

Despite the significant advancements in cowpea storage with the introduction of Purdue Improved Crop Storage (PICS) bags (Baributsa et al., 2020), further research is needed to assess their long-term efficacy, scalability, and the development of alternative hermetic storage solutions in West and Central Africa to address postharvest losses and promote sustainable food security. Postharvest losses significantly impact food security and agricultural productivity in developing countries. Unlike in developed economies where such losses are often attributed to consumer behavior, developing countries primarily face challenges related to financial constraints, inefficient management, and technological limitations (Conteh et al., 2015; FAO, 2011; Premanandh, 2011).

Improved storage technologies offer potential solutions to reduce post-harvest losses (World Bank et al., 2011) and enhance food security and household well-being (Fuglie, 1995; Parmer et al., 2017). However, farm households, being diverse in their characteristics, may face limitations in adopting advanced storage technologies due to financial constraints, lack of information, and limited access to technology (Foster & Rosen Zweig, 2010; Tesfaye & Tirivayi, 2018). The Food and Agriculture Organization (FAO) of the United Nations emphasizes that increased agricultural investment in developing countries can facilitate the adoption of new technologies and potentially contribute to poverty reduction.

PICS (Purdue Improved Crop Storage) bags were first introduced in Nigeria in 2007 as part of a Bill & Melinda Gates Foundation-funded study. This initiative sought to reduce post-harvest losses in cowpea (bean) storage by offering farmers a pesticide-free, hermetic storage solution (Moussa et al. 2014). The bags were later adopted in several states, including Kano, via awareness campaigns and agricultural extension programs.

Agricultural extension programs and different farmer-focused awareness efforts aided the broad adoption of PICS bags in Kano and other parts of Nigeria. By sealing the crops in the airtight PICS bags, farmers could effectively prevent pest damage for extended periods, thus contributing to food security and reducing economic losses (Baributsa et al. 2010).

Several improved storage technologies have been introduced to farmers, merchants and agro-processors in Nigeria and Kano state in particular. However, research on the extent of PICS bag usage and the factors influencing their adoption in this zone remains scarce. More specifically, no research from

our literature search has been done to analyze the determinants for adoption of PICS bag in the study area. The dearth in information as to the extent to which PICS bag are adopted in Dawanau Market, Kano state, necessitated this study. Hence, this research seeks to bridge this gap by assessing the following objectives: to identify and describe the socio-economic characteristics of the merchants; to assess the extent of PICS bag technology usage by the merchants; to determine the factors influencing the adoption of PICS bag technology by the merchants; and lastly, to identify and describe the major constraints in the use of PICS bag technology. By analyzing the socio-economic characteristics of merchants and identifying challenges in PICS bag adoption, this study seeks to provide valuable insights for extension agents, policymakers, and future research focused on mitigating postharvest losses and enhancing food security.

Materials and Methods

The study area was carried out at Dawanau International Grains Market, situated in Kano State. The market that deals with both cash and food crops, and has served the grain needs of the state, nation, and neighboring nations, as well as operating as a storage hub for grains, to regulate the commodity's price when the need arises. A three-stage sampling technique was adopted for the study. In the first stage, a purposive sampling technique was used to select the Dawanau International Grains Market based on the preponderance of grain marketing activities in the state. The market has six sections, as follows: i). Section A for Cowpeas, Soya Beans, Maize, Hibiscus, Sesame, and Locust Bean; ii) Section B for Cassava Chips and Flower, Groundnut, Bambara nuts, and Local Wheat; iii) Section C for Yam Tubers, Sugarcane, and Local Chickens; iv) Section D for Retailing of All Kind of Food Items; v) Section E for Transport Companies and Agents, Mechanics, Spare Parts, Chile Pepper, and Slaughtered Animals; vii) Section F for Warehouses and Machinery (cleaning, loading, and offloading). The second stage, involved the purposive selection of section (A) out of six sections in Dawanau market based on the high concentration of grain marketers in the section. Due to unavailability of registered number of merchants in the section, the last stage involved the random selection of eighty (80) respondents which gives the total number of sample merchants. Meanwhile, primary data was used for this study which was collected through the use of a well-structured questionnaire administered with the aid of computer based assisted interview (mWater) Also, information from articles, gazette, journals, and unpublished works etc. has been used for the course of this research as secondary data.

Tools of Analysis

Data Analysis was carried out using SPSS version 20 and STATA version 13 software. Descriptive statistics such as mean, frequency and percentage, Binary Logistic regression model and Garrets Ranking Technique were used to achieve the objectives for the study.

Diffusion of Innovations Theory complimented by Technology Acceptance Model (TAM) are the theories used in this study. Diffusion of Innovations Theory, proposed by Everett Rogers in 1962, is one of the most influential frameworks for understanding how new technologies, products, or ideas spread across a population. Rogers (2003) defines diffusion as "the process by which an innovation is communicated through certain channels over time among the members of a social system." The theory describes the stages of adoption—knowledge, persuasion, decision, implementation, and confirmation—and classifies adopters as innovators, early adopters, early majority, late majority, and laggards.

Diffusion of Innovations Theory provided a strong theoretical foundation for the study. This theory explains how, why, and how quickly new ideas and technologies spread across civilizations. In terms of PICS bag adoption, it helped provide an understanding of how grain merchants at Dawanau Market were

adopting PIC bag technology, the factors influencing their decision, and the role of innovation characteristics such as relative advantage, compatibility, complexity, trialability, and observability.

An attempt is made to recognize the major constraints faced in the use of PICS bag technology by Dawanau grain merchants in Kano State. The estimated percentage position was converted into scores using Garrett's Table, as outlined by Garrett and Woodworth (1969) (Ao & Jamir, 2020). The identified constraints faced by the grain merchants in the Dawanau market are ranked using Garrett's Ranking Technique. The technique was utilized to rank respondents' preferences for various components and characteristics of the practice process. It is used to find the most significant factor that influenced the respondent in their practices. Founded on Garret's Ranking technique, the study had the respondents rank different problems and outcomes based on their impact thereby converting them into score values and ranking with the help of the following formula:

$$\text{Percent position} = \frac{100(R_{ij}-0.5)}{N_j}$$

Where

R_{ij} = Rank given for the i^{th} variable by j^{th} respondents

N_j = Number of variables ranked by j^{th} respondents

The Percent Positions and Garret Values

The Garret rankings were calculated using the applicable Garret Ranking methodology. The garret value was computed using the Garret ranks. The Garret tables and scores for each problem in the preceding table were multiplied by the recorded scores in the next table, and the overall Garret score was obtained by adding each row.

$$\text{Percent position} = \frac{100(R_{ij}-0.5)}{N_j}$$

Results and Discussion

Socio-Economic Characteristics Merchant in the Study Area

The result of socioeconomic characteristics is presented in Table 1. It is evident that the grain merchants were dominated by the aged merchants (51.69 years). This means they are above economically active age brackets. Thus, they are usually not self-motivated and innovative. According to Mwangi and Kariuki's (2015) research, young farmers are more dynamic and willing to take on the risks associated with adopting new agricultural technologies than older farmers, who are frequently more conservative (traditional) and hesitant to adopt new technologies. Household size indicated that the majority had more than 10 family members with a mean of 12 persons. However, the mean household size of 12 persons is higher than the national average of 5, as recorded by the National Bureau of Statistics (2010). Responses on marketing experience show a mean of 21 years, indicating that merchants have been involved in the profession for quite some period.

Table 1

Quantitative variables: Age, Household size and years of experience

Variables	Minimum	Maximum	Mean	S.D
Age	18	75	51.69	12.181
Household size	1	31	12.49	7.855
Years of experience	3	52	21.13	9.80

Source; Field survey 2023.

In Kano State, access to agricultural extension services is facilitated by government agencies, non-governmental organizations, and private agricultural firms, especially on the first contact. The Agricultural Development Program (ADP) is the primary government institution responsible for providing extension services in the state. Extension officers under the ADP are tasked with disseminating information on improved farming practices, new technologies, and market opportunities to farmers and merchants (Abubakar et al. 2018). Subsequent contacts can be made directly with the extension of agents.

These findings corroborate those of Manda et al. (2016), who demonstrated that farmers with frequent interactions with extension agents were more likely to adopt sustainable intensification practices. Similarly, Udimal et al. (2020) found that access to extension services significantly influenced farmers' decisions to adopt improved storage technologies, such as hermetic bags.

Merchants at Dawanau Market, like many others in rural and peri-urban areas, may have difficulty accessing extension services since there is an insufficient number of extension agents to serve the large population of farmers and merchants, because the extension agent-to-farmer ratio in Nigeria is far lower than the desired level, implying that many farmers and merchants do not receive timely or adequate extension services (Adedoyin, 2020). Additionally, lack of education and language hurdles sometimes prevent or limit merchants from completely comprehending the information offered by extension agents, particularly if it is not delivered in their native language or adapted to their reading levels.

Table 2

Qualitative variables: Sex, marital status, membership, access to extension agent, awareness on PICS bag and participation on use of PICS bag.

Variables	Frequency	Percentage (%)
Sex:		
Male	80	100
Marital Status:		
Single	4	5
Married	75	93.8
Widowed	1	1.3
Membership:		
Member	68	85
Non-member	12	15
Extension Access:		
Access	56	70
Non-Access	24	30
Awareness on PICS bag		
Aware	76	95
Not Aware	4	5
Use of PICS bag		
Yes	32	40
No	48	60
Total	80	100

Source; Field survey 2023.

The result in the Table 2 revealed that 100% of the respondents were male. The unavailability of female is probably because the business requires frequent outing from home to the market, which is against the culture and religion of the people in the study area. This is similar to the findings of Yakubu, (2010) who reported that majority of the respondents of Purdue improved cowpea storage in Jigawa State

were male. Also, 93.8% of the marketers were married. Such a result is expected, as married people bear the responsibility for their family members, making them more committed and able to make rational decisions in business. Also, Table 2 revealed that 70% have access to extension agents and this was exceptionally higher in the area due mainly to the merchants selected for the study. Also, 85% of the surveyed merchants were members of an association. Membership of association offer certain benefits to members such as input procurement, information on output market and subsidy.

Table 3 shows the sources of information about PICS bag reported by respondents. Markets (53.2%) and PICS project (32.8%) were the main sources of information for most of the grains' merchants. This is expected as the technology is quite aware in the market. Other sources include radio 12.5% and friends (1.5%). Also, more than a quarter (41.1%) of the merchants purchased PICS bags from the market. On the basis of the reason for not using PICS bags, 86.8% of the merchants reported that the technology is too costly for them to afford. Hence, there is a need for government intervention to support the use of the technology for better food safety and security.

Table 3

The table below shows the source of information on PICS bag, source of PICS bag and reason for not participating

Variables	Frequency	Percentage (%)
Source of information on PICS bag:		
Radio	8	12.5
Markets	34	53.2
PICS project	21	32.8
Friends	1	1.5
Source of PICS bags(purchase):		
PICS project	8	14.3
ADPs	10	17.9
Markets	23	41.1
Others	15	26.8
Reason for not using PICS bag:		
Prices is too much Costly	46	86.8
No Interest	2	3.8
Old method is better	5	9.4

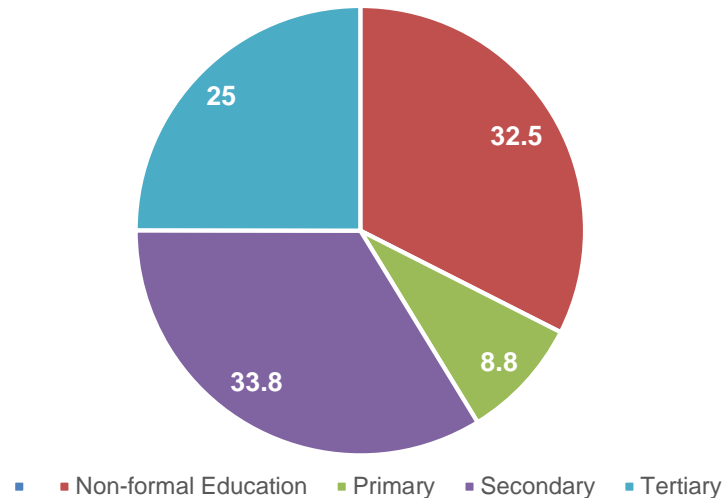
Source; Field survey 2023.

The results in Figure 1 show that 33.8% of the respondents had secondary education, followed by tertiary (25%), non-formal (32.5%), and primary (8.8%). This implies that formal education was the most prominent education level attended by most of the respondents. This finding is in line with that of Yusuf et al. (2009) who reported that 62% of grains merchant in the urban areas had formal education in Sokoto State.

The main occupation of the respondents, as presented in Figure 2, revealed that more than fifty percent (66.3%) of respondents considered trading/marketing grains as their predominant occupation and source of livelihood. 26.3% engage in farming, 6.3% work as civil servants, while others (1.3%) engage in other livelihood activities such as barbing, masonry, bricklaying, etc. It is common in developing countries like Nigeria for household members to engage in other occupation to complement their earnings.

Figure 1

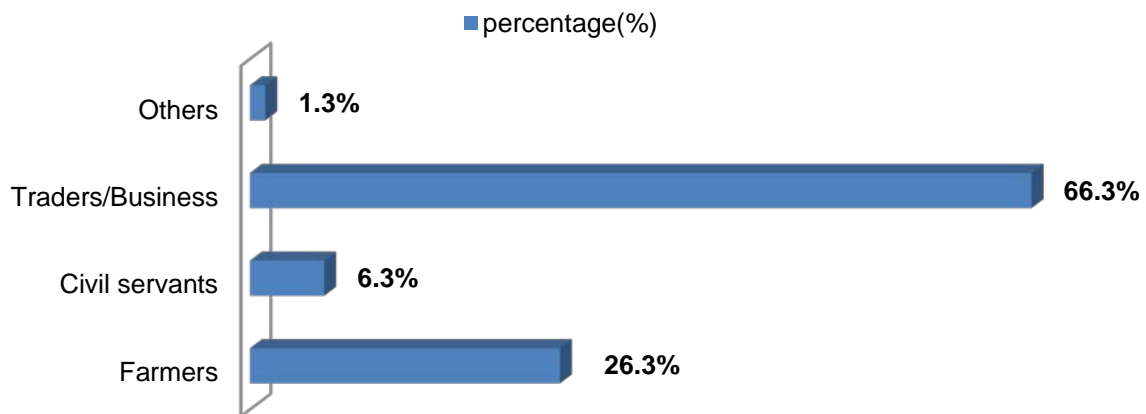
Distribution of the respondents based on educational level



Source: Field survey 2023.

Figure 2

Shows the Distribution of the occupation of the respondents.



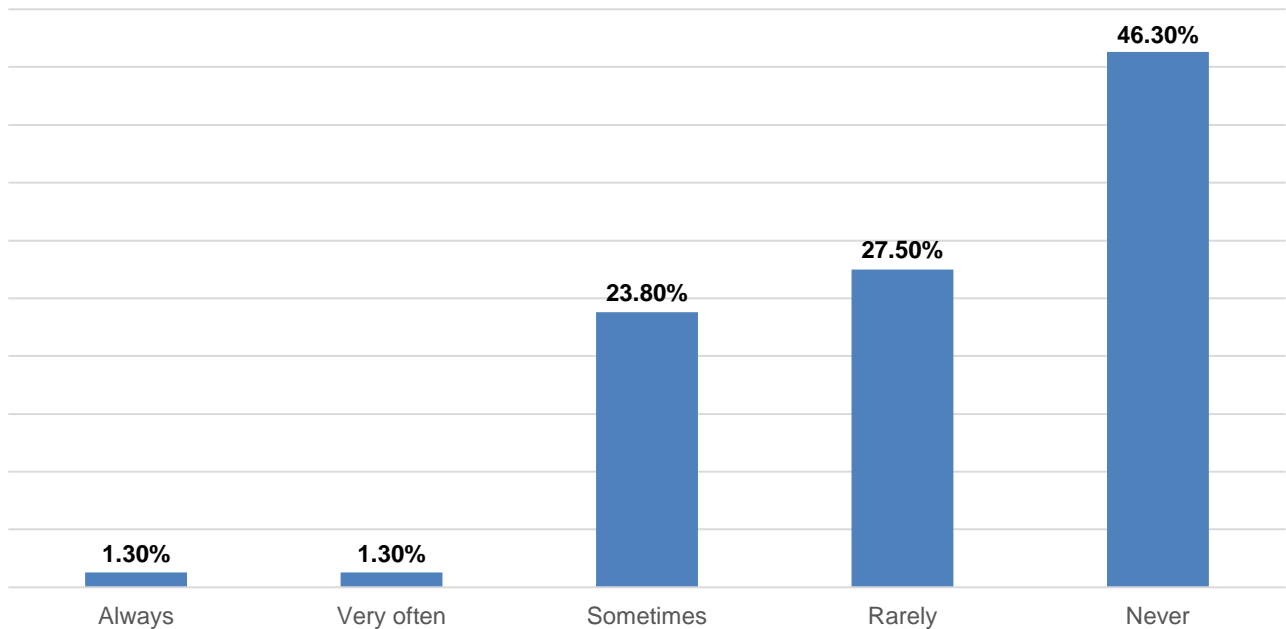
Source: Field survey 2023.

Extent in the use of PICS bag technology by the merchants

The results in Fig 3 revealed the extent of PICS (Purdue Improved Crop Storage) bag usage among merchants in the study area. The findings reveal that a significant majority of the merchants either rarely or never use PICS bags, with 46.3% reporting that they never use them and 27.5% using them rarely. A smaller proportion of merchants use the bags occasionally (23.8%), while only a tiny fraction (1.3%) report consistent use ("Always" or "Very Often"). It implies that the adoption of PICS bags among these merchants is generally low. The high percentage of those who rarely or never use the technology may indicate barriers such as limited awareness, accessibility issues and cost concerns. Identifying and addressing these challenges could be key to increasing the adoption and regular use of PICS bags in this population.

Figure 3

Shows the distribution of respondents on extent use of PICS bag



Source: Field survey, 2023

Socioeconomic Determinants of Merchants Adoption of PICS bag in the Study Area

The table 4 displays the findings of a binary logistic regression analysis, which explores the impact of different socioeconomic factors on the adoption of PICS bag technologies by merchants. The analysis was conducted using a forward stepwise method, where variables are added to the model incrementally based on their statistical significance. The R-square value of 0.450 suggests that about 45% of the variability in PICS bag adoption can be explained by the socioeconomic factors included in the model.

Age: The coefficient for age is positive (0.175) and highly significant at the 1% level ($p = 0.000$). This indicates that as merchants get older, their likelihood of adopting PICS bag technologies increases. Older merchants often believe their accumulated expertise and experience make them better equipped to evaluate technological information compared to younger farmers (Mignouna et al., 2011; Kariyasa & Dewi 2011).

Household size: The coefficient for household size is negative (-0.208) and also significant at the 1% level ($p = 0.001$). This suggests that larger households are less likely to adopt PICS bags. In larger households, there might be more diverse opinions and preferences, leading to differing attitudes towards adopting new products like PICS bags. Factors such as budget constraints, storage space availability and individual preferences can impact adoption. Smaller households might find it easier to reach a consensus on decisions, but the specific influence would depend on cultural, economic, and social factors.

Membership in Organizations: The coefficient for organizational membership is positive (1.836) and marginally significant at the 10% level ($p = 0.058$). This implies that merchants who are members of organizations are more likely to adopt PICS bag technologies, although the effect is weaker compared to age and household size. Membership tends to increase ones' access to information of PICS technology. This variable is expected to have a positive sign in the model.

Access to Extension: The coefficient for access to extension is positive (1.813) and significant at the 5% level ($p = 0.012$). This implies that merchants with access to agricultural extension services are more inclined to adopt PICS bag technologies. Extension representatives typically advise merchants on the presence, effective use, and benefits of PICS bag technology. Extension agents serve as a link between technology developers (researchers) and users. This helps to lower transaction costs associated with disseminating information about PICS bag technology to a diverse community of farmers (genius et al, 2010).

Table 4

Result of Binary Logit Regression (Forward Step-wise) for the Influences of Socioeconomic on the Adoption of PICS bag Technologies.

Explanatory variables	B	S.E	Wald	Df	Sig.
Age	0.175	0.45	14.958	1	0.000***
Household size	-0.208	0.64	10.566	1	0.001***
Membership	1.836	0.969	3.587	1	0.058*
Extension Contact	1.813	0.725	6.252	1	0.012**
Constant	-5.954	2.148	7.684	1	0.812
Observation(N) =80					
R-square = 0.450					
Dependent Variable: PICS bag Adoption					

Source: Survey, 2023 Note: ***, **, * = significant at 1%, 5%, and 10% probability levels respectively.

Major Constraints Face to the Use of PICS Bag Technology by Dawanau Grains Merchant in Kano State

The estimated percentage positions were converted into scores using Garrett's Table, as outlined by Garrett and Woodworth (1969). For each factor, individual scores were summed, and total and mean scores were calculated. The factor with the highest mean value is considered to be the most important. Below is the tabular representation of the major constraints faced in the use of PICS bag technology by Dawanau grains merchants in Kano State. The table provides a random categorization of the constraints found during personal interviews and with the help of questionnaires.

Table 5

The table shows the preference and ranking of major constraints faced to the use of PICS bag Technology by Dawanau Grains merchant in Kano State.

Major constraints facing by the grains merchant	Ranks giving by the respondents					
	1 th	2 th	3 th	4 th	5 th	6 th
Inadequate finance	29	10	7	6	6	22
Lack of Awareness	63	5	2	1	0	9
Location of Vendor's unknown	1	2	11	13	22	31
Poor Quality of Cowpea	1	1	6	12	22	38
Inadequate of sufficient training on PICS bag	0	1	4	10	13	52
Un-availability of PICS bag	0	3	4	9	14	50

Source: Field survey 2023.

The result is provided in the following table below.

Calculation of Garret Value and Ranking

Table 6

The description of Garret value and ranking of problems faced by Grains merchants are shown below.

s/No	100(Rij-0.5)/NJ	Calculated value	Garrett Value
1	100(1-0.5)/6	8.33	77
2	100(2-0.5)/6	25	63
3	100(3-0.5)/6	41.66	54
4	100(4-0.5)/6	58.33	46
5	100(5-0.5)/6	75	37
6	100(6-0.5)/6	91.66	23

Source: Author's computation, 2023

Table 7

This table above shows the Garrett value of the respondents

Variables	Ranks given by the respondents						Total	Average	Rank
	1 th	2 th	3 th	4 th	5 th	6 th			
In-adequate finance	2233	4851	77	77	0	0	7238	90.47	1 st
Lack of Awareness	630	315	126	63	63	189	1386	17.32	6 th
Location of Vendor's unknown	378	208	594	324	216	216	1836	22.95	5 th
Poor Quality of Cowpea	276	0	598	552	460	414	2300	28.75	4 th
In-adequate of sufficient training on PICS bag	222	0	814	814	481	518	2849	35.61	3 rd
Un-availability of PICS bag	506	207	713	874	1196	1150	4646	58.07	2 nd

Source: Author's computation, 2023

Major constraints face to the use of PICS bag Technology

Based on Garret's Ranking Technique, it was revealed that 'inadequate finance' was the major problem, with the highest Garret score of 7238 and an average score of 90.47. This is not surprising because, earlier, the respondents indicated that 60% of the respondents are not utilizing the PICS bag, due to the high cost of the technology. This is in line with economic theories on technology adoption that suggest that initial investment costs can be prohibitive for smallholder farmers and small-scale merchants. This could be associated with the fact that their low-income levels or lack of access to credit. Also, Moussa et al. (2014) reported in agreement that the adoption of PICS bags was still constrained by financial issues, even though PICS bags were widely recognized for their efficacy in reducing post-harvest losses.

The least constraints with an average score of 28.75, 22.95 and 17.32 are poor quality of grains, local vendor's location and lack of awareness respectively. The low score attributed to the poor quality of grains indicates that grain quality is not a major factor influencing merchants' adoption of PICS bags. This could be due to the fact that PICS bags are primarily used for their ability to protect grains from pests and spoilage, rather than being directly associated with the quality of grains at the point of purchase. This finding is in line with studies like that of Moussa et al. (2014). Also, the relatively low score for the constraint "local vendor's location" suggests that, while some merchants may find it challenging to locate PICS bag vendors, this is not a predominant barrier to adoption. It is possible that merchants are aware of vendors or can locate them with relative ease. This is contrary to what Baributsa et al. (2010) found

out where they noted that in some regions, the distance to vendors and the availability of PICS bags in local markets posed a moderate barrier to adoption.

The lowest average score of 17.32 for "lack of awareness" implies that most retailers are properly aware of the PICS bag technology and also indicates that the merchants probably polled were well-informed about the existence and benefits of PICS bags. This supports the findings of Baributsa et al. (2014).

The adoption challenges can only be met if the major constraints faced in the use of PICS bag technology by Dawanau grains merchant in Kano state are identified and prioritized for further improvement. Based on Garret's Ranking Technique, it was revealed that 'inadequate finance' was the major problem, with the highest Garret score of 7238 and an average score of 90.47. This is not surprising because, earlier, the respondents indicated that 60% of the respondents are not utilizing the PICS bag, due to high cost of the technology. The result is in line with the findings of Katanga et al. (2016) whose study revealed that, 44.7% of the traders were constrained by in-adequate finance. Accordingly, 'Unavailability of PICS bag' with Garret scores of 4646 and an average score of 58.07 is represented second. The calculation with an average score of 35.61 ranked 'Location of Vendor's unknown' third, while the least constraints with an average score of 28.75, 22.95 & 17.32 are poor quality of grains, local vendor's location and lack of awareness respectively.

Conclusion

It can be concluded from the study that grains merchants in Dawanau international Grains market, Dawakin Tofa local Government Area of Kano state were all men and display a lower level in terms of using PICS bag Technology. The reason for the low level used of this technology is due to high cost of the technology between the old methods and the presence method of storage of grains. Also, grains merchants in the study area have very low adoption, which is an indication of their non-use of the PICS bag. Furthermore, access to extension agents/services was high. Hence, using one marketer to deliver a message can help since members tend to help build one another's capacity, leading to merchant-to-merchant diffusion of messages. Finally, inadequate finance and the high cost of PICS bags were the major constraints in the use of the technology, among others.

Recommendations

Based on the findings of this study, the following recommendations were made:

1. The government and policy makers need to play an important role by subsidizing or offering financial incentives to lower the cost of PICS bags, making them more affordable for merchants. This strategy could encourage greater trial and eventual adoption of the technology.
2. Research Institute such as Nigerian Stored Products Research Institute (NSPRI) should create a feedback system where merchants can share their experiences, challenges, and suggestions regarding PICS bags. This input can be used to improve the product and its distribution process.
3. There is a need to train more extension agents on postharvest and value addition technologies to enable more capable hands in addressing food security and safety.
4. Implement training programs to educate merchants on the correct use of PICS bags, ensuring they fully understand how to optimize the benefits.
5. Initiate targeted awareness campaigns to inform merchants about the advantages of using PICS bags, particularly their effectiveness in reducing post-harvest losses.

6. The study further calls for research into the area of post-harvest storage, food security and farmers' participation in the adoption of storage technologies.

Limitations of the Study

The study is limited to Dawanau international grains market which might not capture the broader usage or challenges of adopting PICS bag technology in other states.

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Enhancing Reading Fluency: Repeated Reading of Researcher-Made Localized Materials

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Abstract

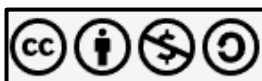
The ability to read fluently and effectively is one of the keys to opening doors to educational success. Although the importance of fluent reading has been taught to learners at school, there are still many students who are having difficulty reading fluently. To address the problem stated, researchers of this study used four (4) researcher-made localized materials, which are repeatedly taught. This study utilized the multiphase mixed method research design to determine the effect of the intervention program on the reading fluency of the students. It was conducted to determine the struggling readers of 11th-grade HUMSS students at John J. Russell Memorial High School. The researchers conducted pre-assessment reading and determined 35 readers who subsequently served as the participants. After the intervention program, it was observed that the participants attained higher Word Correct Per Minute (WCPM) in their post-test. The pre-test recorded mean score was 116.97 WCPM, while the post-test recorded mean was 139.66 WCPM. The p-value of the data set is ($p < 0.001$), which denotes that the difference between the results of the pretest and posttest is highly significant. This was also further strengthened by the feedback obtained from the students through a guided interview. Based on the participants' statements, repeated reading of researcher-made localized materials has improved their reading speed and their reading accuracy.

Keywords: *Contextualization, Intervention Program, Philippine Context, Reading fluency, Repeated Reading, Researcher-Made-Localized materials, Struggling Readers, Word Correct per Minute*

Introduction

Reading is a fundamental skill. The ability to read fluently and effectively has the potential to open doors to educational success. As reading fluency ought to be an important skill to understand and decipher the meaning of the text, students lack the ability to understand passages critically. The acquisition of language proficiency is both a means and an end to educational achievement. However, fluency in reading is always dealing with a complex interaction of factors that results in students' poor reading, learning, and achievement. Although the importance of fluent reading has been taught to learners at school, there are still many students who have difficulty reading fluently.

Among all the countries that took part in the Program for International Student Assessment (PISA), the Philippines had a notable percentage of low scorers. Eighty percent of Filipino students fell



short of the required reading proficiency. The pupils' deficiency in fundamental reading and comprehension skills is the reason for their low performance in the subjects of Science, Math, and English (OECD, 2016). Numerous scholars debate why the Philippines, one of the world's best English-speaking nations, comes in last in the poll. They claim that the basic word definition is the main emphasis of reading instruction here; while this is true, it poses issues for reading comprehension and fluency. Essays should be all around Filipino students, who should then attempt to relate to and think about them to improve their comprehension. They added that mastering the mother tongue by heart will help one comprehend the second language correctly. Prioritizing the study of the second language, English, comes after the first language is mastered. They claim that when pupils learn both their mother languages and English at the same time, they become confused (Caraig & Quimbo, 2022).

Among all the countries that took part in the Program for International Student Assessment (PISA), the Philippines had a notable percentage of low scorers. Eighty percent of Filipino students fell short of the required reading proficiency. The pupils' deficiency in fundamental reading and comprehension skills is the reason for their low performance in the subjects of Science, Math, and English (OECD, 2016). Numerous scholars debate why the Philippines, one of the world's best English-speaking nations, comes in last in the poll. They claim that the basic word definition is the main emphasis of reading instruction here; while this is true, it poses issues for reading comprehension and fluency. Essays should be all around Filipino students, who should then attempt to relate to and think about them to improve their comprehension. They added that mastering the mother tongue by heart will help one comprehend the second language correctly. Prioritizing the study of the second language, English, comes after the first language is mastered. They claim that when pupils learn both their mother languages and English at the same time, they become confused (Caraig & Quimbo, 2022).

To give and aid on poor reading fluency of the students, Rafel and Tamban (2022) discovered that Localized reading resources assist learners in understanding words and sounds while also allowing teachers to make direct connections with students' cognitive and emotive domains. This improves students' academic performance in terms of their English subject test outcomes. Moreover, Saquido and Velasco (2024) pointed out that Teachers as curriculum makers and implementers should craft and provide the supplemental materials applicable to address the needs of the learners. Students' reading fluency, comprehension skills, and growth as proficient readers all improve as they use local materials. Additionally, this may assist them in appropriately pronouncing the words they have learned. Because they frequently attempt to create connections between what they already know and their surroundings, the students can improve their critical thinking skills and will be able to communicate their newly acquired knowledge from the literature included in the materials with friends and family.

During the classroom observation, they discovered a similar problem of reading fluency with the students at John J. Russell Memorial High School. As language proficiency is both a means and an end to educational achievement, the acquisition of its proficiency requires fluent reading nonetheless fluency in reading is always met with a complex interaction of factors resulting in students' poor reading, learning, and achievement.

Even though the secondary level has a variety of reading issues many of which are more serious than those at the primary level, reading instruction and remediation are often only provided in the elementary-level school environment. Due to this, children in the secondary level who suffer from limited reading abilities frequently exhibit reading-related flaws, such as inadequate comprehension techniques, little foundation knowledge, and a limited vocabulary. Moreover, according to Lee (2018), learners who struggle with reading have a higher risk of dropping out of school, becoming unemployed, and having poorer incomes. Finding a good reading intervention program while pupils are still in high school is so

essential.

To address the problem stated, researchers referred to various studies and one of these is repeated reading. According to Veenendaal, et al. (2014), repeated reading is a process of dividing a piece into manageable sections that may be read and reread several times in a minute. Before reading the following section, students concentrate on reading the first section of the story quickly and precisely. This model's repetition can help readers understand the story more thoroughly and more fluently. Moreover, for students to easily relate themselves and understand the materials, the use of contextualization and localization of reading passages may also be used.

Moreover, for students to easily relate themselves and understand the materials, the use of contextualization and localization of reading passages may be used. Both localization and contextualization adhere to the principles of making the lesson flexible, imaginative, pertinent, meaningful, and adaptable to students' cognitive levels and instructional requirements. Teachers must be adaptable and imaginative while utilizing localization and contextualization in the classroom. Henriksen (2021) recommended that instructors in charge of developing localized teaching resources attend seminars and training courses on the steps involved in developing effective learning resources.

Common issues about reading fluency have been observed by the researchers at John J. Russell Memorial High School. In fact, in the Regional Mid-Year Assessment for the subject Oral Communication of grade 11, only 165 out of 479 students, or 34.45% who took the exam achieved or exceeded the Minimum Proficiency Level. To determine the participants of the study, the researchers used the universal screening tool by DIBELS (Dynamic Indicators of Basic Early Literacy Skills). The DIBELS assessment uses one-minute timed readings, letter naming, nonsense word reading, and sight word identification. Adults, usually teachers, administer the assessment. Teachers give subtests to determine a score/rating for each topic listed above. Each of these components has its own score/rating scale (Deeney, & Shim, 2016). There are 35 students out of the whole population of 60 who were not able to attain the benchmark for their grade level. With that, the researchers used the repeated reading strategy of Researcher-made-localized material as the intervention for this study.

Materials and Methods

This study utilized the multiphase mixed method research design by Creswell (2013). It includes the descriptive quantitative research design, one group pre-test-post-test research design, and sequential explanatory mixed method research design.

Multiphase is a mixed-method approach in which researchers conduct several mixed-method projects, which may include mixed-method convergent or sequential approaches that may only include the quantitative or qualitative design in a longitudinal study with a focus on a common objective for multiple projects (Creswell, 2013).

In the first phase of the study or the identification of the participants, the researchers determined participants using a universal screening tool to measure the learner's reading rate in words per minute. According to Brysbaert (2019), teens read at a rate of 195 to 204 words per minute when reading silently and 150 to 183 when reading aloud. With that, students who were unable to read 150 words per minute were determined as struggling readers or below-average readers and became the participants of the study. The researchers only chose those students below the benchmark level, as they need more assistance in reading. Furthermore, this also allows the researchers to become more focused on the implementation of the intervention program in the small group.

The researchers employed a purposive sampling technique by selecting students who did not achieve the required word correct per minute for their grade level. Purposive sampling is a non-probability

sampling technique in which units are chosen because they possess traits that are required in the sample. Participants are selected based on their fluency rates, and those participants who are reading below the 11th-grade benchmark become the participants of the study.

After the conduct of the pre-assessment reading, the researchers selected the students who were reading below the average rate. Therefore, out of the total population, 35 students received the intervention program.

For the conduct of the intervention, the researchers used the DIBELS instrument. The DIBELS assessment uses one-minute timed readings, letter naming, nonsense word reading, and sight word identification. Adults, usually teachers, administer the assessment. Teachers give subtests to determine a score or rating for each topic listed above. Each of these components has its own score/rating scale (Deeney & Shim, 2016). In this study, the researchers used Philippine English as the standard or the basis for giving scores to the students' fluency rate. The Philippine variety of English has acquired specific traits of pronunciation, vocabulary, grammar, and discourse determined by the local languages and culture of its Filipino speakers (Anderson, 2017).

The researchers created four localized reading materials for the research participants. Each material is divided into parts for each working session. These materials were validated by the Language, and Research Master Teachers to ensure their accuracy and alignment with the needed competencies of the grade 11 curriculum. They also ensured that the materials were based on the students' local environment and knowledge for them to have a more meaningful reading experience.

The researchers gave the students a copy of Researchers-Made-Localized Reading Materials and instructed them to read it out loud three times during the work sessions. They corrected any errors the student had made while reading the material. Words that were mispronounced, omitted, inserted, substituted, or improperly spoken during the first three seconds of speech were referred to as miscues. Repetition and self-corrections done within 3 seconds were not counted as errors (Conolly & Westwood, 2021). After the third read-aloud by the students, the researchers gave the participants a minute to finish the passage, marked any errors without speaking to them, and recorded their fluency rate. After implementing the whole intervention program, the researchers conducted a guided interview for the students to assess their improvement throughout the working sessions and to know their perception towards the repeated reading of researcher-made localized materials.

The researchers utilized the experimental quantitative research design, specifically the one-group pretest-posttest design. A one-group pretest-posttest design is a kind of study methodology that behavioral researchers commonly use to examine the effect of a treatment or intervention on a specific population (Moskal, 2022). Participants have been given the same assessment measures before and after receiving treatment or being exposed to a condition, with such measurements used to ascertain if any changes might be attributable to the treatment or condition.

Moreover, the researchers also adopted and modified the social validity interview guide used by Alotaibi (2022) to assess the students' perceptions of the intervention program that will be implemented by the researchers. The guide consists of an open-ended question that is used to determine the effectiveness of the research intervention.

Lastly, the study was conducted following the office order from the committee for research at Bulacan Agricultural State College. All data supporting this research were reported by the researchers. Other people's contributions were acknowledged. In relation to the study, the researchers did not engage in any dishonest behavior. Even if concealing identities could have made the study less accurate, they have complied with protocols to safeguard participants' privacy. The goal, technique, methods, and

conclusions of the study were openly disclosed by the researchers to the participants. Moreover, the researchers gave the students an assent form that indicated their willingness to be part of the study and what they expected to do as participants. All the student participants have the right to withdraw if they don't feel comfortable with the conduct of the study. Lastly, the researchers of this study strictly adhere to the DO 16, s. 2017 or the Research Management Guidelines (RMG). This law provides guidelines on how to manage research projects at the national, regional, school division, and school levels. This policy also enhances the support mechanisms for research, such as funding, capacity building, and partnerships.

Results and Discussion

Students' Reading Fluency Prior to the Implementation of Intervention Program.

The researchers have conducted a pre-assessment reading to determine the struggling readers among the 11th-grade HUMSS students. The scores are recorded and those students who are not able to reach the benchmark become the participants of the study.

Table 1

Descriptive measures of students' scores before the Intervention

Benchmark Cut-Scores	Frequency (f)	Percentage
Above Benchmark (184 words and above)	4	6.67 %
At Benchmark (150 – 183 words)	21	35.00 %
Below Benchmark (0 – 149 words)	35	58.33 %
Total:	60	

Based on the results of the pre-assessment reading, there are 35 students, or 58.33% of the participants, who were reading below the benchmark. The mean score of their WCPM falls between 0-149 words with an average of 116.97. This result indicates that the majority of the learners from grade 11-HUMSS were reading below the average level. Therefore, out of the total population, these 35 students were identified to be the recipients of the intervention program.

Students' Reading Fluency after the Intervention Program.

Table 2

Descriptive measures of students' scores after the Intervention

Benchmark Cut-Scores	Frequency (f)	Percentage
Above Benchmark (184 words and above)	0	0 %
At Benchmark (150 – 183 words)	23	65.71 %
Below Benchmark (0 – 149 words)	12	34.29 %
Total:	35	

In the first phase of the study, the researchers selected 35 students to become the participants of this research. These students are chosen based on their WCPM. Before the conduct of the study, they are reading below the average level for their grade level. After weeks of implementation of repeated reading of researcher-made localized materials, the researchers conducted post-assessment reading.

Participants were given the same assessment pre-assessment and post-assessment tool to ascertain if any changes might be attributable to the treatment or Intervention.

Table 2 shows the frequency and descriptive statistics of student scores following the intervention program. Out of the total number of students, 12 learners (or 34.29% of participants) remain below the benchmark level. Meanwhile, 23 learners, or 65.71% of participants, are now reading at an average level. However, none of the participants can attain scores above the benchmark for their grade level.

Figure 1

Comparison of Pre-Assessment and Post-Assessment Reading

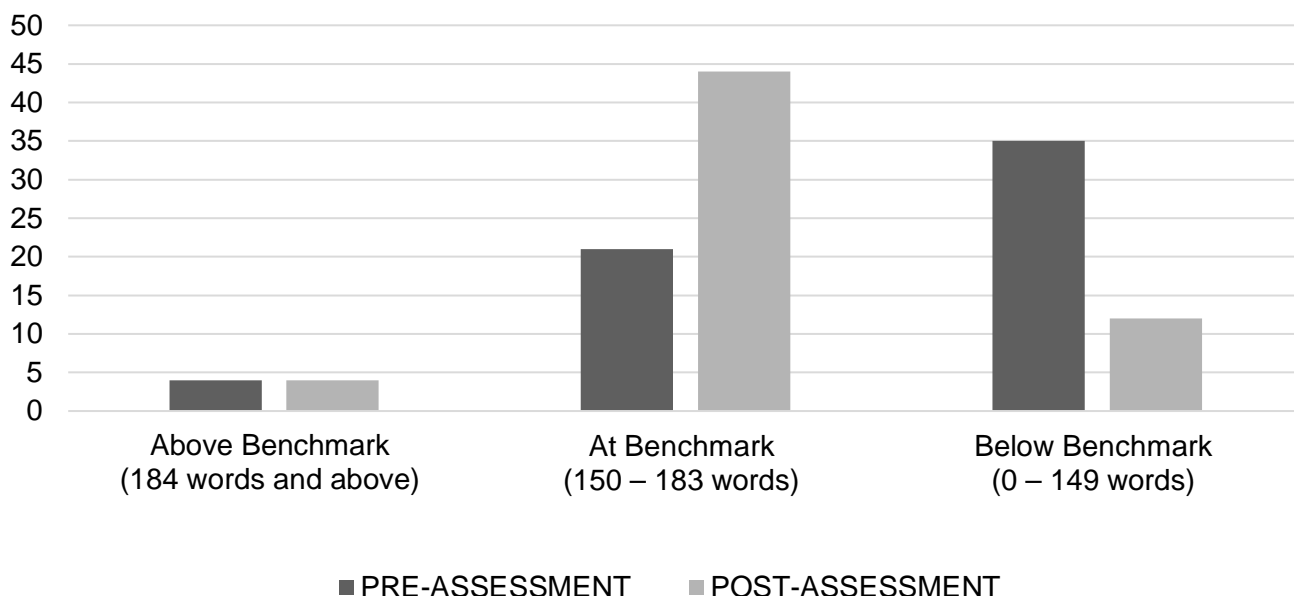


Figure 1 shows the overall performance of the learners after the implementation of the intervention program. Despite the fact that the majority of struggling readers have improved their WCPM, some learners remain below average. These results were affected by some of the challenges of the study. The implementation of the program is only a supplement; it would be much better if the students were also reading in their homes. Moreover, during the implementation, there are cases of absenteeism among the participants of the study; this may also hinder the development of their reading fluency.

Jacob and Kaufman, (2017) found that repeated reading is recognized as a teaching strategy for adolescent readers who are having difficulty reading. For two of the three children, fluency improved as a result of the repeated reading intervention. The number of words each student correctly read in a minute was recorded to monitor their progress. Two of the students' words correct per minute (WCPM) increased towards the end of the study (from 41 WCPM to 64 WCPM and from 103 WCPM to 111 WCPM, respectively), whereas the third student's word accuracy decreased by more than 20 words (94 WCPM to 70 WCPM). Researchers contend that this can be explained by the student's increased precision. These results show that the intervention was effective in increasing reading fluency.

As this study utilized the use of sequential explanatory research design, the collection and analysis of quantitative data was followed by the analysis and interpretation of the qualitative data. After the conduct of the intervention, the researchers interviewed the participants to determine their perception of the program.

The level of students’ reading fluency before and after the intervention.

Table 3 presents the result of the paired sample t-test of the pre and post-assessment. This data explains the result of the repeated reading of research-based-localized reading materials.

Table 3

Paired sample T-Test Result of students’ scores

	N	Mean (\bar{x}) ±	SD	SEM	T Stat	P-value<0.05
Pre-Test	35	116.97 ±	21.25	3.59	-8.059	<0.001
Post-Test		139.66 ±	25.22	4.26		

**Computed mean is highly significant at p<0.001*

As shown in the table, it was observed that the participants attained higher WCPM in their post-test after the implementation of the intervention program. The pre-test recorded mean score was 116.97 WCPM while the post-test recorded mean score was 139.66 WCPM. This finding conforms with the study conducted by Brysbaert (2019), where the number of WCPM has been found to increase with continued reading instruction. Analysis of a child's immediate word count per minute increases after fluency interventions revealed that the repeated reading condition outperformed different strategies.

The Standard Error Mean (SEM) of the data set is 3.59 for the pre-test and 4.26 for the post-test. The standard error measures the spread of sample mean estimates around the true population mean. The standard error decreases as the sample size increases, showing that the projected sample mean value better approximates the population mean.

Moreover, the results of the paired-sample t-test show that the post-test scores (Mean=139.66, SD=25.22) is significantly higher than the pre-test scores (Mean=116.97, SD=21.25), $t(34) = -8.059$, $p < 0.001$. The null hypothesis is rejected which implies that repeated reading intervention of researcher-made-localized material has created a positive influence on the reading fluency of the students. According to Sukhram and Ellen (2017), once repeated reading has been put into practice, teachers can promote fluency by including a feedback element in the intervention. To properly demonstrate how to read the paragraph effectively where mistakes were made, the feedback is concentrated on student errors. Students are given plenty of opportunity to practice each section until they can read it correctly.

Perceived Influence of the Intervention to the Reading Fluency

Table 4

Theme Cluster for Qualitative Analysis

Main Theme(s)	Theme Cluster	Formulated Meanings
A. Reading at a Better Speed	Better Word Recognition	The students asserted that their word recognition has improved throughout the conduct of the study. With this, they became not that hesitant to read a word which led them to become a fluent reader.
B. Reading with Better Accuracy	Improved Pronunciation	According to the participants, their pronunciation has improved. Through this, they are now able to pronounce words more accurately.

To deepen the quantitative results, qualitative analysis was made, and it revealed two main themes for the perception of the students about the repeated reading of researcher-made-localized materials. These themes are “reading at a better speed” and “reading with better accuracy”. Moreover,

using thematic analysis, the researchers found subthemes such as Better Word Recognition and Improved pronunciation. These themes emerged from the participants' answers to the interview guide about their perception of the repeated reading intervention of researcher-made localized reading materials.

Table 4 indicated the themes that were formulated by the researchers upon knowing the perception of the participants about the intervention.

Upon the analysis of the results, it confirms that repeated reading of researcher-made-localized materials has positively affected the students by helping them to read a lot faster and with better accuracy. It can be asserted by their statements:

“It helped me to read faster than my reading ability before because of practicing regularly” (respondent number 16, sentence number 1).

“Natulungan ako ng repeated reading na mas mapabilis ang aking pagbasa at maayos ang aking pronuncitaion at maraming pang iba” [Trans]. “I like repeated reading because it helps me improve my skills in reading such as the speed, pronunciation and more” (respondent no. 27, sentence no. 1).

“Gusto ko ang repeated reading dahil sa pamamagitan nito, maipapakita ko ang aking sa pagbabasa at kung paano ko nasasabi ng maayos ang mga salita” [Trans.] “I like repeated reading because through this, I can show my reading skills and how I deliver the words correctly” (respondent no. 3, sentence no. 1).

“Isa sa mga gusto ko sa repeated reading ay mas nagkaroon ako ng kaalaman tungkol sa kwento at nalalaman ko kung paano bigkasin ng tama ang mga salita” [Trans.] “One of the things that I like in repeated reading is that I gained more knowledge about the story, and I get to know how to pronounce a word accurately” (respondent no. 1, sentence no. 1).

After weeks of intervention, repeated reading of researcher-made localized materials created a positive impact on the students. The results indicated that participants of the study have greatly improved their reading speed and accuracy. This result can also be proven by their WCPM which is used as the deciding factor of their fluency rate. Knowing how to read fluently is needed as reading is considered one of the core skills that a person or a student must have. Numerous research concur that repeated reading can increase the speed and the fluency rate of the students. According to De Rycker (2014), repeated reading instruction has been demonstrated to increase reading rates through WCPM. When examining a student's immediate increases in words per minute after fluency interventions, the repeated reading condition performed better than other strategies (Carver et al., 2017).

Zavala and Cuevas (2019) investigated how frequently and aloud readings of poetry affect readers' fluency. After the four-week intervention, oral fluency had improved in both groups. Throughout the experiment, the rhyming group's mean score climbed from 30 WCPM to 43.3 WCPM. The repeated reading group started with an average score of 46.6 WCPM and ended up with a score of 57.8 WCPM on average. The difference between the groups was not statistically significant enough to support the findings. Since just fourteen students took part in the study, more investigation is needed to determine the effectiveness of each strategy.

Moreover, through a review of earlier studies, Driggs (2013) examined the effect of repeated reading (RR) on reading fluency for children with reading challenges. In this study, many intervention strategies were investigated. One method in particular is known as systematic error correction (SEC).

Any errors the reader committed while reading are corrected post-reading by the interventionist or teacher throughout this phase. This strategy is frequently used in conjunction with regular reading.

Additionally, at the end of every reading session for each student, the researchers made sure that they knew their errors and mispronounced words for them to have an idea of how to correct themselves. With this, students will have an opportunity to remember or to correct their errors the next time they encounter those words. According to Hussein (2020), feedback is crucial for improving reading accuracy and fluency. A learner must receive feedback right away after making a mistake. In addition, Busso et al. (2017), stated that it is essential to adhere to certain guidelines to improve the effectiveness of fluency-building activities. If improvements are to be expected, education needs to be systematic, consistently offered, and adult-guided. Students who receive prompt feedback are more likely to recall the correction than the mistake. Appropriate feedback is very important in developing reading accuracy and fluency.

Conclusion

Based on the findings of the study, the following conclusions were drawn:

The study revealed that the majority of the whole population of learners failed to attain the expected benchmark or average score for their grade level; therefore, those students who were not able to achieve the needed benchmark became the participants of the study.

The researchers implemented the Repeated Reading of Researcher-Made-Localized Materials due to the given challenges on reading fluency. Results showed that the majority of the participants who were reading below the benchmark level before the conduct of the study had greatly improved their reading fluency. With the aforementioned results, the null hypothesis is therefore rejected.

Although the study created positive outcomes, it would have been better if the intervention program had been implemented for a longer period. Additionally, there must also be enough facilitators because monitoring many learners and ensuring that they are improving is hard, especially if the sample size is large.

Moreover, qualitative data also supported the results by providing the students' perceptions about the impact of the intervention program on their reading fluency. Based on the participants' statements, repeated reading of researcher-made localized materials has improved their reading speed and their reading accuracy.

With the aforementioned claims and results, this study has concluded that the repeated reading strategy of researcher-made localized materials is an effective strategy for enhancing the reading fluency of the students.

Recommendations

In light of the findings and conclusions of the study, the following recommendations were made:

First, the students and teachers may use repeated reading of researcher-made localized materials as a strategy to enhance reading fluency. Researchers successfully implemented this intervention and saw positive results. From below the benchmark, some students leveled up and attained the average level.

Furthermore, the students and teachers may also implement the research-based intervention over a longer period. This intervention was implemented only in a short period of time, yet the researcher proved that the implementation was effective. Teachers and students may use this strategy for a longer period to determine other positive effects and how helpful repeated reading of researcher-made localized materials is in enhancing reading fluency.

Additionally, it would be beneficial if the facilitators of the program would undergo training first before conducting the study. This will ensure that they will accurately implement the intervention and monitor the progress of the learners.

This research was only focused on identifying the effect of repeated reading of researcher-made localized reading materials on the reading fluency of the students; therefore, the researchers would like to recommend that future researchers also focus on other reading-related problems, specifically reading comprehension.

Since this research is done after the pandemic, where the learning gaps of the students are notable, the researchers also suggest conducting this study with students in similar contexts. With this, the effectiveness of researcher-made localized reading materials will further be validated.

Lastly, since this study is only focused on the side of the students, future researchers should also emphasize the preparation of the moderators (teachers) in using the RMLRM and their perceptions towards the reading program.

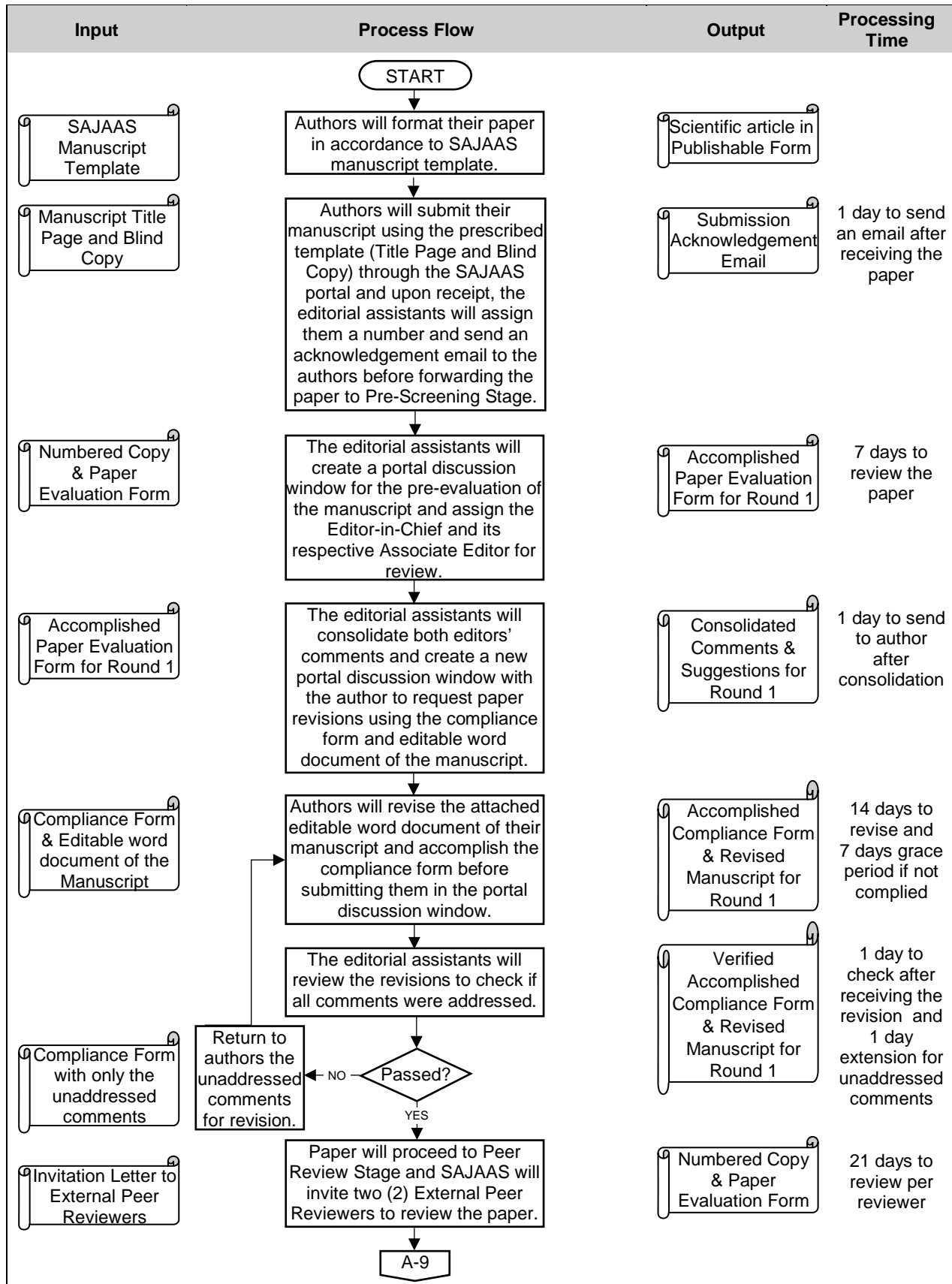
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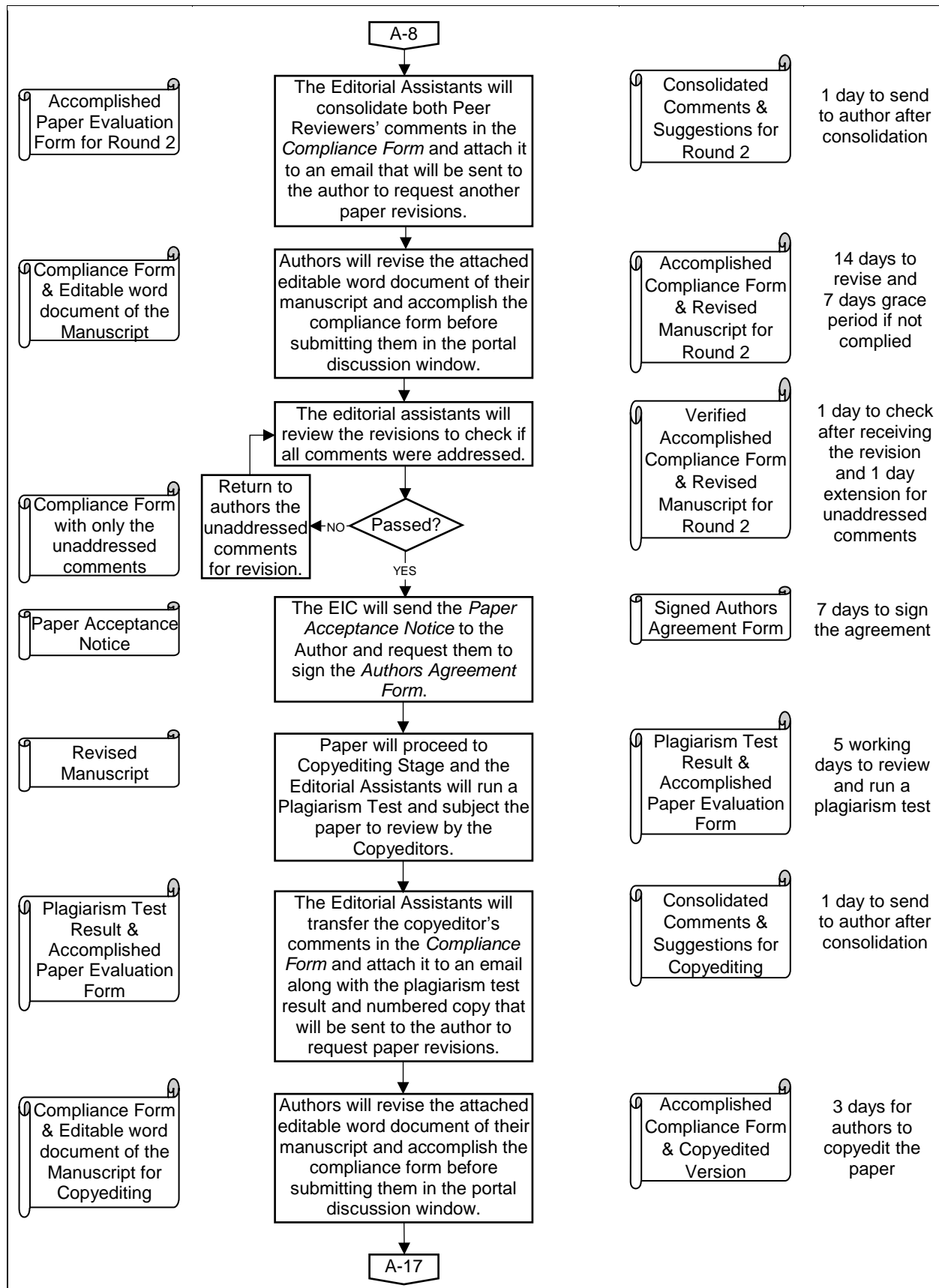
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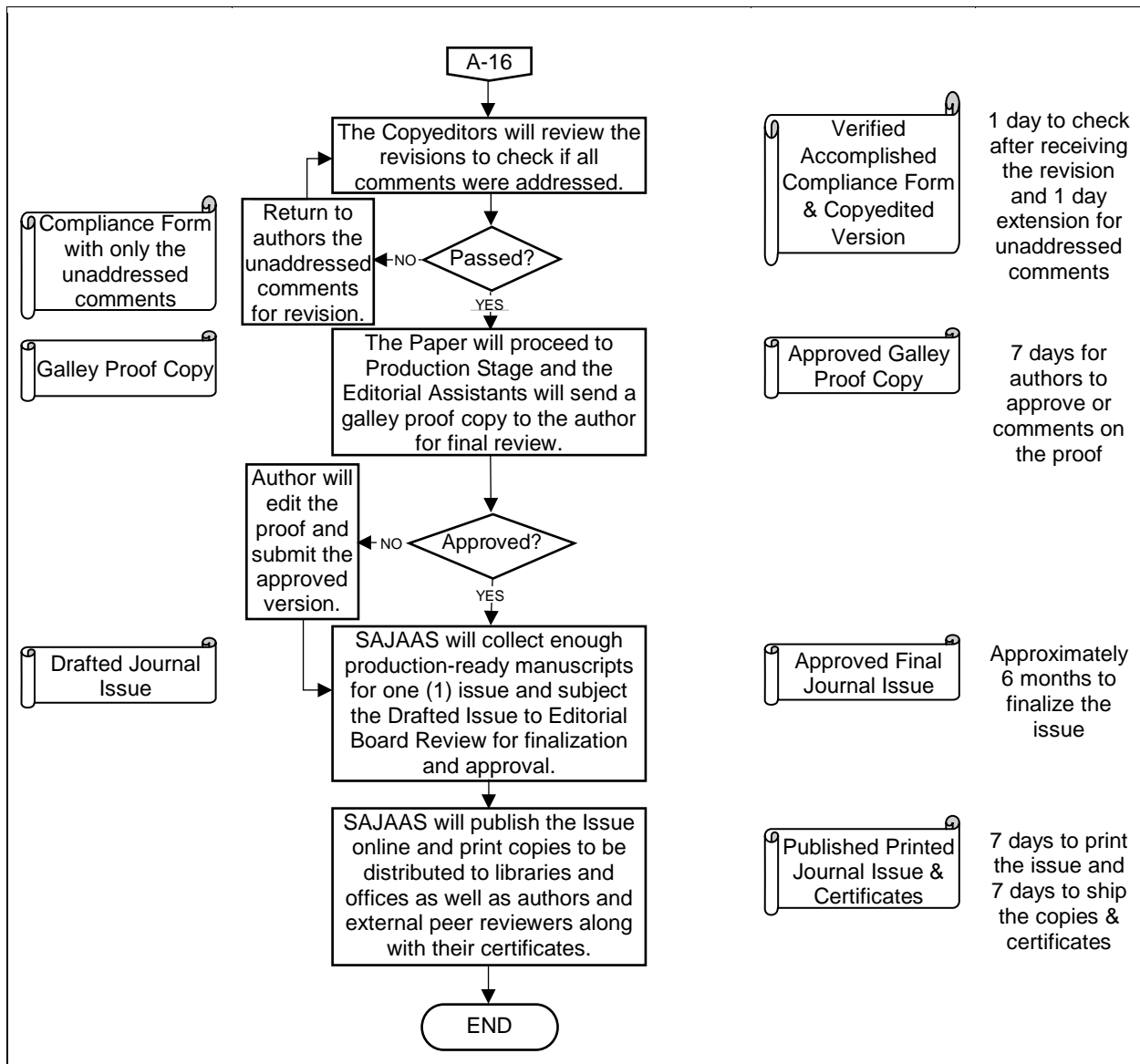
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Publication Process Flow Chart







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For the **Paper Format**, the article should be typed on a letter size bond paper (8.5 by 11 inches), with 1-inch margins on top, right, and bottom, and left. The text should be in Arial font size 11 with 1.15 line spacing. Downloadable templates for title page and blind copy can be accessed at the website. Papers may be submitted through the SAJAAS website sajaas.basc.edu.ph or via email to sajaasjournal@basc.edu.ph.

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Volume X Issue X

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words** (Fonts size 14, Arial, Boldface, Left alignment, 1.15 spacing)

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Last Name, First Name Middle Initial of Author 2²

Corresponding Author: *emailaddress@gmail.com*

¹ *Affiliated organization (Office, Institution, Barangay, Municipality/City, Province, Country) of Author 1*

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pp. x-xx (must not exceed 16 pages and 6000-word limit from abstract page up to references)

Title Case: Capitalize the first letter of non-conjunction, non-preposition, and non-article words (Font size 14, Arial, Boldface, Left alignment, 1.15 spacing)

Abstract

It should be a paragraph that concisely informs the reader about the research topic, its objectives, methods used, key findings, and implications. It must contain up to 250 words only and must not contain undefined abbreviations. It must be in one paragraph only. (Font size 11, no indentation, justified, 1.15 spacing)

Keywords: *List of up to five keywords about the paper, to be used for indexing purposes and in alphabetical order.* (Font size 11, italic face, 1.15 spacing)

Introduction

The Introduction should help the reader understand how the study shall contribute to the current knowledge in the subject area. This section should clearly describe the problem or gaps in the current related research findings and the literature it addresses. It should also justify the significance of conducting this study leading to the statement of the purpose and objectives of the study. (Font size 11, Arial, Justified, indented, 1.15 spacing, with space after paragraph)

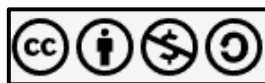
Materials and Methods

The Materials and Methods section should be clearly and concisely written. This section should provide enough information for a competent researcher to repeat the procedure and verify the results. This section identifies the type of research design used, sources and materials employed and important characteristics, sampling procedure, data collection techniques/ tools, time periods, study setting, as well as procedures for assessment of data. Statistical tests used must be cited and should specify the data analyzed. Authors should use the System International (SI) for the units. In case of use of machine, equipment, or supplies with trade names, use the generic name and write between parentheses the trade name with ®, manufacturer and the manufacturer's address of city, state and country. The trade name, if cannot be avoided, must be used only in the Materials and Methods section of the paper. (Font size 11, Arial, Justified, indented, 1.13 spacing, with space after paragraph)

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Subsection Heading (Title case, Font size 11, Arial, Bold face, Left Alignment, with space after paragraph)

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When using quotations, if the text or interview consists fewer than 40 words, incorporate it into the text within the paragraph and enclose it with double quotation marks (“”). If the direct quotations are stated in vernacular language, it should be italicized. Then, it will be followed by the English translation enclosed in parentheses. (Font Size 11, Arial, 1.15 spacing, justified, with space after paragraph)

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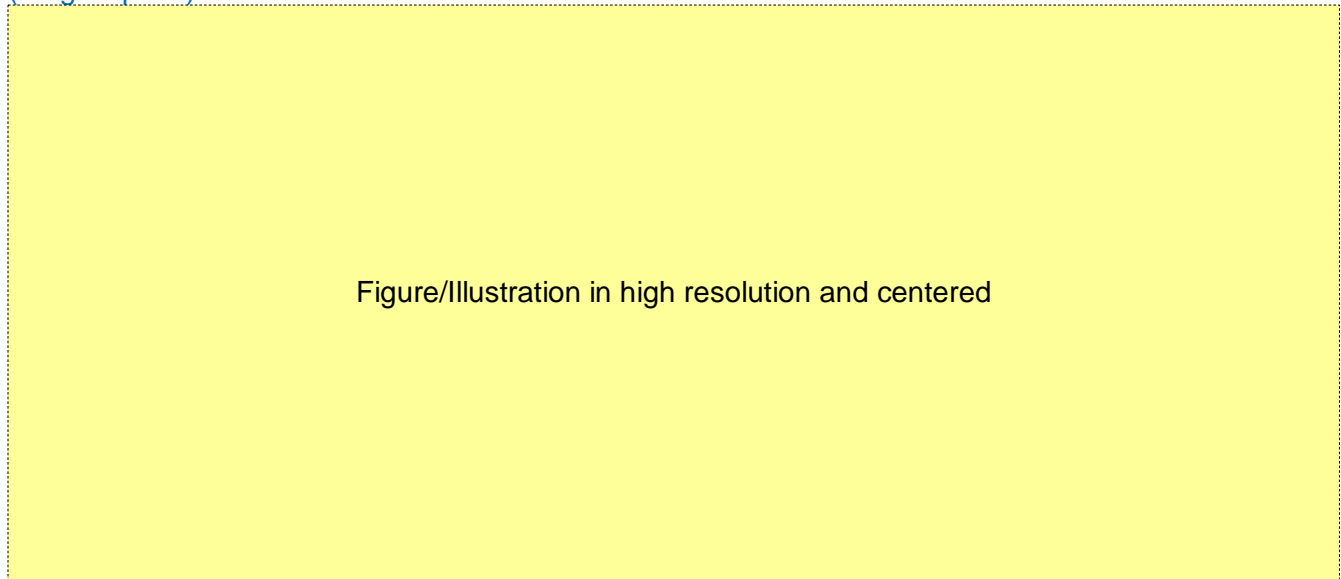
Figures and illustrations should be simple, few and labelled completely. Figures should be prepared at final size for reproduction with a minimum type size of 9 points, Arial. The numbering of the figures will be dependent on the chronology of citation within the text. To direct the reader to the figure within the text, spell it out, i.e. “Figure 1”. All symbols, arrows, numbers, or letters used to identify parts of the illustrations should be explained in the legends. Where necessary, magnification should be shown by a scale marker drawn on the photograph. Figures should be saved as separate electronic files (.jpg) and submitted in .jpg format at least 300 dpi.

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Conclusion

This section presents the answers to the research questions or objectives of the study. The author may highlight here what he/she can conclude from the key findings but should be cautious to not just repeat what has already been stated in the result and discussion. (Font Size 11, Arial, 1.15 spacing, indented, justified, with space after paragraph)

Recommendations

The author may include in this section their suggestions for advanced researchers of opportunities for future research based on the findings in this study. They may suggest a new direction, new objectives, and/or new method for the conduct of similar study in the future. They may also suggest ways on how the problem or gaps identified in the study can be better addressed by the concerned authorities. (Font Size 11, Arial, 1.15 spacing, justified, with space after paragraph)

References

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