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Efficacy of Peer-Assisted Reading Program in Improving Students' Reading Comprehension Level

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Abstract

This research investigates the effectiveness of the Peer-Assisted Reading Program (PARP) in improving reading comprehension for seventh-grade students. Initially, a pre-test was administered, and 65.79% of the students were categorized in the "Frustrational" reading level and had an average score of 10.42 (52.11%), unfortunately indicating comprehension difficulty. After the intervention, the post-test results indicated an average of 13.76 (68.82%), with 68.42% at the "Instructional" reading level and 18.42% at the "Independent" comprehension level. A paired sample t-test was conducted and indicated a statistically significant difference ($t = 6.11$, $p < 0.001$) and indicated a large effect size (0.991). Students provided mixed impressions of the program, where they identified benefits such as improved articulation of analysis and increased motivation levels of reading because of the reading appeal and shortcomings of being too long or misalignment with reading and questions and assessment. This information indicates a necessity for further individualized instructional planning, using greater attention to building individualized and strategic instructional planning for all learners to support reading comprehension.

Keywords: reading comprehension, grade 7, PISA, reading program, peer-tutoring

1. Introduction

Reading is one of the macro skills that students must develop to achieve a better learning experience. Reading comprehension should not be a problem in high school since learning to read starts in elementary school. However, in the Philippine context, reading comprehension is still considered one of the problems most teachers in the academe face, including in high school. This problem affects the students' teaching and learning process, especially during the individual or group tasks assigned to them. Teachers in the 21st century provide engaging activities that enhance students' critical thinking skills, wherein reading comprehension is one of the means to a better understanding of the instructions. Thus, students must develop their reading comprehension to improve engagement and participation.

The Program for International Student Assessment (PISA) in 2018 revealed that Filipino students have poor reading comprehension,

ranking the lowest among the 79 participating countries (Aquino & Tingson, 2021). It is noteworthy that reading comprehension affects the student's academic performance. Students with reading comprehension levels below their grade level faced increased risks of academic challenges and possible dropouts (Ocampo, 2023). Furthermore, socioeconomic problems, insufficient access to quality educational resources, and traditional pedagogical practices that do not engage students in the learning process are also seen as problems that affect the development of students' reading comprehension (Idulog et al., 2023). Addressing these problems through a more engaging and new teaching style can help mitigate the problems in reading comprehension.

Over time, many studies have supported the effectiveness of peer-assisted learning strategies in improving students learning. Teachers can apply this strategy to enhance students' reading comprehension levels. Peer-assisted learning strategies promote a cooperative learning environment, which helps one another attain one goal in reading (Fitriani & Tarwana, 2020). The researcher utilized PALS as the primary strategy in the Peer Assisted Reading Program, which was implemented in the school year 2024-2025 in the private secondary school in the Philippines, wherein students are encouraged to take on the role of both tutor and tutee to foster a sense of responsibility which enhances learning engagement (Hasnani & Ismail, 2020). The strategy revealed positive results in improving reading comprehension levels and positive motivation from their peers. In addition, peer-assisted learning strategies also help to quickly identify the students' different learning needs and preferred learning styles; thus, providing them with peers as their tutor can improve their morale in reading (Suson et al., 2020).

The Peer Assisted Reading Program is a program that aims to improve students' reading comprehension levels through a peer-assisted learning strategy. The program was created due to the recent results of the CEM Reading Test for grade 7 students and in the context of one of the private school, the CEM Reading Test Result revealed that 32.88% of students were still classified as challenged readers ranging from very poor reading comprehension level to low average reading comprehension level (Astrero et al., 2024). The result recommends that a reading intervention program must be developed to cater to the needs of these identified challenged readers.

The Peer Assisted Learning Strategy, which the researcher used as the primary strategy for the program, can be credited with learning theories such as Vygotsky's social development theory, which suggests that learning occurs with the social context and the needs of the students, thus identifying the needs of the tutees can help them learn better (Yawiloeng, 2021). In addition, the peer interaction between the tutee and the tutor helps them to quickly activate schema, which is essential in reading comprehension (Idulog et al., 2023). Furthermore, it is also asserted that when students are engaged in peer scaffolding to identify the answer during the reading program, it enhances their reading comprehension and motivates them to learn (Yigit & Durukan, 2023). Thus, providing learning strategies that support one another, like peer tutoring or peer-assisted learning strategies, shows positive results in increasing engagement in the learning process, which is applicable in improving the reading comprehension levels of the participants.

Recent studies indicate a problem in reading comprehension among Filipino students, which was revealed in the PISA 2018 result and CEM Reading Test. Thus, the results suggest a targeted intervention program to mitigate this problem. While many studies support the effectiveness of peer-assisted learning strategies in improving learning, there is limited research on their implementation in the Philippine context, specifically in improving the reading comprehension level of students. This research gap calls for a further study on the use and effect of peer-assisted learning strategies through peer-assisted reading programs in improving the reading comprehension of the challenged grade 7 readers.

In conclusion, the teachers, administrators, and parents need to look for an intervention strategy to improve the reading comprehension level of the students. Reading comprehension is essential because it will help students learn better, which affects their academic success. The peer-assisted reading program, which was rooted in the peer-assisted learning strategies, is the proposed intervention program to improve the reading comprehension level of grade 7 students. The program allows the students to work collaboratively to answer the reading test, which promotes engagement and understanding of the text being read, that is essential to their academic

success.

1.1 Research Questions/Objectives

Thus, this study aims to evaluate the effectiveness of the peer-assisted reading program, which was implemented in the academic year 2024-2025. This study particularly sought to answer the following research questions.

1) What was the reading comprehension level of the participants before they participated in the implementation of the Project PARP?
2) What was the reading comprehension level of the participants after they had participated in the implementation of Project PARP?
3) Is there a significant difference in the participant's reading comprehension level before and after implementing Project PARP?
4) What are the participants' perceptions on the strengths and weaknesses of using Project PARP to improve their reading comprehension?

1.2 Hypothesis

H_0 – There is no significant difference between the participant's scores in the pre-test and post-test of reading comprehension level before and after the implementation of project PARP.

1.3 Proposed Intervention, Innovation, or Strategy

Project PARP (Peer-assisted Reading Program) is a targeted reading intervention program that aims to improve the reading comprehension level of the students. This classroom-based reading intervention program used various reading materials and activities, including the reading material from the Philippine Informal Reading Inventory (PHIL-IRI), Strategies to Achieve Reading Success (STARS) Series C, and teacher-made reading activities. These materials are used to promote love for reading to the students. The primary strategy utilized in this program is anchored to the plan developed by Hasnani & Ismail (2020), the peer-assisted learning strategy or PALS. This strategy suits the students' needs since most of them are challenged readers and identified to be better readers if they have company. Each student is paired with their trusted classmates inside the classroom to avoid awkwardness and be judgment-free while conducting the reading program.

Furthermore, the program is based on Lev Vygotsky's social development theory, which states that children's cognitive development and learning ability may be influenced and mediated by social interaction. Thus, peer tutoring as a reading intervention strategy can enhance student reading comprehension levels. Engaging students in tasks with their peers can improve their social interaction skills and academic performance.

Table 1. Project PARP Phases of Implementation

Phases of Implementation	**Goals and Objectives**	**Activities or Strategies**	**Resources Needed**	**Time Frame**
Phase 1: Diagnostic Test	1. To identify the reading comprehension level of the participants using the Philippine Informal Reading Inventory (Phil-IRI)	✓ The researcher printed the necessary materials for the diagnostic test, including the Phil-IRI Screening Test for Grade 7 and ZipGrade answer sheets. ✓ The researcher conducted the diagnostic test inside the classroom. ✓ The researcher recorded the data and identified the reading comprehension level of the participants.	PHIL-IRI Screening Test for Grade 7	July 26, 2024

Phase 2: Orientation	2. To give orientation on the objectives, scope, rationale, and process of conducting Peer-Assisted Reading Program	✔ The teacher/researcher oriented the tutors and tutees on the process, rationale, scope, and objectives of the Peer-Assisted Reading Program.	PHIL-IRI Assessment Questionnaire Answer Sheet Sample	July 26, 2024
Phase 3: Implementation Proper *Actual Implementation of Project PARP (Peer Assisted Reading Program)*	3. To increase reading comprehension of students through peer tutoring.	✔ The researcher conducted a classroom-based reading program every Friday in their English classes. ✔ The teacher/researcher paired each student in the class with their trusted peers. ✔ The researcher with the lowest scores can choose from the high-scoring students as their peer tutors.	PHIL-IRI Reading Materials Strategies To Achieve Reading Success (STARS) Series C Teacher made reading Materials.	August 14, 2024 – February 21, 2024
Phase 4: Post Implementation *Post Test*	4. To evaluate the improvement of students reading comprehension.	✔ The teacher-researcher conducted a post-test evaluation to evaluate the participant's progress in the study.	PHIL-IRI Reading Post Test for Grade 7	February 28, 2025
Phase 5: Program Evaluation	5. To evaluate the effectiveness of YEARS-RP	✔ Conduct evaluation through interview to the participants.	Interview Questions Cellphone as recording device.	March 3, 2025

Table 1 shows the phases of the proposed Peer-assisted Reading Program. There are five (5) phases to the program's implementation. Phase 1 is the selection of the target tutees and tutors. In this stage, English teachers conducted a reading diagnostic test to identify the students' reading comprehension in the different content areas. Phase 2 will be the program orientation, which aims to inform the tutors and tutees about the program's objectives. Phase 3 will be the actual implementation of the program; this phase aims to improve the student's reading comprehension. Phase 4, the post-test, this stage will determine whether the students improve their reading comprehension through the peer-assisted reading program. Lastly, in phase 5, the participants involved in the program evaluated the program's effectiveness, strengths, and weaknesses.

1.4 Conceptual Framework

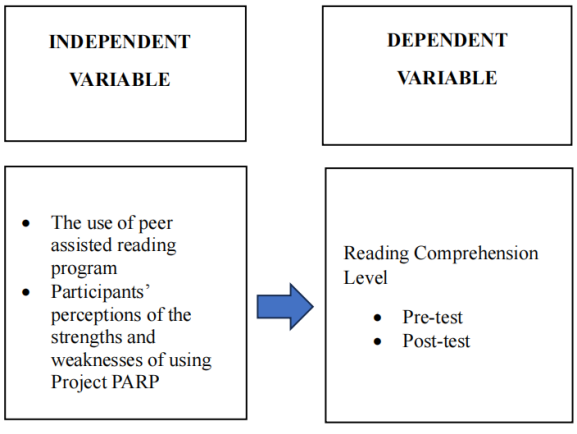

Figure 1. Research Paradigm

This framework illustrates the relationship between the study's independent variable (IV) and the dependent variable (DV). The frameworks suggest a causal relationship between peer-assisted reading programs and improving the participants' reading comprehension levels. In the dependent variable, the researcher will measure the participants' reading comprehension levels through the pre-test and post-test. In addition, the researcher also employs a semi-structured interview questionnaire to evaluate the participants' perception of the strengths and weakness of using Project PARP in improving their reading comprehension level.

2. Review of Related Literatures and Studies

This chapter reviews various studies and literatures that supports, defines and gives further information in evaluating the peer-assisted reading program through peer-assisted learning strategies. It will also present different background on the importance of reading comprehension to the academic performance of the learners.

2.1 Philippine Informal Reading Inventory (Phil-IRI)

The Philippine Informal Reading Inventory (Phil-IRI) is designed by the Department of Education (DepEd) to evaluate the reading proficiency of Filipino students. This material is intended critically to identify who needs to undergo a reading intervention program, which is essential to cater to the student's needs in reading to improve their academic performance. Various studies reveal the effectiveness, application, and educational challenges related to the reading proficiency of Filipino learners.

Phil-IRI is a classroom-based assessment tool that measures the student's reading comprehension level. This classroom-based assessment tool is crafted to provide the teachers with a better understanding of the learners' reading proficiency by facilitating classroom instructions to address the student's needs (Villalva, 2023). In addition, differentiated instruction and differentiated lesson plans are challenging tasks for teachers to cater to the diverse learning styles and the needs of the students; in terms of reading proficiency level, the Phil-IRI assessment tool is proposed to cater to these needs.

The effectiveness of Phil-IRI can be evaluated through the different reading strategies. Bernardo and Mante-Estacio (2023) highlight the correlation between metacognitive strategies and students' reading proficiency. It is claimed that when students use metacognitive strategies, they will be more engaged in discovering new ideas through reading. Furthermore, metacognitive awareness can significantly improve the student's reading skills, essential in interpreting Phil-IRI results. The relationship of metacognitive awareness in reading proficiency improves comprehension and critical skills in students (Bernardo et al., 2021).

Despite this proposed reading assessment tool, the Department of Education should note that there is still a problem with instructions and resources to improve the reading abilities of Filipino students. Factors that include limited access to quality resources and socioeconomic status affect the literacy development of the students (Idulog et al., 2023). This common problem is supported by different researches, which suggest that there must be a program that promotes early literacy that is incorporated into the different teaching approaches to promote the culture of reading (Librea et al., 2023). This claim is valid with the observation of low reading proficiency in elementary schools across the Philippines, which suggests the creation of a targeted reading intervention that promotes the love for reading at an early age.

Explicit instruction is one of the most important reading strategies in most studies exploring remediation and improving reading proficiency. The study conducted by Gatcho and Hajan (2022) revealed that explicit instruction helps student significantly improve their reading performance. This study is anchored to the main goal of the Phil-IRI, which is to improve students' reading proficiency through instructional intervention.

In conclusion, the Philippine Informal Reading Inventory (Phil-IRI) plays a vital role in improving the reading proficiency of Filipino students; it is also considered a standardized reading assessment to evaluate the students' reading proficiency. Through the review of different studies about reading strategies incorporating Phil-IRI, it is evident that using a different approach, which includes differentiated instruction and explicit instruction, is important in enhancing the reading capabilities of the learners.

2.2 Science Research Associates (SRA) Reading Laboratory

The Science Research Associates Reading Laboratory is one of the tools available to foster

practical reading skills, particularly for those with difficulty reading. The review of this literature deals with the contribution of the SRA Reading Laboratory as appropriate for different reading strategy frameworks based on modern literature. SRA Reading Laboratory is a structured reading training method that places great importance on different learning strategies. Dhanarattigannon states, as evidence, that including much reading into the SRA materials can significantly improve the ability of struggling learners in reading and later on enhance reading and comprehension (Dhanarattigannon, 2022). It supports the statement made by Sobeck that SRA possesses a leveled reading program based on research on reading comprehension, phonics, vocabulary, and fluency (Sobeck, 2016).

SRA Reading Laboratory contains systematic text with grades in various abilities, allowing the teacher to give appropriate instruction without much preparation time (Sobeck, 2016). The user-friendly nature of SRA materials supports learners and teachers in using the strategy. Texts are partitioned into levels so students can gradually engage with and work through more difficult texts within a support framework (Sobeck, 2016). It integrates a diverse student demographic's linguistic and cognitive need and promotes inclusivity in literacy learning. In addition, the learners can also work and choose to do the activity alone or with peers. The importance of peer assistance is still appropriate, especially for those with questions while reading the passage. However, the SRA reading laboratory is designed to engage the students with different reading materials to increase the reading competency level of the target learners.

In conclusion, the Reading Laboratory is one of the many proper interventions to direct instruction in reading at the various levels of individual development in learners; this can hardly be interpreted to support claims for reading intervention effectiveness. SRA builds the reading environment for student success by combining text idioms with leveled reading selection and varied instructional strategies. Research findings reveal the use of SRA in the remediation of reading problems and in some empirical research that fully describes each particular strategy.

2.3 Synthesis

This review of the related literature (RRL) effectively underscores the Philippine Informal Reading Inventory (Phil-IRI) and the Science Research Associates (SRA) Reading Laboratory as tools to measure and cultivate reading skill. The Phil-IRI is described as a vital tool in improving Filipino students' reading comprehension level, it is the department of education (DepEd) initiative systemically designed to both identify and provide intervention for reading skill gaps. The literature indicates metacognitive strategies and explicit teaching are key to supporting the Phil-IRI process. The SRA Reading Laboratory is constructed as a systematic process that utilizes leveled reading materials and strategies customized to support readers who struggle. Nevertheless, the review also has critical omissions. Overall, there is an absence of deep analysis of the practical realities of implementing Phil-IRI into practice, aside from the methodological effort and socioeconomic challenges noted. In addition, the review would benefit from reviewing research that more deeply examines the longer-term effects of the SRA Reading Laboratory, and how its use might be modified to fit into the current digital learning era. Thirdly, there is a fair number of limited comparisons between both tools, that reflects their strengths, weaknesses, and fit for learner profiles and educational settings. Lastly, an extended exploration of the tool integration with modern theories around reading and technology-enabled learning would add to the RRL.

3. Methodology

This chapter presents the method used in this study. Specifically, the following are included: research design, sampling design, the role of the researcher, data sources, data gathering procedure, instruments, data analysis, ethical considerations.

3.1 Research Design

This study is categorized as action research, whose primary aim is to determine the effects of the reading intervention program (Project PARP – Peer-assisted Reading Program) on the reading performance of the grade 7 students in the University of La Salette, Incorporated High School. A quasi-experimental research design was utilized particularly the pre-test and post-test control group designs. The researcher used a quasi-experimental research design to evaluate the intervention's effect on students' reading comprehension. A quasi-experimental research design allows the researcher to determine the

improvement of the pre-test and post-test scores of the participants and assess the effects of the proposed reading intervention program.

Furthermore, the researcher also used qualitative research design, particularly the phenomenological approach. This approach is particularly suited to this study to explore and determine the lived experiences and perceptions of the participants in the strengths and weaknesses of the peer-assisted reading program. Phenomenology is a broad field of study. In this research methodology, the researcher seeks to collect data that reveals how the participants experience and how they feel about it. This concept acknowledges that there is no one objective reality; instead, everyone perceives things differently (5 qualitative research designs and research methods, 2021).

3.2 Study Site and Participants

The research was done at a private junior high school in Santiago City. This study involves 37 grade 7 students as the participants. They were chosen because they were new to the institution and had different backgrounds regarding reading comprehension levels. Implementing the peer-assisted reading program is vital to improving their reading comprehension level, most especially based on the pre-test results. Many of them are identified as Frustrated readers. Thus, the program should be tested in this group.

3.3 Validation of the Instruments

3.3.1 Pre-test & Post-test Instruments

The researchers utilized the Phil-IRI screening assessment tool to identify the reading comprehension level of the participants. Before implementing the pre-test, the researchers distributed the assessment tool to grade 7 students who did not participate in the program to assess the material's validity and reliability. The researchers used the Kuder & Richardson (KR20) test for internal consistency. Based on the tryout assessment result, the material's internal consistency is 0.71, which is translated as high internal consistency. The result indicated that the assessment tool is suited to the student's level. Furthermore, the grade 7 English teachers also validated the instrument for its face validity and the material's difficulty level.

3.3.2 Semi-Structure Interview Instrument

The researchers crafted semi-structured interview questions to reveal the student's perception of the program's implementation. They sought three validators to validate the connection of the probe questions to the research question to be answered. Based on the recommendations provided by the validators, the researchers revised the questions. After the validation process, the researchers implemented a tryout run to test the interview questions to see whether they could provide a theme connected to the researcher's objectives.

3.4 Instrument

3.4.1 Pre-test/Diagnostic Test

Before beginning the intervention program, the researcher administered a pre-test to determine the participants' starting level of reading comprehension. The pre-test included the grade 7 reading screening exam from the Philippine Informal Reading Inventory (Phil-IRI) package. The Phil-IRI is a standardized reading assessment exam used to measure the reading comprehension abilities of Filipino students. The pre-test findings establish a baseline for the participants' reading comprehension ability.

3.4.2 Post-Test

After implementing Project PARP, the researcher administered the post-test to measure the effect of the intervention program on the participant's reading comprehension levels. The post-test administered consisted of the same test administered in the pre-test. The researcher compared the post-test score with the pre-test score to determine the effectiveness of the peer-assisted reading program (Project PARP).

3.4.3 Semi-Structure Interview Questions

The researchers employed semi-structured interview questions to gain the students' insights and personal experiences of the participants during the program. The open-ended interview questions allowed the participants to provide feedback on the reading intervention program's effectiveness, strengths, and weaknesses. The researcher analyzed the responses to the interview questions through thematic analysis to gain insights into the participants' perceptions of the proposed intervention. To ensure the validity of the interview questions, three experts, including the principal, the assistant to the principal, and the English coordinator, validated the semi-structured interview questions to confirm the connection of the interview questions to the research questions. The insights and suggestions provided by the validator were

applied to refine the questions.

3.5 Data Collection Procedure

The researchers implemented the data gathering procedure as follows:

Before the Implementation

1) The researchers sought the principal's approval to implement the peer-assisted reading program and conducted a study assessing its effect on the participants' reading comprehension levels.
2) The researchers implemented a pre-test to assess the reading comprehension level of the participants. Using the results, the researchers identified the program's tutors and tutees.
3) The researchers recorded the data to compare the differences between the pre-test and post-test to check the program's effect.
4) The researchers oriented the participants on the objectives and strategies for improving their reading experience.
5) The researchers assigned the participants to their most trusted peers to alleviate awkwardness during the program.

Actual Implementation

1) The researchers implemented the designed program for the peer-assisted reading program.
2) The researchers used the Strategies to Achieve Reading Success (STARS Series C) that Deborah Adcock and Joan Krensky developed. The program assessed 12 reading lessons, which included finding the main idea, recalling facts and details, understanding sequence, recognizing cause and effect, finding word meaning in context, drawing conclusions and making inferences, distinguishing between fact and opinion, identifying the author's purpose, interpreting figurative language, and distinguishing between real and make-believe.
3) During the program's actual implementation, the participants were paired with their most trusted peers to help them with the reading comprehension activity. However, the teacher gradually released the scaffold to develop the student's reading comprehension skills.
4) The researchers implemented the peer-assisted reading program procedure in the following stages:

Table 2. Stages of Reading Program

Stage 1	Total Peer-assisted Activity	In stage one (1) of the program, the students are engaged with their peers in answering the pre-reading activities, reading the text, and answering the reading comprehension assessment. The students share their answers with their peers and their answers in the reading comprehension test. This stage was applied in lessons one (1) through six (6).
Stage 2	Semi-Independent Reading Practice	Stage two (2) lessens the readers' peer assistance duration. The participants only engage in peer assistance during the pre-reading activities. However, during the formal reading assessments, the participants answer them independently. This stage was applied in lessons seven (7) to nine (9) of the programs.
Stage 3	Independent Reading Practice	The final stage of the reading program implemented the independent reading practice, where the participants independently answered the pre-reading activity and reading assessments. This stage was applied in lessons ten (10) to twelve (12).

5) After implementing the program, the researchers conducted a post-test assessment to identify the participants' improvement in reading comprehension.

After the Implementation

1) The researchers verified and recorded the students' scores in the pre-test and post-test. The scores were recorded and tabulated using Microsoft Excel and validated through the Jamovi version 2.6.13 application.
2) The participants evaluated the program by providing their insights. The researchers used a semi-structured interview question. The researchers transcribed the responses

and identified the themes based on their responses.

3) The researchers finalized the paper and ensured its completeness.
4) The researchers presented the findings' results and shared them with the community.

3.6 Data Analysis Procedure

The researchers identified the participants' reading comprehension levels using the pre-test and post-test. Thus, the participants' scores were converted into percentages; they adopted the Phil-IRI reading comprehension computation and interpretation, as demonstrated below.

Equation 1. Reading Comprehension Formula

$$\frac{Number\ of\ correct\ answers}{Number\ of\ questions} x100 = \%\ of\ Reading\ Comprehension$$

Table 3. Reading Comprehension Level

Comprehension Score	Reading Comprehension Level
80-100%	Independent
59-79%	Instructional
58% and below	Frustrational

The researchers tallied the data using Microsoft Excel, which enabled statistical analysis of the findings. The researchers handled the participants' scores equitably to compute the frequency. This research used a paired sample t-test to characterize significant differences between the pre-test and post-test procedures. The researcher used the Jamovi version 2.6.13 program to examine the study's data. To measure the effect of the peer-assisted reading program, the pre-test and post-test scores were compared using the derived t-statistics, p-value, and effect size (Cohen's d).

4. Results and Discussion

This chapter presents the outcome of the quantitative analysis of the research questions answers. The results are presented based on the questionnaire answered by the respondents.

4.1 Pre-test Score

Table 4. Participants Pre-test Scores and Reading Comprehension Level

Participants ID	Pre-test Score	Percentage	Reading Comprehension Level
17101	11	55	FRUSTRATIONAL
17102	11	55	FRUSTRATIONAL
17103	10	50	FRUSTRATIONAL
17104	12	60	INSTRUCTIONAL
17105	16	80	INDEPENDENT
17106	11	55	FRUSTRATIONAL
17107	15	75	INSTRUCTIONAL
17108	10	50	FRUSTRATIONAL
17109	7	35	FRUSTRATIONAL
17111	16	80	INDEPENDENT
17112	7	35	FRUSTRATIONAL
17113	9	45	FRUSTRATIONAL
17114	10	50	FRUSTRATIONAL
17115	7	35	FRUSTRATIONAL
17116	12	60	INSTRUCTIONAL
17117	12	60	INSTRUCTIONAL
17118	10	50	FRUSTRATIONAL

17119	12	60	INSTRUCTIONAL
17120	9	45	FRUSTRATIONAL
17121	10	50	FRUSTRATIONAL
17123	11	55	FRUSTRATIONAL
17124	5	25	FRUSTRATIONAL
17125	2	10	FRUSTRATIONAL
17126	16	80	INDEPENDENT
17127	8	40	FRUSTRATIONAL
17129	12	60	INSTRUCTIONAL
17130	13	65	INSTRUCTIONAL
17131	9	45	FRUSTRATIONAL
17132	6	30	FRUSTRATIONAL
17133	8	40	FRUSTRATIONAL
17135	10	50	FRUSTRATIONAL
17136	14	70	INSTRUCTIONAL
17138	7	35	FRUSTRATIONAL
17139	17	85	INDEPENDENT
17140	9	45	FRUSTRATIONAL
17141	9	45	FRUSTRATIONAL
17142	14	70	INSTRUCTIONAL
17143	9	45	FRUSTRATIONAL
MEAN	10.42105263	52.10526316	FRUSTRATIONAL

Table 4 shows the pre-test results and related reading comprehension levels of 38 participants identified by ZipGrade IDs. According to the result, several participants had difficulty comprehending the reading content. The pre-test scores, ranging from 2 to 17, are converted into percentages, whereby participants are classified into any of the three levels of reading comprehension, that is, "Frustrational," "Instructional," or "Independent."

The mean score of 10.42, or about 52.11%, corresponds to a majority of the participants with the level of reading comprehension classified as "Frustrational." This indicates that they scored below 60% on the pre-test. Hence, they have significant difficulties in understanding the reading material. Some other participants were at an "Instructional" level, meaning that with some help, they could comprehend the reading content.

Only a few participants achieved scores of 80% or above: 17105, 17111, 17126, and 17139, indicating the "Independent" level, where they can show excellent skills in reading comprehension. A different approach integrating these language proficiencies can afford students the possibility of overcoming reading-related challenges (Lervag et al., 2017; Clemens et al., 2018). The results of the assessment, therefore, powerfully argue for a specific intervention to improve the reading skills of struggling participants. The overall results make it evident that there is an urgent need for some specific targeted interventions to enhance the reading capabilities of the majority, given that the average score here places these students at a level characterized as "Frustrational," or one in which they struggle to comprehend the texts reasonably (Connor et al., 2018).

4.2 Frequency Counts and Percentages of the Level of Reading Comprehension Level of the Participants Before the Program

Table 5. Frequency Counts and Percentages of the Level of Reading Comprehension Level of the Participants Before the Program

Level of Reading Comprehension Level	Pre-test	
	F	%
Independent	4	10.53
Instructional	9	23.68
Frustration	25	65.79
TOTAL	**38**	**100**

The reading level analysis shows serious concern: 65.79% are at the Frustrational level, indicating significant reading comprehension deficits before any intervention, thus calling for desperate measures. About 10.53% functioned at the independent reading level; Richards-Tutor et al. (2015) found that foundational skills interventions have positive effects, especially for younger students. Of these, only 9 (23.68%) participants demonstrated instructional level mastery, meaning most still needed help. According to Daniel et al. (2021), students below a certain level would be less developed and, hence, need assistance in comprehension. The number of participants categorized as being at the frustrational level suggests an apparent urgency for structured interventions.

Establishing baseline skill sets is paramount for assessing progress. If they could get such focused intervention, they should improve upon early literacy interventions (Wanzek et al., 2015). Also, the association between the reading levels and the intervention outcomes complements comprehension-based interventions assure long-term gains in reading skills (Suggate's, 2014). The variation in pre-test results indicates their capability and the anticipated effect, if there are any, interventions will strengthen their reading skills over time.

4.3 Post-test Scores

Table 6. Participant Post-test Scores and Reading Comprehension Level

Participants ID	Post-test Score	Percentage	Reading Comprehension Level
17101	16	80	INDEPENDENT
17102	15	75	INSTRUCTIONAL
17103	11	55	FRUSTRATIONAL
17104	8	40	FRUSTRATIONAL
17105	15	75	INSTRUCTIONAL
17106	16	80	INDEPENDENT
17107	15	75	INSTRUCTIONAL
17108	15	75	INSTRUCTIONAL
17109	13	65	INSTRUCTIONAL
17111	15	75	INSTRUCTIONAL
17112	15	75	INSTRUCTIONAL
17113	16	80	INDEPENDENT
17114	16	80	INDEPENDENT
17115	12	60	INSTRUCTIONAL
17116	14	70	INSTRUCTIONAL
17117	16	80	INDEPENDENT
17118	14	70	INSTRUCTIONAL

17119	15	75	INSTRUCTIONAL
17120	14	70	INSTRUCTIONAL
17121	11	55	FRUSTRATIONAL
17123	14	70	INSTRUCTIONAL
17124	10	50	FRUSTRATIONAL
17125	12	60	INSTRUCTIONAL
17126	15	75	INSTRUCTIONAL
17127	13	65	INSTRUCTIONAL
17129	12	60	INSTRUCTIONAL
17130	15	75	INSTRUCTIONAL
17131	12	60	INSTRUCTIONAL
17132	15	75	INSTRUCTIONAL
17133	16	80	INDEPENDENT
17135	12	60	INSTRUCTIONAL
17136	14	70	INSTRUCTIONAL
17138	14	70	INSTRUCTIONAL
17139	15	75	INSTRUCTIONAL
17140	16	80	INDEPENDENT
17141	10	50	FRUSTRATIONAL
17142	12	60	INSTRUCTIONAL
17143	14	70	INSTRUCTIONAL
MEAN	13.76315789	68.81578947	INSTRUCTIONAL

Table 6 illustrates the post-test result and reading comprehension performance of 38 participants. The results show a range of scores, which average 13.76 out of 20 and correspond to an average percentage of 68.82%. Most participants are in the instructional level, which indicates that some support is still needed to understand the material. The result revealed that a reasonable number of students exhibit independent reading ability. At the same time, a concerning portion is classified as Frustrational, and they struggle quite a bit even with assistance of the program. This diverse range of scores reinforces the relevance to specific learners of particular instructional strategies designed to address their needs.

4.4 Frequency Counts and Percentages of the Level of Reading Comprehension Level of the Participants After the Peer-Assisted Reading Program

Table 7. Frequency Counts and Percentages of the Level of Reading Comprehension Level of the Participants After the Peer-assisted Reading Program

Level of Reading Comprehension Level	**Post-test**	
	F	**%**
Independent	7	18.42
Instructional	26	68.42
Frustrational	5	13.16
TOTAL	**38**	**100**

Table 7 presents the frequency counts and percentages of the participants' reading

comprehension levels after the peer-assisted reading program; 68.42% still require instructional support for improved reading comprehension. While 18.42% of those achieved independent reading comprehension, which offers a ray of hope from the intervention. Still, some students fell to the frustrational level, about 13.16 %; hence, the overwhelming realization that inattentiveness in their comprehension skills continues to exist. The findings imply that although the intervention benefited some students, a vast population still requires another level of support for their reading abilities (Suson et al., 2020; Tomas et al., 2021).

Such results correspond with previous studies linking reading skills with instructional strategies in practice. It has been known that watching over one's progress in a task is very significant, particularly for students moving from Grade 5 to 7 (Edossa et al., 2022). Furthermore, considerable focus on intervention strategies and those who failed at them would depend on the intervention and background cognitive abilities (Lovett et al., 2021). Thus, more instructive personalized interventions can help with future reading needs (Agao-Agao, 2023; Navarra, 2020).

On top of that, instruction in reading varies greatly depending on how these methodologies are used. Stoics, culturally relative reading material, and differentiated instruction would raise Filipinos' reading proficiency (Idulog et al., 2023; Potot et al., 2023). It stresses the importance of frequently changing instructional methods and the students' constant need for support in their difficulties with reading comprehension (Suson et al., 2020; Okkinga et al., 2021). With the peer-assisted reading program generating a good outcome for some Grade 7 participants, the data concludes the ongoing support requirement aligned with modified instructional approaches to address diversified learners' requirements (Potot et al., 2023).

4.5 Frequency Counts and Percentages of the Level of Reading Comprehension Level of the Participants Before and After the Peer-Assisted Reading Program

Table 8. Frequency Counts and Percentages of the Level of Reading Comprehension Level of the Participants Before and After the Peer-assisted Reading Program

Level of Reading Comprehension Level	Pre-test		Post-test	
	F	%	F	%
Independent	4	10.53	7	18.42
Instructional	9	23.68	26	68.42
Frustrational	25	65.79	5	13.16
TOTAL	**38**	**100**	**38**	**100**

Improvements are interpreted by perceivable definite shifts with the Peer-Assisted Reading Program in the reading comprehension level of seventh-grade learners. The intervention resulted in a percentage increase in the number of students at the instructional level from the pre- to the post-test. At the same time, those identified as Frustrational had a noticeable decline to 13.16%. The data also shows that 65.79% of the participants are categorized as having a Frustrational level as their reading ability, and only 10.53% could read at the independent level. Improvements might be seen at the Instructional level: their percentages had risen from 23.68% to 68.42% during the post-test, while Frustrational readers decreased to 13.16%.

Furthermore, the number of independent readers also rose to 18.42. Structured peer interaction, especially argumentative, proves a significant prediction of comprehension scores (Muhammad et al., 2024). Collaborative strategies- e.g., peer tutoring- effectively support independent reading and academic progress (Fitriani & Tarwana, 2020; Suhendri, 2022). The success of the Peer-Assisted Reading Program is considerable. Such a program can provide a test into the Philippine educational arrangement since it develops comprehension proficiency and provokes independent reading habits among learners. Such an effort, this assessment, marked the need for collaborative learning practices to close the reading proficiency gap.

4.6 Difference Between the Level of Reading Comprehension of the Participants Before and After

the Program

Table 9. Difference between the Level of Reading Comprehension of the Participants before and after the Program

Paired Sample t-test	N	MEAN	SD	*t-statistics*	*p-value*	Effect Size
Pre-test	38	10.4	3.27	6.11	<.001	0.991
Post-test	38	13.8	2.01			

According to the paired sample t-test, there is a statistically significant improvement in reading comprehension done after the program. Specifically with 38 participants, pre-test reading comprehension scores came at a mean of 10.4 and post-test at 13.8. With a t-statistic of 6.11 and a corresponding p-value of under .001, this difference is extremely unlikely to have occurred by chance and consequently is highly suggestive of a true effect from the program. The very large value of the effect size of 0.991 indicates high practical value, suggesting substantial improvement in reading comprehension. The conclusion that the program actually enhanced the reading comprehension levels of these participants is accordingly supported with strong evidence.

4.7 Participant's Perception of the Strengths and Weaknesses of the Peer-Assisted Reading Program to Improve their Reading Comprehension

The participant's perceptions of the strengths and weaknesses of the peer-assisted reading program were identified by the focus group discussion consisting of a series of open-ended questions that aimed to gather the students' perceptions and experience with the reading intervention. The FGD revealed two themes regarding the program's strengths, including engaging stories and passages, skill development, and the ability to find the answers within the text.

4.8 Peer-Assisted Reading Program Strengths

Participants' willingness to engage in the peer-assisted reading program highlights the vital roles of curiosity and intrinsic motivation in facilitating the reading process. A participant from the Focus Group Discussion claimed, "*The best part is the story in the reading program because sometimes the student will be curious about the passage.*" The statement suggests that participants were excited and interested in the stories in the peer-assisted reading program. Such findings are consistent with literature that illustrates how children's engagement increases with exposure to interesting reading material that draws on emotional and cognitive curiosities (Shah et al., 2018; Reichardt et al., 2023). Specifically, research shows that stimulating passages stimulate student curiosity and prompt readers to investigate deeper into the reading experience (Shah et al., 2018; Reichardt et al., 2023). In addition, studies demonstrate that intrinsic motivation, such as curiosity and enjoyment, are key distinctions of reading behavior and are vital for learning success (Hall et al., 2016). All in all, this is illustrative of the educational philosophy that relies on incorporating peer-assisted reading strategies to effectively take advantage of natural student curiosity in literacy learning (Hasnani & Ismail, 2020; Fitriani & Tarwana, 2020).

Moreover, the participants indicated that discussing the readings helped improve their analysis and comprehension skills. As one student stated, "*The best part of the reading program is the stories because it teaches us a lot of skills like how to analyze questions and helps us improve our reading.*" The program contributed to developing critical reading skills. This finding aligns with previous literature suggesting peer interaction is a major contributor to increased reading comprehension. Studies illustrate that peer-supported learning approaches foster students' reading ability through collaborative engagement (Al-Dokom & Al-Qeyam, 2024; Hasnani & Ismail, 2020; Robison, 2022; Cooc & Kim, 2017). Beyond collaborating during reading, students helped each other better comprehend what they had read. Additionally, students benefitted from learning in a community that made learning more fun. Examples included collaboration and supportive peer learning, and some students also described a positive atmosphere, making the reading process productive (Fitriani & Tarwana, 2020; Halim et al., 2020).

As stated in various studies, the focus on peer-assisted strategies represents a more extensive

understanding of what works in effective reading methods. The program's approach, where students can talk about the readings, corresponds with studies that show cooperative learning fosters greater academic and social growth (Gámez & Lesaux, 2015; Coll & Durán, 2015). Peer tutoring methods particularly benefit learners, showing that students, regardless of ability, can increase their reading ability with consistent peer support (Yawiloeng, 2021; Chaemsai & Rattanavich, 2016). The qualitative feedback from students showing they enjoyed their learning experiences demonstrates the power of storytelling as a realization, not just of comprehension, but also motivation to read more, which again aligns with the understanding of narrative bringing younger readers toward critical thinking (Roma, 2019; Yawiloeng, 2020). These findings validate that peer-assisted reading strategies support important reading skills while ensuring an active, connected learning environment.

4.9 Peer-Assisted Reading Program Weaknesses

The focus group discussion results revealed that participants identified several significant weaknesses in the peer-assisted reading program. In particular, students noted challenges related to the length and difficulty of the reading material. One participant stated, "*kasi masyado po kasing mahaba [because it is too long.],*" suggesting that the length of the texts may have been daunting and contributed to their difficulty remembering the information. This is consistent with research highlighting that excessive input adds to fatigue and limits students' engagement, negatively impacting their overall learning experience (Räisänen et al., 2020). In addition to length and difficulty, students commented on the lack of coherence between the reading assignment and the assessment questions; one comment noted that "*The weaknesses that the reading program is sometimes the stories are hard to read and sometimes when I am answering a question, wala po doon yung sagot [the answer is not right there.]*" Suggesting that there may be a breakdown between the materials and the comprehension evaluation, making the learning experience more complex (Räisänen et al., 2020).

In addition to concerns about having to read rich data that was long and clear, focus group participants indicated that the material format influenced their ability to remember what they read. For example, one student noted that complex stories are not easily remembered, saying, "*nakakalimutan kasi masyadong mahaba, pag masyado syang mahaba it will give you a point na nakakalimutan niyo na sya? [I forget because it is too long; when it is too long, it will give you a point that you are forgetting it?]*" (Räisänen et al., 2020). This is a common occurrence in learning and can be understood within cognitive load theory, which describes when learners are overloaded with information that exceeds their processing capacity (Erickson et al., 2020). The point here is important: It is necessary for the material to not only be concise but also appropriately demanding enough to be comprehensible without adding cognitive load.

Lastly, the problems mentioned by students point to the need for reading interventions to be more individualized to improve learning impact. Previous studies indicate that interventions varying in complexity and relevance can engage students more and increase motivation and comprehension (Rosenzweig et al., 2018; Guthrie & Klauda, 2014). The focus group data not only highlighted actionable feedback on areas for improvement with a peer-assisted reading program for students; it also indicated a need for educational methods to be accommodating and supportive of individual differences in learning styles and comprehension levels more broadly. Additionally, using adaptive learning techniques may relieve reading and learning weaknesses indicated by students, making it less challenging to overcome difficulties with the length and coherence of the material while optimizing their learning environment (Guthrie & Klauda, 2014).

4.10 Participants' Suggestions to Improve Peer-assisted Reading Program

The insights gained from the focus group discussions about participants' recommendations for changing direct instruction in the peer-assisted reading program highlight essential aspects for improvement. Participants universally suggested that texts need to be shorter to quickly get answers, meaning they want the portions of the story to be more concise. For example, one student communicated how important the portion length is by stating the following: "*Liitan lang po yung stories ng sakto para po mahanap po agad yung mga sagot. [Shorten the stories appropriately so that the answers can be found quickly.]*" Another participant followed along, suggesting that we should not worry about the length of the story and the "*Liitan po yung story. [Shorten the story.]*" Participants overwhelmingly suggested that the stories needed to be shorter

because they thought the narratives were too long and would impact comprehension and engagement with the material at small group learning. This concern for length aligns with the literature suggesting that shorter reading excerpts can enhance the effectiveness of literacy interventions by making reading material more accessible for students (Abeberse et al., 2011).

Alongside shortening the text, the program participants expected more explicit structural organization in the reading program. Program suggestions included implementing a two-column format—questions in Column A and responses in Column B—for the reading exercise. This could help students directly align responses to each corresponding question ("*maglagay po ng Column A and Column B po. [add Column A and Column B.] like, yung column A po yung mga questions and yung column B po yung mga sagot. [Column A are the questions and column B are the answers.]*"). This suggestion aligns with educational research indicating that organized educational materials promote increased comprehension and academic success (Rondeaux et al., 2023). The request for "keywords" also indicates that students want methods to help them identify key concepts or information directly within the text, which aligns with literacy instructional practices that are based on educational transparency (Abeberese et al., 2011).

Finally, the focus group members discussed the need for improvements in the quality and number of the questions. They called for more modest, understandable questions to correspond with the brief text fragments. Comments like "the questions should be improved, the questions in the strands should be smaller, and the sentences should be shorter" demonstrate a strong desire for simple language and doable tasks. Simplified language in instructional materials may improve learners' engagement and comprehension (Sørensen et al., 2015). Overall, the focus group findings revealed an overwhelming agreement for changes to the peer-assisted reading program's clarity, brevity, and structural structure to improve learners' literacy results.

5. Conclusions and Recommendations

This chapter presents the whole study with the salient findings surfaced at in answer to the problems posed in Chapter I. Furthermore, the conclusion drawn based on the findings and the recommendation based on the conclusion.

5.1 Conclusions

A study into the use of Project PARP (Peer-Assisted Reading Program) reveals essential information about the reading comprehension levels of participants. The results of the pre-test show that participants had a mean reading comprehension score of 10.42, or approximately 52.11%, which placed most student participants at the "Frustrational" functional reading level, meaning they were reading with significant difficulty, as noted in the research by SÖNMEZ & Çetinkaya (2022). It was reported that approximately 65.79% pointed to the Frustrational level, indicating a need for immediate and focused interventions (Librea, 2023). The participants demonstrated very low levels of reading comprehension at baseline; thus, the need to provide deliberate, structured support was imperative, as participants were unable to independently comprehend grade-appropriate texts, which is consistent with previous studies that examined the efficacy and benefits of individualized reading interventions to help struggling readers (Imbaquingo & Cardenas, 2023).

Following Project PARP, the results of the post-test exhibited a positive effect. The mean score of the project participants (average = 13.76 or 68.82%) indicated a shift to the "Instructional" level of reading comprehension among 68.42% of the students (Yulianti & Sukasih, 2023). Although several students reached an "Independent" reading level, an estimated 18.42% did not receive important support, even after the reading intervention. A small percentage of students, 13.16%, remained at the "Frustrational" reading comprehension level. Although the reading intervention had a positive effect, it also suggested that some students continued functioning within the "Frustrational" level (SÖNMEZ & Çetinkaya, 2022).

The paired sample t-test data showed statistically significant differences between pre-and post-test scores (t-statistic = 6.11, $p < .001$) and suggested that the reading intervention benefited participants' comprehension abilities and supported the usefulness of structured reading interventions. In conclusion, the peer-assisted reading program appeared to promote and improve reading skills among the participants as a structured intervention (Sudiatama et al., 2023).

The participants' perspectives on the strengths and weaknesses of Project PARP further demonstrate the qualitative impact of the initiative. Students mentioned positive

experiences discussing readings and collaboratively working through comprehension challenges, highlighting children's social interaction in reading (Bayani, 2022). They noted that oral engagement with stories sparked curiosity and an intrinsic interest in reading further (Bergen et al., 2022). However, participants also cited specific weaknesses, like the length and difficulty level of the readings, as occasionally daunting, contributing to retention issues that support the relevance of cognitive load theory in educational contexts (Dewi & Sari, 2022).

In summary, the evaluation of data collected from Project PARP reveals a positive shift in reading comprehension levels after the program was implemented while also providing valuable data from students regarding the program's positives and negatives. The data stresses the importance of addressing ongoing support and developing differentiated instructional practices for students, the articulated complexities of literacy, and the importance of targeted interventions for improving reading comprehension (Imbaquingo & Cardenas, 2023; Dewi & Sari, 2022). Future iterations of Project PARP include modifying reading materials to match the students' cognitive capacities, sustaining the positive aspects that promote curiosity, and addressing deficiencies highlighted by participant feedback to support student learning.

5.2 Recommendations

Based on the result of this study, the researchers recommend the following:

1) The implementation of the peer-assisted reading program. Based on the quantitative data gathered, the program improves the participants reading comprehension level.
2) Use students' level appropriate reading text, not age-appropriate reading text. Thus, the researchers recommend the use of the Science Research Association (SRA) reading laboratory to cater students' level of reading comprehension to foster engagement to the material while improving their reading comprehension level.
3) The questions and organization of the reading program must be structured; the participants recommend various type of test in the program which includes two-column test format.

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In Search of Appropriate Pedagogy that Could Enhance Students' Interest and Academic Achievement in Qualitative Analysis: A Consideration of Predict-Observe-Explain-Explore (POEE) and Demonstrate-Observe-Explain (DOE) Strategies?

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Abstract

This research investigated if secondary school students' interest and achievement in the context of qualitative analysis could be enhanced using predict-observe-explain-explore (POEE) or demonstrate-observe-explain (DOE) instructional strategies. The study was conducted in Kogi Central Education zone of Kogi State, Nigeria. The study adopted quasi-experimental design. 1489 senior secondary three (SS3) students offering chemistry was the population of the study. The sample of the study was 206 students offering chemistry drawn from the population using purposive sampling technique. Qualitative Analysis Interest Questionnaire (QAIQ) and Qualitative Analysis Academic Achievement Test (QAAAT) were the instruments used for data collection. Cronbach's Alpha was used to calculate the reliability coefficient of QAIQ which yielded 0.93 while the Kendell Coefficient of Concordance was used to calculate the inter-rater reliability of the QAAAT which yielded 0.86. Mean and standard deviation were used to answer the four research questions while analysis of co-variance (ANCOVA) was used to test the four null hypotheses that guided the study. The finding revealed that that the mean difference in the interest rating between the groups (POEE group and DOE group) was significant in favour of POEE group [$F_{1, 205}$=4.604, P<0.05]. It was further revealed that the mean difference in the academic achievement scores between the groups was statistically significant in favour of POEE [$F_{1, 205}$=89.004, P<0.05]. Thus, it was recommended that in-service chemistry teachers should be encourage to adopt POEE strategy in order to enhance students' interest and academic achievement in the context qualitative analysis.

Keywords: Predict-Observe-Explain-Explore (POEE), Demonstrate-Observe-Explain (DOE), qualitative analysis, students' interest, academic achievement

1. Introduction

Chemistry as a subject is made up of both theory and practical. The practical aspect consists of quantitative and qualitative analysis. Qualitative analysis is often associated with compound identification. The teaching of chemistry, especially qualitative analysis, involves both manipulative/process skills of teaching theoretically and conducting a laboratory practical session. Students lack practical experience due to the fact that they are not familiar with laboratory apparatus and could not deduce correct inferences from observation. The students' poor achievement in chemistry, especially in qualitative analysis may be attributed to their non-familiarity with the use of simple laboratory equipment; poor teaching styles, imprecise statements; spelling errors; inadequate exposure to laboratory techniques; lack of observational skills; inability to write symbols properly and assign correct charges to ions, among others (WAEC Examiner, 2021). In the same vein, students' lack of understanding of the procedures and reactions involved in chemistry, especially in qualitative analysis is one of the causes for poor academic achievement in qualitative analysis (Lay & Osman, 2023).

Berger (2015) opined that theoretical understanding of qualitative analysis is abstract or difficult because the students did not know what to think about it because during laboratory practical, students usually find it difficult to link the theoretical knowledge gained to the laboratory experiments performed. It seems that students are not interested in the manipulative or process skills involved in laboratory works such as arranging the apparatus, carry out experimental activities, taking measurements and recording the results/inference which may invariably affect their academic performance especially in the context of qualitative analysis. Chemistry is generally taught as both theory and practical. The practical is divided quantitative and qualitative analysis. Qualitative analysis which is the main focus of this research deals with the identification of elements or group of elements present in a sample of compound and also reveals whether a particular ion is present or absent.

Shamsulbahri and Zulkiply (2023) opine that poor interest and academic achievement in chemistry is often blamed on poor teaching methods adopted by chemistry teachers because most students carried out the laboratory experimental activities without a clear understanding physical or chemical changes involved. Thus, these students' poor scientific understanding is likely to be as a result of ineffective instructional teaching strategies adopted by teachers which have invariably affected students' interest toward studying chemistry especially in the context of qualitative analysis. Interest may greatly affect students' alertness, degree of dedication and cognitive engagement toward learning chemistry especially qualitative analysis. When a scientific task is made interesting, students are usually passionately involved (Nwoji, 2024). Thus, an instructional lesson plan or objective should be practically aligned, engaging and interesting. The readiness to be involved in chemistry activities depends on the level of students' interest and considering the fast pace of innovation in scientific understanding, being intellectually active learners who are aware of their own thinking, interest seem required (Ajayi, 2025). Qualitative analysis is often action-based. If chemistry teachers can utilize hands-on based instructional strategies effectively during chemistry instruction especially qualitative analysis, there is tendency that students' interest may be enhanced, ultimately leading to a higher academic performance.

In recent times, stake-holders in education, have been attempting to see how the students' interest and academic achievement in Chemistry can be influenced positively through the effective teaching. Most teaching methods such as lecture method, field-trip, team method and discussion method only encourage rote learning without really exposing students to problems that will make them to be actively involved in teaching/learning process (Ajayi & Achor, 2021). Since some of these methods conventional according to Gabriel, Osuafor, Cornelius, Obinna and Francis (2018), have not really bring about much needed improvement in the teaching and learning of chemistry especially qualitative analysis, the present concern is; How do we teach chemistry especially qualitative analysis effective in order for enhance students' interest toward qualitative analysis, and ultimately enhance their academic achievement? Thus, there is a need to search for innovative instructional strategies that have the potential to encourage hand-on activity and link students prior or existing ideas and explore the aptness of these ideas. In this regard, the researchers investigated if Predict-Observe-

Explain-Explore (POEE) or Demonstrate-Observe-Explain (DOE) instructional strategies could enhance students' interest and academic performance in chemistry especially in the context of qualitative analysis.

Predict-observe-explain-explore (POEE) teaching strategy investigates apprehension by demanding the students to carry out some activities. The students must make the expected result of such activities known and must justify the reason for their prediction. Then, depict what they see happen and finally reconcile any disagreement between their prediction and observation. In 1992, Gunstone suggested Predict-Observe-Explain (POE), the approach of POE necessitate students forecasting the result of tasks, then carry out and observe the event and make explanations based on their observations of such event (Hilario, 2015). Ajayi and Achor (2021) opined that the most important feature of the POE is providing the opportunity for students to make predictions based on their prior experiences of related events that happened in their day-to-day lives. However, the researcher adopted Predict-Observe-Explain-Explore (POEE) to emphasis the importance of exploring.

Predict-Observe-Explain-Explore (POEE) allows students' initial ideas to be investigated, giving teachers the information about students' thinking and the need to investigate the concept. POEE fosters students' exploration and challenge the prior conceptions they bring to the classroom. POEE instructional strategy encourage students to reflect on their previous knowledge before making a prediction about tasks and discuss their prediction with peers. Then, carry out and observe a laboratory activity and scientific explanations of the result giving students a more in-depth conceptual understanding (Acar-Sesen & Mutlu, 2016). In POEE students are required to predict the expected result of an experiment. Then, carry out the experiment and observe. In a situation where there is any conflict between the students' predictions and observations, then students' explanations are explored (Hilario, 2015). The importance of using DOE strategy in teaching lies in the fact that it bridges the gap between theory and practice, allows learners to become good observers and generates their interest.

Demonstrate-observe-explain (DOE) instructional strategy involves the presentation of the activities or tasks related to the facts and principles of an instruction by the teacher in the laboratory, aiming to facilitate the task of learning by showing or practically revealing to the students' certain scientific processes or activities without the students necessarily involved in hands-on task. In most cases, DOE is usually aided by the teacher. This is because the teacher demonstrates the tasks while the students observe and explain the process through the teacher's guide. The teacher must understand and be equal to the task of carrying out the activities for the students to observe and explain (Dorgu, 2015). In, DOE teaching strategy, the teacher is the principal actor while the learners watch with the intention to act through explanation later. Demonstrate-observe-explain (DOE) display or exhibition usually done by the teacher while the students watch with keen interest. The act of demonstration by the teacher while the students observe readily helps to kindle more natural interactions between the students and the teacher (Okotubu, 2020). DOE allows teaching of concepts and principles of real things by combining explanation with handling or manipulation of real events.

Gender is an important component of psychological and self-concept experience of being a masculine or a feminine. Some researchers revealed significant gender differences in cognitive engagement, attitude, academic performance, skill acquisition, interest and critical thinking in chemistry. Some of the factors identified to have accounted for the observed differences in the achievement of male and female students in Chemistry. Ajayi (2025) and Anazor (2019), concluded that male students had higher academic achievement and motivation toward chemistry respectively than their female counterparts. However, the findings in Shamsulbahri and Zulkiply (2021) revealed that there was no significant difference between gender and achievement in separation techniques. Thus, the issue of gender in relations to interest and academic achievement has attracted the attention of many science education researchers and remains contradictory. It can be concluded that the students' poor interest and poor academic achievement in chemistry, especially in qualitative analysis have persisted which is often blamed on poor teaching strategies adopted by teachers. However, studies on DOE and POEE on students' interest and achievement in qualitative analysis have not been investigated. Hence, the present study investigated if secondary school students' interest and academic

achievement in the context of qualitative analysis could be improved using predict-observe-explain-explore (POEE) or demonstrate-observe-explain (DOE) instructional strategies in Kogi Central Education zone of Kogi State, Nigeria.

1.1 Purpose of the Study

The purpose of this study was to investigate if senior secondary school students' interest and academic achievement in the context of qualitative analysis could be improved using predict-observe-explain-explore (POEE) or demonstrate-observe-explain (DOE) instructional strategies. Specifically, the study:

1) determine if students' interest rating could be enhanced in qualitative analysis using POEE or DOE instructional strategies;
2) find out if students' academic achievement scores could be enhanced in qualitative analysis using POEE or DOE instructional strategies;
3) determine the interaction effects of strategies and gender on students' interest rating in qualitative analysis; and
4) find out the interaction effects of strategies and gender on students' academic achievement in qualitative analysis.

1.2 Research Questions

The following research questions guided the study.

1) What is the mean interest ratings difference between students taught qualitative analysis using predict-observe-explain-explore (POEE) instructional strategy and those taught using demonstrate-observe-explain (DOE) instructional strategy?
2) What is the mean academic achievement scores difference between students taught qualitative analysis using POEE instructional strategy and those taught using DOE instructional strategy?
3) What is the interaction effect of the instructional strategies and gender on students' interest ratings of in qualitative analysis?
4) What is the interaction effect of the instructional strategies and gender on students' academic achievement scores of in qualitative analysis?

1.3 Research Hypotheses

The following null hypotheses were formulated and tested at 0.05 level of significance:

HO_1: There is no significant difference in the interest ratings of students taught qualitative analysis using predict-observe-explain-explore (POEE) instructional strategy and those taught using demonstrate-observe-explain (DOE) instructional strategy.

HO_2: There is no significant difference in the academic achievement scores of students taught qualitative analysis using predict-observe-explain-explore (POEE) instructional strategy and those taught using demonstrate-observe-explain (DOE) instructional strategy.

HO_3: There is no significant interaction effect between instructional strategies and gender on students' interest ratings in qualitative analysis.

HO_3: There is no significant interaction effect between instructional strategies and gender on students' academic achievement scores in qualitative analysis.

2. Research Design and Procedure

A quasi-experimental design was used for this study. The non-randomized pre-test post-test design in which each of the two groups controlled the other since the researcher wanted to know the comparative effects of the two groups. According to Nworgu (2018), this design is often used in classroom experiment when experimental and control groups are naturally assembled in intact classes so as not to disrupt the school setting. The study was carried out in Kogi Central District in Kogi State, Nigeria. Kogi Central has an area of 328 km² and a population of 320,260 at the 2006 census. Kogi central comprises three education zones namely: Okene/Ogorimagongo, Ajaokuta and Adavi/Okehi. The population of the study was 1489 senior secondary three (SS3) students offering chemistry for 2022/2023 session in all the 44 public secondary schools in Kogi Central. This consists of 36 co-educational schools and 8 single sex schools (Source: Kogi State Science, Technical Education & Teaching Service Commission (STETSCOM) Zonal Office, Okene, 2023).

A sample size of 206, (84 males and 122 females) SS3 students offering chemistry took part in the study using multi-sampling procedures. Senior secondary three (SS3) students offering chemistry were used because the content scope is from SS3 Chemistry curriculum. Qualitative Analysis Interest Questionnaire (QAIQ) and Qualitative Analysis Academic Achievement Test

(QAAAT) were instruments used for data collection. The QAIQ comprises two sections. Section A elicits the biography data of the students while section B consists of 40 items statements which was intended to help students express their interest toward learning qualitative analysis. The instrument is rated on a 4-point Likert-rating scale with four response options. The options are Strongly Agree (SA), Agree (A), Disagree (D) and Strongly Disagree (SD) with number indicators as (SA) = 4, (A) = 3, (D) = 2, (SD) = 1. QAAAT also consists of two sections. Section A consists of bio-data information of the respondents, while section B consisted of 12 essay questions with a total of 40 marks distributed across the 12 essay questions.

Qualitative Analysis Interest Questionnaire (QAIQ) and Qualitative Analysis Academic Achievement Test (QAAAT) were face validated. QAIQ and QAAAT were subjected to construct validity while the lesson plans were vetted. The reliability coefficient of QAIQ was estimated using Cronbach's Alpha (α) with a value of 0.93. while inter-rater reliability of the QAAAT was calculated using Kendall Coefficient of Concordance (W) and a value of 0.86 was obtained. Four research assistants were selected and trained on the teaching strategies and the contents to be covered. The researcher, having prepared the lesson notes using predict-observe-explain-explore and demonstrate-observe-explain strategies that covered all the contents to be taught for three weeks explained to the teachers the steps involved. The training lasted for a period of one week. QAIQ was rated and QAAAT was marked and scored based on marking scheme with the maximum score of forty marks and minimum of zero. Mean and Standard Deviations were used to answer the research questions while Analysis of Covariance (ANCOVA) was used to test the formulated hypotheses at 0.05 level of significance. Since there is no randomization of subjects, it became necessary to use ANCOVA to avoid the error of non-equivalence and to reduce the initial group differences. The pre-test scores were used as covariates to the post-test scores.

3. Results and Interpretation

3.1 Research Question 1

What is the mean interest ratings difference between students taught qualitative analysis using predict-observe-explain-explore (POEE) instructional strategy and those taught using demonstrate-observe-explain (DOE) instructional strategy? The answer to research question 1 is presented in Table 1 and Figure 1 respectively.

Table 1. Mean Interest and Standard Deviation Scores of Students Taught Qualitative Analysis Using POEE and DOE Strategies

Group	N	PRE- QAIQ		POST- QAIQ		Mean Gain within Group
		$\tilde{x}$	δ	$\tilde{x}$	δ	
POEE	95	1.18	0.19	3.82	0.27	2.64
DOE	111	1.16	0.18	3.27	0.24	2.11
Mean diff. between Groups		0.02		0.55		0.53

Key: N=Number of subjects/respondents, $\tilde{x}$= Mean, δ = Standard Deviation.

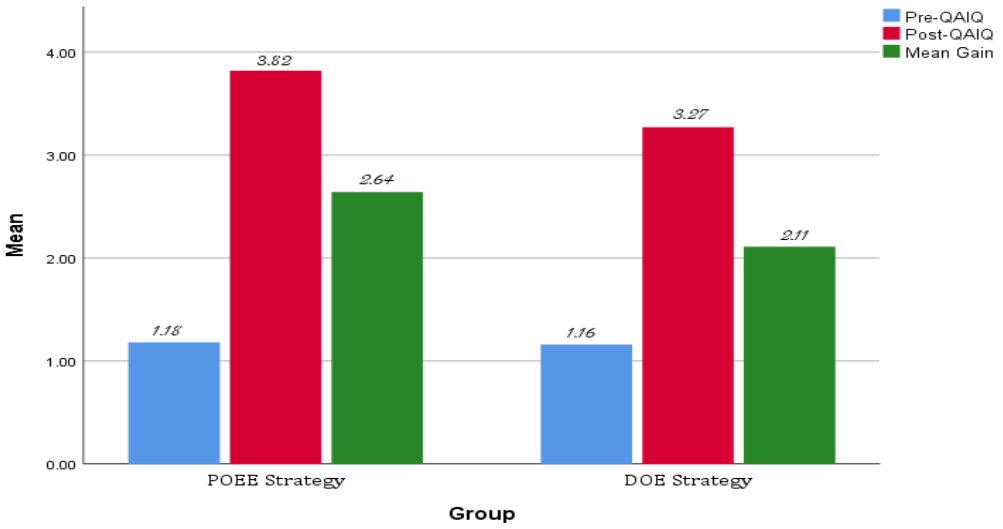

Figure 1. Pre-QAIQ, Post-QAIQ and mean gain in effect of POEE strategy and DOE strategy on students' interest in Qualitative Analysis

The summary of the Pre-QAIQ and Post-QAIQ mean ratings of students taught using POEE strategy and DOE strategy in Qualitative Analysis is represented in Figure 1. The result in Table 1 shows the mean interest rating of students taught using predict-observe-explain-explore (POEE) and demonstrate-observe-explain (DOE) instructional strategies in the context of qualitative analysis on a paired comparative basis. The result shows that students taught qualitative analysis using POEE had a pre-test mean interest rating of 1.18 with a standard deviation of 0.19 ($\tilde{x}$=1.18, δ= 0.19) and a post-test of 3.82 with standard deviation of 0.27 ($\tilde{x}$=3.82, δ= 0.27). The mean interest ratings gain within POEE group was 2.64. Whereas students taught using DOE had a pre-test mean interest rating of 1.16 with a standard deviation of 0.18 ($\tilde{x}$=1.16, δ= 0.18) and a post-test of 3.27 with standard deviation of 0.24 ($\tilde{x}$=3.27, δ= 0.24). The mean interest ratings gain within DOE group was 2.11. However, the data in Table 1 also show that the overall mean interest rating difference between students in POEE and DOE groups was 0.53 in favour of POEE. By implication, this implies that students in POEE group had higher interest rating than students in DOE group.

Hypothesis 1

HO_1: There is no significant difference in the interest ratings of students taught qualitative analysis using predict-observe-explain-explore (POEE) instructional strategy and those taught using demonstrate-observe-explain (DOE) instructional strategy. Table 2 presented the test result of null hypotheses one.

Table 2. Analysis of Covariance (ANCOVA) for Mean Interest Ratings of Students Taught Qualitative Analysis Using POEE and DOE strategies

Source	Type III sum of squares	*df*	Mean Square	F	Sig.	Partial Eta Squared	Decision
Corrected model	557.155[a]	4	139.289	3.647	.007	.068	
Intercept	5270.080	1	5270.080	137.996	.000	.407	
TPr^{QAIQ}	93.789	1	93.789	2.456	.119	.012	
Group	175.822	1	175.822	4.604	.000	.722	S
Gender	55.508	1	55.508	1.453	.229	.007	NS
Group*Gender	75.860	1	75.860	1.986	.160	.001	NS
Error	7676.185	201	38.190				
Total	155667.000	206					

Corrected Total	8233.340	205

Note: S = Significant, NS = No Significant, $\alpha = 0.05$.

Table 2 presents the ANCOVA result for mean interest rating of students taught qualitative analysis using predict-observe-explain-explore (POEE) and demonstrate-observe-explain (DOE) instructional strategies. The data in Table 2 reveal that the observed mean difference in the interest rating between the groups was significant [$F_{1, 205}$=4.604, P<0.05]. Hence, the null hypothesis that there is no significant difference in the interest ratings of students taught qualitative analysis using predict-observe-explain-explore (POEE) instructional strategy and those taught using demonstrate-observe-explain (DOE) instructional strategy was rejected. This implies that there is a significant difference in the mean interest rating between the groups in favour of POEE. Meanwhile, the effect size was 0.722 as indicated by the corresponding partial eta squared value is considered as large effect size. This implies that 72.2% of the difference or variance in the mean interest ratings between the two groups was explained by the treatments. Hence, the difference in the mean interest rating between the groups has a large statistical effect size.

3.2 Research Question 2

What is the mean academic achievement scores difference between students taught qualitative analysis using POEE instructional strategy and those taught using DOE instructional strategy? The answer to research question 2 is presented in Table 3 and Figure 2 respectively.

Table 3. Mean Academic Achievement and Standard Deviation Scores of Students Taught Qualitative Analysis Using POEE and DOE Strategies

Group	N	PRE- QAAAT		POST- QAAAT		Mean Gain within Group
		$\tilde{x}$	δ	$\tilde{x}$	δ	
POEE	95	11.38	2.20	35.89	3.79	24.51
DOE	111	11.43	2.23	28.98	3.14	17.55
Mean diff. between Groups		-0.05		6.91		6.96

Key: N=Number of subjects/respondents, $\tilde{x}$= Mean, δ = Standard Deviation.

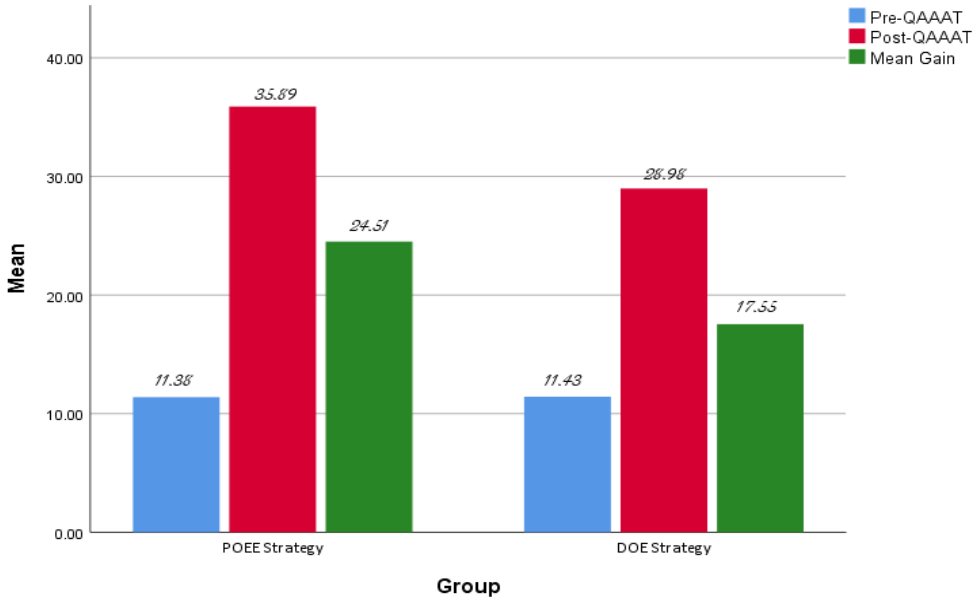

Figure 2. Pre-QAAAT, Post-QAAAT and mean gain in effect of POEE strategy and DOE strategy on students' academic achievement in Qualitative Analysis

The summary of the Pre-QAAAT and Post-QAAAT scores of students taught using POEE strategy and DOE strategy in Qualitative Analysis is represented in Figure 2. The result in Table 3 shows the mean academic achievement scores of students taught using predict-observe-explain-explore (POEE) and demonstrate-observe-explain (DOE) instructional strategies in the context of qualitative analysis on a paired comparative basis. The result shows that students taught qualitative analysis using POEE had a pre-test mean academic achievement scores of 11.38 with a standard deviation of 2.20 ($\tilde{x}$=11.38, δ= 2.20) and a post-test of 35.89 with standard deviation of 3.79 ($\tilde{x}$=35.89, δ= 3.79). The mean academic achievement scores gain within POEE group was 24.51. Whereas students taught using DOE had a pre-test mean academic achievement of 28.98 with a standard deviation of 3.14 ($\tilde{x}$=11.43, δ= 2.23) and a post-test of 28.98 with standard deviation of 3.14 ($\tilde{x}$=28.98, δ= 3.14). The mean academic achievement gain within DOE group was 17.55. However, the data in Table 3 also show that the overall mean academic achievement scores difference between students in POEE and DOE groups was 6.96 in favour of POEE. By implication, this implies that students in POEE group had higher academic achievement than their counterpart in DOE group.

Hypothesis 2

HO_2: There is no significant difference in the academic achievement scores of students taught qualitative analysis using predict-observe-explain-explore (POEE) instructional strategy and those taught using demonstrate-observe-explain (DOE) instructional strategy. Table 4 presented the test result of null hypotheses two.

Table 4. Analysis of Covariance (ANCOVA) for Mean Academic Achievement Scores of Students Taught Qualitative Analysis Using POEE and DOE strategies

Source	Type III sum of squares	df	Mean Square	F	Sig.	Partial Eta Squared	Decision
Corrected model	10465.329[a]	4	2616.332	3.647	.000	.888	
Intercept	1432.618	1	1432.618	137.996	.000	.916	
TPr^{QAAAT}	106.439	1	106.439	2.456	.000	.075	
Group	1662.550	1	1662.550	89.004	.000	.880	S
Gender	.084	1	.084	1.453	.910	.000	NS
Group*Gender	45.076	1	45.076	17.002	.380	.002	NS
Error	1320.598	201	6.570				
Total	134557.000	206					
Corrected Total	11785.927	205					

Note: S = Significant, NS = No Significant, α = 0.05.

Table 4 presents the ANCOVA result for mean academic achievement scores of students taught qualitative analysis using predict-observe-explain-explore (POEE) and demonstrate-observe-explain (DOE) instructional strategies. The data in Table 4 reveal that the observed mean difference in the academic achievement scores between the groups was significant [$F_{1, 205}$=89.004, P<0.05]. Hence, the null hypothesis that there is no significant difference in the academic achievement scores of students taught qualitative analysis using predict-observe-explain-explore (POEE) instructional strategy and those taught using demonstrate-observe-explain (DOE) instructional strategy was rejected. This implies that there is a significant difference in the mean academic achievement scores between the groups in favour of POEE. Meanwhile, the effect size was 0.880 as indicated by the corresponding partial eta squared value is considered as large effect size. This implies that 88.0% of the difference or variance in the mean academic achievement scores between the two groups was explained by the treatments. Hence, the difference in the mean academic achievement scores between the groups has a large statistical effect size.

3.3 Research Question 3

What is the interaction effect of the instructional strategies and gender on students' interest ratings of in qualitative analysis? Research question three is presented in Figure 3.

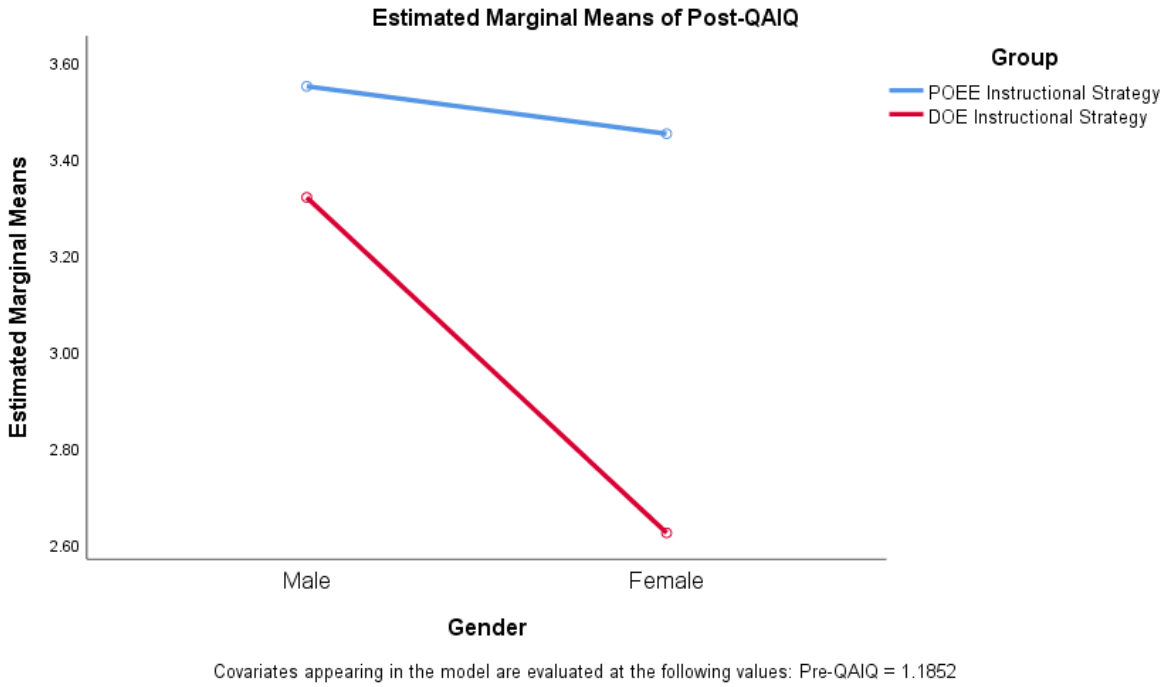

Figure 3. Interaction plot of strategies and gender on students' interest in qualitative analysis

Figure 3 presented a graph of the interaction effect of strategies and gender on the interest rating of students in qualitative analysis. The graph lines for gender did not intercept which suggests that interactive effect of treatments and gender on students' interest in qualitative analysis was very minimal.

Hypothesis 3

HO_3: There is no significant interaction effect between instructional strategies and gender on students' interest ratings in qualitative analysis. The data analysis of Table 2 is used to explain hypothesis 3.

Table 2 presents the interaction effect of instructional strategies and gender on students' interest rating in qualitative analysis. The data in Table 2 reveals that there is no significant interaction effect of treatments and gender on the mean interest rating of students in qualitative analysis [$F_{1\ 205}$ = 1.986, P>0.050]. The null hypothesis is therefore not rejected. Meanwhile, the effect size was 0.001 as indicated by the corresponding partial eta squared value which is considered as small effect size. This implies that only 0.1% of the interaction in the interest rating between the two groups was explained by treatments and gender. Hence, the interaction of treatments and gender on students' interest rating has small statistical effect size.

3.4 Research Question 4

What is the interaction effect of the instructional strategies and gender on students' academic achievement scores of in qualitative analysis?

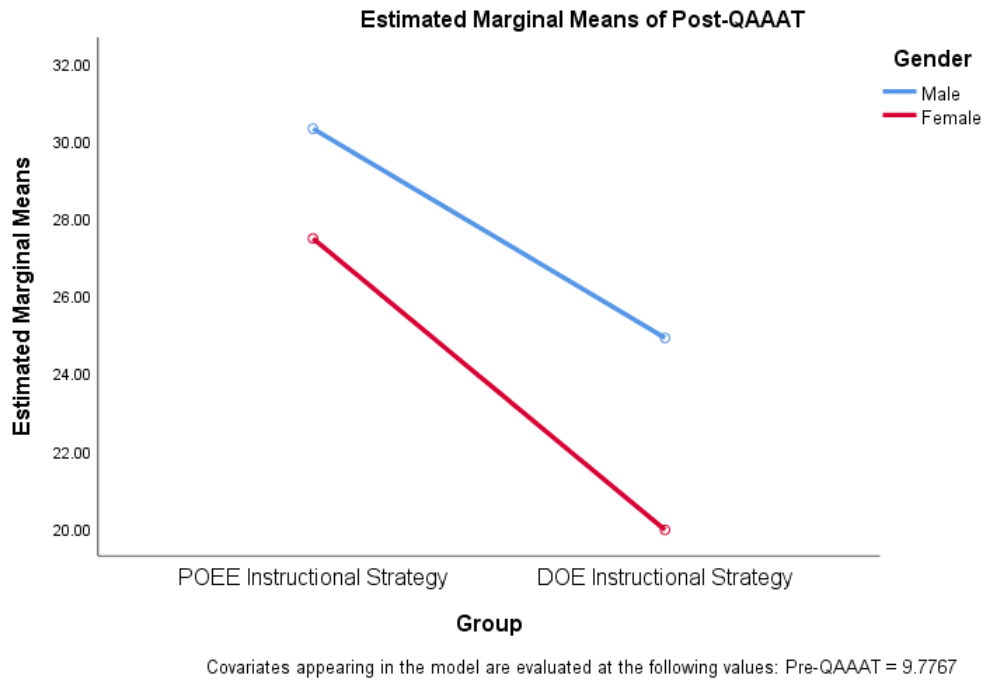

Figure 4. Interaction plot of strategies and gender on students' academic achievement in qualitative analysis

Figure 4 presented a graph of the interaction effect of strategies and gender on the academic achievement scores of students in qualitative analysis. The graph lines for gender did not intercept which suggests that interactive effect of treatments and gender on students' academic achievement in qualitative analysis was very minimal.

Hypothesis 4

There is no significant interaction effect between instructional strategies and gender on students' academic achievement scores in qualitative analysis. The data analysis of Table 4 is used to explain hypothesis 4.

Table 4 presents the interaction effect of instructional strategies and gender on students' academic achievement in qualitative analysis. The data in Table 4 reveals that there is no significant interaction effect of treatments and gender on the mean academic achievement of students in qualitative analysis [$F_{1\ 205}$ =17.002, P>0.050]. The null hypothesis is therefore not rejected. Meanwhile, the effect size was 0.002 as indicated by the corresponding partial eta squared value which is considered as small effect size. This implies that only 0.2% of the interaction in the academic achievement in the two groups was explained by treatments and gender. Hence, the interaction of treatments and gender on students' academic achievement has small statistical effect size.

4. Discussion of Finding

The study investigated the comparative effects Predict-Observe-Explain-Explore (POEE) and Demonstration-Observe-Explain (DOE) instructional strategies on senior secondary students' interest and academic achievement in the context of qualitative analysis in Kogi Central of Kogi State, Nigeria. The findings revealed that students taught qualitative analysis using POEE had higher mean interest rating than their counterparts taught using DOE. ANCOVA result revealed the difference in the mean interest rating of the students taught qualitative analysis using POEE strategy and those taught using DOE strategy was statistically significant in favour of POEE group. The finding of this study is in line with Hilario (2015), Sreerekha, Arun, and Swampna (2016) and Ajayi and Audu (2020). Findings that the POEE strategy was effective in terms of gathering students' predictions and reasons for the prediction of outcomes in an open-ended format. With the consistency in the above previous research findings, it is clear from the findings of this present study that POEE strategy is more efficacious than and superior to

DOE strategy in enhancing students' interest in qualitative analysis. The likely explanation for this outcome may be connected to the fact that the POEE strategy propelled the students and gave them the persisting tendency for critical thinking based on their previous knowledge to forecast, make self-discovery, have willingness to carry out their activities with concentration and enjoy the activities in the content since POEE strategy is activity oriented and more of student-centered. The strategy gives the learners the opportunity to reconcile their prediction with explanation after carrying out the experiment. It was obvious that the introduction of POEE strategy as one of the treatments enhanced the interest of the students in qualitative analysis tremendously.

The result revealed that students taught qualitative analysis using POEE had higher mean academic achievement scores than their counterparts taught using DOE. ANCOVA result revealed the difference in the mean academic achievement scores of the students taught qualitative analysis using POEE strategy and those taught using DOE strategy was statistically significant in favour of POEE group. This finding agrees with Acar Seşen and Mutlu (2016) who reported that laboratory activities based on POEE strategy task were more effective than the traditional cook-book laboratory setting for promoting the pre-service elementary teachers' conceptual understanding. The finding is also in line with Ajayi and Achor (2021) who revealed that predict-explain-observe-explain significantly enhances students' metacognitive awareness than discussion method in organic chemistry. The likely explanation for this may be connected to the fact that POEE strategy allows students to reflect on their experiences with an understanding of a subject before making a prediction about the outcome of an experiment and discussing the prediction with classmates. The performance steps during POEE strategy also give the learners the opportunity to become skillful because it affords them the chance to carry out the task by themselves.

The interaction effect between instructional strategies and gender in relation to the students' interest and achievement in qualitative analysis was found not statistically significant respectively. This indicated that the effect of instructional strategies on Chemistry learning was not significantly different for both female and male participants. The findings in the present study supported Ajayi, Ameh and Alabi (2025) who stated that regarding the interaction between instructional method and gender, no significant interaction effect was found. This indicated that the effect of instructional methods on qualitative analysis learning was not different for female and male students. In this case, there is no need for separation of instructional strategies for male and female students, since POEE approach could be used successfully for the two groups.

5. Conclusion

Based on the findings, the researchers concluded that the students taught qualitative analysis using Predict-Observe-Explain-Explore (POEE) instructional strategy had higher interest and academic achievement respectively than those taught qualitative analysis using Demonstrate-Observe-Explain (DOE) instructional strategy. It was concluded that interaction effect of instructional strategies and gender on students' interest and academic achievement respectively was not statistically significant. In this regard, it was concluded that, there is no need for separation of instructional strategies for male and female students, since POEE approach could be used successfully for the two groups. Thus, the researchers opines that, the difference between the students in POEE group and DOE group in terms interest and academic achievement in favour of POEE group could be due to the fact that POEE instructional strategy being more activity oriented and students-centered which fully demanded students prior-knowledge or experience, hands-on activities, critical thinking, operational and manipulative skills to solve problems related to qualitative analysis compared to DOE group where students only watch the activities demonstrated by the teacher without actively participating (hand-on) in such activities.

Thus, recommendations were made:

1) In-service chemistry teachers should be encouraged to employ the use of Predict-Observe-Explain-Explore (POEE) instructional strategy during teaching/learning process in other to enhance students' interest and academic achievement in the context of qualitative analysis and probably chemistry in general.
2) Workshops, seminars and conferences should be organized by professional and examination bodies such as STAN, TRCN, WAEC, NECO, NABTEB, and JAMB for

science teachers on the use of POEE instructional strategy as to improve students' interest and academic achievement in qualitative analysis.

3) Curriculum developers should be encouraged to include POEE instructional strategy in the training programme of pre-service Chemistry teachers.

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Teaching with Humor: Reflections on Its Relevance in Pedagogical Practice

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Abstract

This study focuses on an affective dimension of pedagogical practices in the classroom—humor—to foster more human and emotional interactions. Through a literature review, it reflects on how humor can be an effective tool in teaching and learning, helping to create more positive environments conducive to educational development. This knowledge is valuable for structuring initial teacher training programs, and equipping educators to integrate humor intentionally and strategically. Humor, as a form of social interaction, is important in fostering closer interpersonal relationships and creating a positive classroom climate. Teaching with humor can strengthen these relationships, facilitate student learning, and significantly contribute to academic success. Additionally, the intentional use of humor aligns with the principles of educational sustainability, fostering a more inclusive, emotionally balanced, and collaborative learning environment that promotes the well-being of both students and teachers. The creation of sustainable educational spaces, grounded in trust, respect, and empathy, has a direct impact on building more cohesive and resilient communities. The conclusions highlight the need for teachers to consider humor as a pedagogical tool that can reduce interpersonal barriers and foster an environment of trust, respect, and collaboration. In this context, initial teacher training assumes a strategic role in providing educators with the necessary skills to apply humor in teaching effectively. Thus, it is emphasized that humor not only enhances the teaching and learning process but also plays a crucial role in building a more emotionally balanced, cooperative, and self-regulated society. Therefore, humor is presented as a crucial element in promoting sustainable pedagogical practices, contributing to the strengthening of social and emotional values essential for sustainable development.

Keywords: humor, learning, school/academic environment, academic environment, interpersonal interactions, teacher training, educational sustainability

1. Introduction

Humor, as an affective and social phenomenon, plays a significant role in daily life by providing stress relief and creating moments of relaxation. In educational settings, humor proves to be a

valuable tool, capable of capturing students' attention, facilitating the learning of complex concepts, and fostering a more welcoming and inclusive environment (Pozsonyi & Soulstein, 2019). Nevertheless, reaching a consensus on the definition of humor remains a challenge, as it takes on different meanings depending on the context in which it is applied (Ngai, 2025). It is a phenomenon that is highly dependent on the environment and audience, potentially leading to unexpected or even unintended interpretations (Kim & Plester, 2019).

According to Martin and Ford (2018), humor is multifaceted, encompassing anything that is expressed or performed and elicits laughter or pleasure in others. This perspective highlights humor as both a social and mental phenomenon, involving cognitive and psychological processes, as well as an emotional response that reflects the enjoyment of something amusing (Li, 2025). In summary, humor involves the interaction between social, psychological, and emotional dimensions, making it a complex and subjective experience (Bartzik et al., 2021; Girão, 2021).

Although most studies focus on the individual effects of humor, Gheorghe and Curșeu (2024) observe a growing interest in investigating it as a social and group phenomenon. However, findings remain varied, and challenges arise in conceptualising and measuring humor in collective contexts. These aspects are particularly important in educational settings, where humor can influence both individual development and social dynamics, aligning with the principles of educational sustainability, which promote an inclusive and collaborative environment (Erdoğdu & Çakıroğlu, 2021).

The effectiveness of humor in teaching depends on various contextual factors, such as the classroom environment, the teacher-student relationship, and the individual needs of learners. While humor offers clear benefits, such as increasing motivation and facilitating learning, it is essential to understand its limitations and how it can be applied effectively (Chen et al., 2023). The use of humor should be context-sensitive, respecting students' cultural and emotional differences and aligning with educational objectives (Jiang et al., 2019). This reflection aims to explore how humor can positively impact teaching and learning—not only by enhancing student engagement but also by fostering more positive interactions between teachers and students, contributing to a more collaborative and inclusive learning environment.

Several studies, such as those by Martin and Ford (2018), indicate that humor is deeply connected to interpersonal relationships, serving as both a psychological reinforcement and a communication facilitator. However, as noted by Attardo (2020), not all types of humor are suitable for the classroom environment, requiring careful use to avoid negative effects on academic performance. The literature on the subject suggests that humor, when applied intentionally, can foster a healthier and more productive learning environment, enhancing motivation and strengthening social connections (Boydstun et al., 2023). Moreover, it highlights that humor in the classroom can improve student engagement and reduce stress (Ellingson, 2018; Jeder, 2015).

This study aims to reflect on the importance of humor as a central element in pedagogical practices, highlighting its relevance for educational sustainability. With proper training, teachers can integrate humor constructively, fostering emotionally balanced and collaborative teaching. Thus, humor goes beyond being a mere pedagogical technique, becoming an essential pillar for sustainable development in the school environment, positively impacting the well-being of both students and educators.

2. Theoretical Rationale

The significance of humor in the school environment is closely linked to its impact on interpersonal relationships, students' well-being, and the promotion of a collaborative learning atmosphere, aligning with the principles of educational sustainability. The theoretical rationale for humor highlights its essential role in social interactions, particularly in academic contexts, where it serves as an integral part of a teaching strategy that can energise learning—provided it is applied under appropriate conditions (Boydstun et al., 2023; Gheorghe & Curșeu, 2024; Martin & Ford, 2018).

Lourenço and Valente (2021) highlight that affective and cognitive aspects are inseparable in the learning process, with affective interaction being essential for student engagement and educational success. They argue that a lack of affective engagement can lead to hostile or ineffective responses in student-teacher relationships, ultimately harming the learning environment. In this context, humor can play a

crucial role in creating a more emotionally balanced atmosphere, fostering more positive interactions.

Humor in pedagogical practices, according to Lourenço and Valente (2021), has the potential to generate both positive and negative affective impacts on the teacher-student relationship. When used constructively, humor can strengthen the bond between educator and student, creating a welcoming and stimulating environment for the learning process (Erdoğdu & Çakıroğlu, 2021). The literature highlights that humor contributes to student motivation and engagement, facilitating the understanding of complex content and promoting closeness between those involved in the educational process (Attardo, 2020; Martin & Ford, 2018).

In a context of greater social awareness, a deeper understanding of the role of humor in education becomes essential. The metacognitive approach to the use of humor in teaching is crucial, as it can increase student interest, reduce tension, and improve the effectiveness of learning activities. According to Embalzado and Sajampun (2020), humor has been linked to positive psychological and physiological effects, such as stress reduction and the improvement of interpersonal relationships.

The impact of humor on student motivation has been widely investigated. Studies indicate that the use of humor in classroom activities contributes to increased student engagement in tasks, boosts their confidence, and generally facilitates learning (Nashruddin & Alam, 2021; Cho et al., 2019). The literature also reveals that, when applied appropriately, humor can reduce stress and increase students' attention, creating a more productive and healthy learning environment (Iivari et al., 2020; Jeder, 2015).

However, despite the benefits demonstrated in various studies, there is a duality of opinions regarding the inclusion of humor in pedagogical practices. Some studies, such as the one by Wu et al. (2021), suggest that humor can, in certain situations, distract students or be perceived negatively, impairing focus on learning tasks. In this regard, research by Masek et al. (2019) reveals that integrating humor into the learning process can distract students during task completion. Attardo (2020) also warns against the misuse of humor, emphasizing that not all types of humor are suitable for the educational context and may interfere with students' academic performance.

On the other hand, a study conducted by Embalzado and Sajampun (2020) with higher education students shows that the use of humor in the learning process not only enhances student engagement but also contributes to creating a more emotionally positive and less tense environment. In this regard, research by Miller et al. (2017) highlights that appropriately integrated humor fosters active learning methods, creates more relaxed classroom environments, significantly boosts student engagement in understanding content, and increases interest in studying different subjects.

In relation to educational sustainability, the strategic use of humor can be seen as a way to create a more inclusive, collaborative, and emotionally balanced learning environment. According to Martin and Ford (2018), humor is directly linked to interpersonal relationships and can be an essential factor in promoting a healthy teaching environment, acting as a kind of reinforcement for the psyche (Esi, 2017). When integrated into pedagogical interactions in a reflective and context-sensitive manner, humor can help reduce tensions, improve student performance, and create an atmosphere conducive to learning.

However, to ensure that humor is effective and does not cause negative effects, it is essential for teachers to have proper training to integrate humor constructively into their pedagogical practices. The literature suggests that humor, when used reflectively and with pedagogical intent, can have a positive impact on both student development and the school environment, serving as a pillar for educational sustainability (Boydstun et al., 2023; Gheorghe & Curșeu, 2024).

Humor has proven to be a valuable tool in teaching, contributing to motivation, interaction, and learning effectiveness. Studies such as those by Bakar (2019) highlight the importance of incorporating humor, whether spontaneous or planned, into lessons, noting that it can significantly increase student engagement. According to the author, humor reduces the tension associated with the learning process and stimulates more effective thinking skills, creating a lighter and more conducive environment for teaching.

On the other hand, Jeder (2015) explores how humor, by capturing students' attention, not

only improves social interaction with teachers and peers but also reduces anxiety in the classroom. The author highlights the positive impact of humor on the closeness of the teacher-student relationship, emphasizing that a relaxed environment fosters more lasting motivation to learn.

Complementarily, Embalzado and Sajampun (2020) suggest that the quality of interactions between students is significantly improved when humor is present in the teaching process. According to Iivari et al. (2020), humor combines academic seriousness with a pleasant environment, showing that this form of emotional intelligence contributes to ideal learning conditions and prolonged attention.

Student perception is also crucial. Asiedu-Addo et al. (2017) emphasize that the way students perceive their classes and teachers directly affects their interest in learning. These authors warn of the negative impact of unfavorable perceptions, which can demotivate students and decrease their engagement with certain subjects. In this context, humor emerges as a strategy to transform these negative perceptions, making lessons more engaging and stimulating a love for learning.

Additionally, Esi (2017) highlights that humor can be an effective way to combat boredom and lack of motivation in lessons, often caused by undynamic teaching methods. However, the author warns about the need for caution in its use, avoiding exaggerations, irony, or strategies that could lead to misunderstandings. When used appropriately, humor not only makes activities more enjoyable but also promotes effectiveness in teaching (Pérez-Bonet et al., 2021).

Overall, all these studies reinforce that humor is not merely an optional resource, but a powerful pedagogical strategy that benefits both students and teachers. According to Gheorghe & Curșeu (2024), it transforms the learning process, reduces tensions, stimulates creativity, and fosters a closer and more collaborative relationship among all involved. Thus, humor emerges as a bridge between academic rigor and a more human and engaging teaching approach.

3. Humor in the Classroom Context

3.1 The Impact of Humor on the Emotional and Socio-Emotional Classroom Environment

It is evident across all levels of education that the educational system generates stress in the majority of the school community. This happens because it often focuses on transmitting content that is far removed from students' interests, expectations, and reality (Valente, 2019). When teaching becomes rigid and overly formal, it weakens student development, limits their active participation, and turns the curriculum into something uninspiring and emotionless (Barrantes-Elizondo, 2016). As a result, there is a decline in engagement and academic performance (Attardo, 2020), which can lead to demotivation, frustration, impulsivity, and indiscipline—issues that are prevalent in many classrooms.

However, humor can play an essential role in creating a more positive emotional environment, helping to break down barriers in the learning process (Embalzado & Sajampun, 2020). Introducing moments of relaxation and lightness into lessons can increase student engagement, making teaching more dynamic and appealing.

Thus, a classroom environment that values humor can help reduce student stress and anxiety, minimizing demotivation and encouraging greater participation (Ellingson, 2018). Furthermore, it can be a powerful ally in preventing frustration, impulsivity, and indiscipline, fostering healthier relationships between students and teachers, and making the educational process more engaging and effective.

As noted by the Lourenço and Vaslente (2021), there is an increasing need to transform traditionally rigid classrooms into spaces where learning takes place in a more dynamic and engaging way. The goal is to create an environment where emotions can be expressed and experiences with teachers give emotional meaning to knowledge. According to the authors, this fusion of experience and learning becomes part of each student's life story, combining cognitive and emotional aspects in the process of knowledge construction. Li (2025) states that, being a highly demanding mental activity that involves both cognitive and emotional factors, the processing of verbal humor consumes more attentional resources than the processing of non-humorous content.

Indeed, Martin and Ford (2018) highlight that cognitive psychology has had a significant impact on the study of humor, as it encompasses and influences different areas, helping to

understand the mental processes involved in the perception and interpretation of stimuli. The authors point out that the perception of incongruity is an essential cognitive mechanism for humor, playing a crucial role in how we interpret and react to different situations. Mora (2013) emphasizes the importance of not overly focusing on the cognitive domain and instead giving more emphasis to the outcomes in the emotional field. In this sense, there is an urgent need for an approach that transforms and replaces a rigid, warm pedagogy with one where humor is a methodology capable of creating a healthy and emotionally enriching learning environment.

On the other hand, Novick et al. (2002) question the importance of including humor in the learning of today's students and emphasize that the academic world must consider the generational differences that exist. Students in today's global era exhibit distinct characteristics from those of a decade ago, particularly in terms of emotional difficulties, experiences with depression, stress, and a lack of experience with learning strategies. The authors highlight that the rapid evolution of globalization has had a direct impact on classroom learning conditions. Thus, creating a favorable environment for teaching and learning in today's and future classrooms increasingly involves the integration of socio-emotional aspects into the educational process.

To better understand this integration, Novick et al. (2002) highlights that the learning process includes five essential socio-emotional dimensions: self-awareness, emotional regulation, self-motivation, empathy (including perspective-taking), and social skills.

Self-awareness refers to students' perception that classroom activities are preparation for real-life situations, making the classroom an environment conducive to self-awareness. This awareness is crucial for a positive impact on learning success.

The study by Wang and Lee (2019) shows that students' self-awareness encourages the perception of the importance of their learning. This, in turn, increases self-motivation and self-confidence, which are linked to learning success, strengthening metacognition and positively impacting the quality of learning outcomes. Research by Atmojo et al. (2020) and Elmi (2020) support these findings, stating that self-awareness is strongly correlated with both the quality of learning and the outcomes of learning. These results further confirm the close relationship between aspects of students' self-awareness, such as self-management and social awareness, in academic performance.

Inserted in positive psychology, Seligman (2002) mentions that humor can be an essential element in the development of self-awareness, as it allows individuals to approach life and challenges with a lighter and more reflective perspective. This humorous process promotes self-understanding by helping students recognize and accept their emotions, enabling them to build a more positive relationship with the learning environment and develop greater emotional self-awareness.

Emotional regulation refers to the ability to manage intense feelings, allowing students to remain calm and better engage in classroom activities. This skill helps prevent emotions such as stress, frustration, and anxiety, fostering a more active and positive involvement in the learning process.

A study by Cristóvão et al. (2017) confirms the relationship between emotional management skills, student participation, and academic performance quality. The results show that the development of these skills plays an essential role in promoting well-being and academic success. Furthermore, since these skills are learnable, they contribute to reducing problematic behaviors and improving student citizenship. Some studies indicate that students' ability to manage emotions is influenced by the teacher's ability to manage conflicts in the classroom (Maamari & Majdalani, 2019; Valente & Lourenço, 2020), highlighting the need for an emotional management model for students during the classroom learning process.

Humor can play a crucial role in emotional regulation, serving as an effective strategy to reduce stress and promote a more relaxed and motivating learning environment. According to Kuiper et al. (2004), humor functions as an emotional regulation mechanism, helping students reinterpret challenging situations in a lighter way and maintain an emotionally balanced state. In this way, integrating humor into the educational context can not only improve students' emotional well-being but also enhance their participation and academic performance.

Self-motivation refers to the ability to direct one's own behavior towards achieving goals, facing challenges and difficulties with initiative, persistence, and effort. According to Lourenço and Paiva (2010), this competency is directly related to beliefs such as self-efficacy, outcome expectations, intrinsic interest or value, and goal orientation, which influence the way students approach their tasks.

We can identify three main components of self-motivation: (i) expectancy, which relates to the student's perception of their ability to complete a task; (ii) value, which is linked to the student's goals and the importance they attach to the tasks; (iii) affect, which encompasses the emotions and concerns associated with the activity.

Highly self-motivated students tend to set ambitious goals for themselves and others, and are more receptive to feedback about their academic performance. Additionally, self-motivation plays an essential role in activating memory, facilitating the retention and recording of learning acquired during classroom activities (Novick et al., 2002).

Humor can play an important role in self-motivation, helping individuals approach challenges with a more positive and resilient attitude. Studies such as those by Jun and Lee (2024) suggest that humor can strengthen intrinsic motivation, making tasks more engaging and encouraging persistence in the face of difficulties. By reducing stress and promoting a lighter, more enjoyable environment, humor contributes to a favorable emotional state, essential for individuals to stay focused on their goals and develop greater self-confidence in their personal and professional performance.

Empathy and the ability to see things from others' perspectives are crucial for life in society. Yamamoto et al. (2018) explain that empathy involves two dimensions: the sharing of emotions (affective component) and adopting the other's point of view (cognitive component). These aspects play an essential role in how individuals interact and coexist within a community.

Lourenço and Paiva (2010) highlight that in the educational context, these skills cannot be separated from the empathy demonstrated by teachers. Therefore, it is essential that, in addition to developing good self-awareness, students are able to establish empathetic relationships with one another, fostering a more positive and enriching school environment where humor and good cheer can also thrive.

Chiu's (2025) study emphasizes the interconnection between humor and empathy, highlighting how humor can serve as a tool to promote more effective professional relationships, enhancing empathy between individuals. The study argues that humor can help build emotional bridges, making interactions more accessible and reinforcing mutual understanding, which is crucial for a healthy work environment.

Finally, social skills are learned behavioral abilities that involve social interactions. According to Del Prette and Del Prette (2018), social skills are a set of culturally accepted behaviors that form competent social performance and generate positive outcomes for the individual in their relationship with others. In a school context, the classroom is considered a miniature learning community consisting of various types of students with different personalities, academic potential, and emotional skill levels, all of which tend to have a significant impact on the quality of academic performance.

Thus, humor can serve as an essential facilitator in the development of social skills, promoting empathy, cooperation, and a more positive interaction environment. Ruch et al. (2018) highlights that humor is associated with a greater ability to form interpersonal bonds and interpret others' emotions, thus strengthening empathy and social competence. In this way, integrating humor into the school environment can contribute to healthier relationships and a more welcoming learning atmosphere.

Novick et al. (2002) emphasize that, to integrate these five dimensions, there are two essential steps. First, the teacher needs to adjust the way they organize activities in the classroom, focusing on a problem-solving model and carefully planning the learning process. This allows for the creation of an activity plan centered on the development of socio-emotional skills. Then, in the second step, it is crucial to leverage already tested and well-implemented strategies in schools, ensuring that they are sustainable in the long term. The authors also highlight that the connection between these five dimensions of socio-emotional learning and

students' academic success is a critical factor. Studies show that most students do not appreciate teachers who teach in an overly serious, rigid, and monotonous environment, as this can negatively impact their performance and engagement in learning.

Embalzado and Sajampun (2020) explain that humor in the classroom should not spoil the learning environment or turn lessons into a stand-up comedy show. The idea is that humor helps students stay focused and learn in a more enjoyable way. Following this principle, more recent studies show that incorporating humor into teaching can improve the relationship between teachers and students (Attardo, 2020; Embalzado & Sajampun, 2020). Additionally, research indicates that lessons with a touch of humor tend to make learning more effective and engaging.

Masek et al. (2019) argue that humor can be incorporated into the classroom in three ways: through learning materials, teaching processes, and strategies used to energize the lessons. According to the authors, humor in learning materials should be used without undermining educational goals, making the content less rigid and more appealing.

It is important to remember that students are adolescents, in a phase of identity construction, and generally do not like overly formal or rigid environments. They prefer a balance: a serious yet relaxed environment. For this, the teacher must know how to use humor strategically, making learning lighter without compromising the content. Ideally, humor and content should go hand in hand throughout the activities, making lessons more engaging and motivating students to value what they learn. Following this approach, Masek et al. (2019) shows that the appropriate use of humor can improve students' performance, skills, and academic success.

3.2 The Integration of Humor as a Pedagogical and Methodological Strategy in the Learning Process

Humor has increasingly been recognized as a facilitating element in teaching, promoting a lighter and more conducive learning environment. When used in a balanced way, it can make lessons more dynamic, stimulate student engagement, and strengthen the relationship between teachers and students.

According to Machlev & Karlin (2017), research shows that humor in the classroom is received differently depending on the students' age. Some studies suggest that humor can increase student engagement, while others caution that it can become a distraction and negatively affect learning. Overall, students have a positive perception of humor in the classroom, and there is a strong link between this perception and their level of participation in learning. Therefore, it is important for teachers to understand the role of humor and know how to use it appropriately and effectively in their lessons.

In this context, Daumiller et al. (2019) clarify that the goal of humor in the classroom is not to divert students' attention or turn teaching into a comedy show, but rather to encourage focus and understanding of the content in a more enjoyable and relaxed manner. Recent studies highlight that integrating humor into the learning process can significantly improve the relationship between teachers and students, as well as contribute to more effective teaching (Attardo, 2020; Bolkan et al., 2018; Embalzado & Sajampun, 2020).

The integration of humor in the classroom can occur in various ways, including the use of learning materials, the adaptation of teaching processes, and the implementation of dynamic and engaging methodologies or strategies. Previous studies suggest that humor, when applied correctly, can make the learning environment more stimulating and accessible, contributing to greater student engagement (Daumiller et al., 2020; Machlev & Karlin, 2017). Humor can be present in instructional materials, as long as it does not compromise learning objectives (Masek et al., 2019). In other words, it is possible to organize content in a less rigid and more appealing way, without losing focus on the essentials.

It's important to remember that students, especially adolescents, are in a phase of building their identity and, generally, do not feel motivated in overly formal or rigid environments. They prefer a balance between seriousness and relaxation, as long as humor is used appropriately within the educational context (Daumiller et al., 2020). Teachers who manage to convey academic content with a touch of humor, without compromising the quality of the teaching, tend to capture students' attention and earn their admiration.

When humor is integrated into the learning process, the study by Miller et al. (2017) suggests that the classroom becomes more relaxed, which

helps students engage more in the activities, making them more effective. The results show that young people between the ages of 17 and 19 prefer a relaxed environment, yet still serious. They appreciate learning conditions that are both serious and relaxed — flexible, but not too rigid.

Another point to consider is that humor can be very useful when applied in teaching methodologies, techniques, and strategies, helping to motivate students to learn. Thus, humor becomes part of the learning method itself (Gnevek et al., 2018) and the teaching tools (Pozsonyi & Soulstein, 2019). Moreover, Omede and Daku (2013) argue that humor can be an excellent pedagogical tool for encouraging learning. By introducing humor into lessons, the environment becomes lighter, which can reduce student anxiety and increase their participation in activities. This creates a more open and collaborative atmosphere, where students feel more comfortable expressing their doubts and opinions, contributing to a more dynamic and effective learning experience.

Indeed, the use of humor in classroom activities is closely linked to students' psychological and emotional states, particularly how they retain content. According to Jeder (2015), when humor is well integrated into lessons, it has a positive impact on information retention and students' ability to maintain attention during learning. Other studies show that using humor as an energizer also helps improve students' concentration, keeping them focused on what is being taught (Tam, 2021; Kurniasih et al., 2018; Mauludin, 2021).

Friedman and Friedman (2019) explain that the use of humor in lessons should be done with balance, considering two important principles: being cheerful and being meaningful. "Cheerful" means creating a pleasant environment where fun should not be the main focus nor exaggerated. A meaningful learning experience only happens when we can connect what we are learning to knowledge we already possess (Silva-Filho & Ferreira, 2022). A study by Torres (2021) showed that if these two principles are well balanced, the lesson becomes enjoyable, and students can easily understand the content because learning success is measured by improved outcomes.

Thus, we can say that humor is essential in life, especially in the school environment, as it is key to creating a healthy and constructive atmosphere within the educational community.

4. Final Reflections

The emotional aspect of students' learning is incredibly important and must be taken into consideration by teachers and educators, as it directly influences the success of classroom activities. This emphasizes that students' opinions about their teachers should not be underestimated. When students have a positive view of how their teachers teach, it can make all the difference in the success of learning (Bakar, 2019). Therefore, it is crucial for teachers to effectively integrate humor into the learning process of their students.

As previously mentioned, much of the emotional load in the classroom is felt in the relationships between teachers and students, including aspects such as eye contact, body language, the content being taught, touch, proximity, tone of voice, methods of welcoming, instructions, corrections, verbal and non-verbal communications, among others. These behaviors and attitudes are part of the interpersonal interactions that have a significant emotional impact on students, which can be either positive or negative, depending on how these interactions are perceived and experienced.

Investing in teacher training is a fundamental task to ensure the success of teaching activities, which are undeniably demanding today due to the complexity of the situations faced. Well-trained teachers can contribute significantly to the improvement of the educational system, ensuring that it benefits all students while addressing each one's individual needs.

Considering this premise, it can be asserted that affectivity plays a crucial role in the pedagogical relationship (Lourenço & Valente, 2021) and, concurrently, in the teaching and learning process. With this understanding, it becomes clear that affective and cognitive aspects are inseparable. Therefore, the teacher, as the essential link facilitating the student's holistic development, must be mindful of the emotional aspect in their teaching practice and reflect on how they are building emotional bridges with their students. Humor can be a valuable tool here, as it creates a more relaxed and connected environment, helping to establish that affective bond, making the learning process lighter and more effective.

The emotional connection must be built on a relationship of closeness, where opportunities for cooperation, respect, trust, and sincerity can be created with the student. Consequently, the school can pave the way to understanding the barriers that hinder interpersonal relationships and provide means to overcome them, fostering a more emotionally aware and self-regulated civil society. The integration of humor in school activities could be a key factor in mitigating these barriers in the teacher-student relationship.

As Ngai (2025) points out, it is essential to establish a consensual definition of humor, especially in the school context, where its application can significantly influence both learning and the classroom environment. However, this definition remains a challenge, as humor takes on different meanings depending on the context in which it is used.

Closing the reflective cycle, and considering the importance of integrating humor into learning in the school context, it can be concluded that humor is an essential and fundamental dimension of the pedagogical relationship. It constitutes an indispensable tool in and for the education of a future, more emotionally aware society.

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Impact of Real-World Problem-Solving Strategy on Biology Students' Comprehension in Makurdi Metropolis

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Abstract

The study determined the impact of Real-World Problem-Solving Strategy (RWPSS) on biology students' comprehension in Makurdi metropolis of Benue State, Nigeria. The study used quasi-experimental design. Three research questions and three hypotheses guided the study. The population of the study consisted of all students in the secondary schools in Makurdi metropolis with 90 as sample using Stratified random sampling technique from two schools. Biology Students Comprehension Test (BSCT) with 20 items constructed by the researcher which yielded a reliability coefficient of 0.80 and validated by one expert in Science Education and one in measurement and evaluation was used to collect data for the study. The data collected was analyzed using descriptive statistics of mean to answer the research questions while the t-test of independent sample was used to test the research hypotheses at 0.05 level of significance. The findings revealed among others that RWPSS is more effective in enhancing comprehension of biology students than CTM, recorded t-test value of 0.055 with a p-value of 0.040. This is less than 0.05 level of significance ($p=0.040<0.05$). RWPSS is more effective in enhancing the comprehension of male and female biology students than CTM, recorded t-test value of 0.055 with a p-value of 0.020. This is less than 0.05 level of significance ($p=0.020<0.05$). The study recommended among others that the Ministry of Education and School administrators should ensure that Real-world problem-solving strategy is used by teachers in enhancing comprehension of biology students irrespective of gender, boarding or day.

Keywords: real-world problem solving, biology students' comprehension

1. Introduction

The world all over has experienced unprecedented development in the past three decades, as a result of advancement in science and technology. This development has come with associates' challenges that need to be solved logically. This calls for grooming young minds with highly innovative and creative abilities for a better tomorrow (Abakpa, Emmanuel, & Odith, 2016). According to Arslan and Emre (2021) the teaching and learning of science in the 21st century should be focused on

education for the betterment of tomorrow by producing graduates that can find lasting solution to the interconnected global environmental challenges like climate change, biodiversity loss, pollution, as well as social challenges such as poverty, inequality, migration and insecurity among others. The author maintained that the teaching and learning of science at the primary and secondary school levels should consist of the influence involved in shaping the development of an individual in a way that he or she would be exposed to real-world problem-solving strategies that could trigger high level comprehension abilities to arrive at permanent solutions. Michael (2022) asserts that Biology is one of the core subjects that if well taught could raise young minds and brains that can provide permanent solutions to the environmental problems through real-world problem-solving modalities.

Anyanwu, Obochi and Isah (2015) opine that teaching and learning biology through real-world problem-solving strategy offers numerous benefits, including increased student engagement, deeper understanding, improved critical thinking, and the development of essential life skills. This approach helps students connect theoretical knowledge to practical applications, making learning more meaningful and relevant. By tackling real-world challenges, students develop problem-solving skills that are transferable to various fields and future endeavors. Amedu (2015) states that real world problem-solving strategy encourages active participation and collaboration, moving away from passive rote learning that is the whole mark of conventional teaching methods. The author stressed that the challenge of solving real-world problems fosters intrinsic motivation, as students are driven by the desire to find solutions and make a difference. By applying concepts to real-world scenarios, students develop a deeper understanding (comprehension) of the issues involved and how it connects to their lives.

Several biology topics lend themselves well to real-world teaching strategies, allowing students to connect abstract concepts to their daily lives. Topics like ecology, genetics, and human biology are particularly effective when taught using real-world examples, hands-on activities, and project-based learning (Yakubu, 2016). According to Usman and Tsedo (2018) topics like ecology can be done through field trips to local parks, forests, or even the student's own backyard can provide real-world observations of ecosystems, food chains, and biodiversity. Students can collect data, analyze it, and discuss the impact of human activities on the environment. Genetics; relating genetic concepts to everyday phenomena like inherited traits (eye color, hair texture), genetic disorders (cystic fibrosis, sickle cell anemia), or the impact of genetic engineering on agriculture can make the topic more relatable and engaging. Activities like extracting DNA from fruit or examining fingerprints can make learning more hands-on. In human biology, Students can connect anatomical concepts to sports, dance, or other physical activities. Exploring topics like the digestive system, the cardiovascular system, or the nervous system through real-world examples like how food is processed, how the body responds to exercise, or how we perceive the world through our senses can make learning more relevant and meaningful (Owoyemi, 2018). Many scholars are of the view that real-world problem-solving strategy can be used in all the topics in biology to promote more proactive science teaching and learning in the 21st century that by far surpasses the conventional teaching methods that have provided little or no result over the years.

Musa (2017) pointed out that conventional teaching methods, while sometimes effective, can hinder deeper understanding and engagement in subjects like biology by focusing on rote memorization and passive learning. This can lead to reduced student interest, difficulty applying knowledge, and a weaker grasp of complex concepts. The author stressed that traditional lectures and textbook-based learning can be monotonous and less engaging, especially for subjects like biology that can be highly visual and hands-on. When concepts are not connected to real-life applications or the students' experiences, it can be harder for them to see the value of the subject and become disengaged (Michael, 2017). Focusing solely on memorizing facts and definitions without understanding the underlying principles can lead to difficulty applying the knowledge in different contexts. Conventional methods often prioritize recall over critical thinking and problem-solving, hindering students' ability to analyze information and make connections that could lead to solving real world problems (Daniel & Gonzales, 2016). There are several

attempts by researchers to prove the efficacy of real-world problem-solving strategy over conventional teaching methods.

Nataša and Radovan (2023) opined that problem-solving activities could be grouped into analyzing and planning problem-solving, discovering solution(s) to the problem, problem-solving evaluation activities and additional activities involving the discussion of the problem and also the degree of student independence in the process of discovering a solution to a problem. Obochi (2021) concluded that problem-solving had significant effects on the academic performance of the students of low ability. Low ability students that were taught physic using problem-solving strategy improved in academic performance and retained the learnt concepts better than those taught using the lecture method. In the vein, Kala, Isah, and Yusuf (2023) concluded that problem-solving instructional strategy used in teaching basic science content has significant main effect on academic achievement and retention when compared with lecture method. Thus, scarcity on studies on impact of real-world problem-solving strategy on students' comprehension in biology has necessitated the present study.

Godpower and Ihenko (2017) affirmed that poor teaching method or poor instructional delivery has overwhelmed our Nigerian educational system and resulted in poor performance of students especially in the core science subjects which is the foundation for many future science-oriented careers. Innovative and creative instructional strategies are the delivery mechanism of classroom instruction in the 21st century therefore become necessary. Teaching and learning of science cannot be complete without effective innovative strategies that has practical elements that allows learners the opportunity to physically interact with the real-world problem-solving strategies to broaden their comprehension abilities. It is so sadden that majority of the teachers in Nigeria still restrict learners only to the confines of the normal classroom teaching and learning with exposing them to real-world problem-solving strategies. The aim of science education globally now is to expose learners to the real-world solving strategies to build understanding around so many societal challenges with a view of finding lasting solutions. But most teachers today pay lip service to this issue and rather spend more time on mere presentation of information to their students in the classroom rather than figuring out how best to expose them to real world problem solving. It is in order to address this problem that this study investigated the impact of real-world problem-solving strategy on senior secondary school biology students' comprehension in Makurdi metropolis Benue State, Nigeria.

1.1 Purpose of the Study

The purpose of this study is to find out the impact of Real-world problem solving on Biology students' comprehension in Makurdi metropolis. This study therefore attempts to:

1) Determine the extent of comprehension of Biology students exposed to Real-world Problem-Solving Strategy (RWPSS) and those exposed to Conventional Teaching Methods (CTM).
2) Ascertain the extent of comprehension among male and female Biology students exposed to RWPSS and those exposed to CTM.
3) Examine the extent of comprehension of Boarding and Day Biology students exposed to RWPSS and those exposed CTM.

1.2 Research Questions

The following research questions were answered in this study.

1) What is the extent of comprehension of Biology students exposed to RWPSS and those exposed to CTM?
2) What is the extent of comprehension among male and female Biology students exposed to RWPSS and those exposed to CTM?
3) What is the extent of comprehension of Boarding and Day Biology students exposed to RWPSS and those exposed CTM?

1.3 Research Hypotheses

The following hypotheses were tested.

1) There is no significance difference on the extent of comprehension of Biology students exposed to RWPSS and those exposed to CTM.
2) There is no significance difference on the extent of comprehension among male and female Biology students exposed to RWPSS and those exposed to CTM.

3) There is no significance difference on the extent of comprehension of Boarding and Day Biology students exposed to RWPSS and those exposed to CTM.

2. Methodology

The study determined the impact of Real-world problem-solving strategy on Biology students' comprehension in Makurdi metropolis Benue State, Nigeria. The study used quasi-experimental design. Three research questions and three hypotheses guided the study. The population of the study consisted of all students in the secondary schools in Makurdi metropolis approved by Benue State Ministry of Education Board with 90 as sample using Stratified random sampling technique from two schools. The experimental group was taught Biology using Real-World Problem Strategy (RWPSS) in line with lessons procedure prepared by the researcher while the control group were taught the same Biology topics using the Conventional Teaching Methods (CTM) lesson plans. Biology Students Comprehension Test (BSCT) with 60 items constructed by the researcher which yielded a reliability coefficient of 0.80 and validated by one expert in Science Education and one in measurement and evaluation was used to collect data for the study. The data collected was analyzed using descriptive statistics of mean to answer the research questions while the Analysis t-test of independent sample was used to test the research hypotheses at 0.05 level of significance.

3. Results

3.1 Research Question 1

What is the extent of comprehension of Biology students exposed to RWPSS and those exposed to CTM?

Table 1. Pretest and Posttest mean Comprehension Scores of Biology Students taught with RWPSS and those taught with CTM

Group	N	Pretest Mean	Posttest Mean	Grand Mean	Remark
RWPSS	45	69.89	79.47	74.68	More Effective
CTM	45	50.88	60.69	55.76	

Mean Scores of Students Comprehension in Biology.

Source: Field Report SPSS April, 2025.

Table 1 shows that pretest mean score of 69.89 and posttest mean score of 79.47 with grand mean of 74.68 for the students taught biology using RWPSS, which is higher than that of those taught using CTM. Therefore, RWPSS is more effective in enhancing students' comprehension in Biology.

3.2 Research Question 2

What is the extent of comprehension among male and female Biology students exposed to RWPSS and those exposed to CTM?

Table 2. Mean Comprehension Scores of Male and Female Students Taught Biology using RWPSS and those Taught using CTM

Gender	Method	N	Post-Test Mean Remark
Male	RWPSS	22	40.10 More Effective
	CTM	23	28.20
Female	RWPSS	23	52.30 More Effective
	CTM	22	30.40

Mean Scores of Students Comprehension in Biology.

Source: Field Report SPSS April, 2025.

Table 2 indicates that with posttest mean comprehension score of 40.10 and posttest mean score of 28.20 for the male students taught biology using RWPSS and those taught using CTM. Also, the female students taught biology using RWPSS recorded posttest mean comprehension score of 52.30 as against those taught using CTM which 30.40. Therefore, Real-World Problem Solving Strategy is more effective and enhances greatly the comprehension of students in biology irrespective of gender.

3.3 Research Question 3

What is the extent of comprehension of

Boarding and Day Biology students exposed to RWPSS and those exposed CTM?

Table 3. Mean Comprehension Scores of Boarding and Day Students Taught Biology using RWPSS and those Taught using CTM

School Status	Method	N	Post-Test Mean	Remark
Boarding	RWPSS	23	35.00	More Effective
	CTM	22	23.31	
Day	RWPSS	22	40.05	More Effective
	CTM	23	25.15	

Mean Scores of Students Comprehension in Biology.

Source: Field Report SPSS April, 2025.

Table 3 reveals that the boarding students taught biology using RWPSS recorded posttest mean comprehension score of 35.00 against those same boarding students taught using CTM which recorded 23.31. Also, day students taught biology using RWPSS recorded posttest mean comprehension score of 40.05 against those taught using CTM that recorded 25.15, Thus, RWPSS is effective in enhancing students comprehension to a great extent irrespective of school status.

Hypothesis 1

There is no significance difference on the extent of comprehension of Biology students exposed to RWPSS and those exposed to CTM.

Table 4. t-test of independent sample on the mean performance scores of students taught Biology using RWPSS and those taught using CTM

Variables	**N**	**Mean**	**SD**	**T**	**Df**	**P**	**Dec**
RWPSS	45	74.6800	0.5221	0.055	88	0.04	N
CTM	45	55.7851	0.5002				

The t-test of independent sample on the mean comprehension scores of students taught Biology using RWPSS and those taught using CTM recorded t-test value of 0.055 with a p-value of 0.04. This is less than 0.05 level of significance ($p=0.04<0.05$). Thus, the null hypothesis is rejected. This means there is significant difference on comprehension scores of students taught Biology using RWPSS and those taught using CTM.

Hypothesis 2

There is no significance difference on the extent of comprehension of male and female Biology students exposed to RWPSS and those exposed to CTM.

Table 5. t-test of independent sample on the mean comprehension scores of male and female students taught Biology using RWPSS and those taught using CTM

Gender Method	N	Mean	SD	T	Df	P	DEC
Male RWPSS	22	20.0500	0.5200	0.055	88	0.02	R
CTM	23	14.0100	0.5101				
Female RWPSS	23	26.1500	0.5230				
CTM	22	15.0200	0.5200				

The t-test of independent sample on the mean performance scores of male and female students taught Biology using RWPSS and those taught using CTM recorded t-test value of 0.055 with a p-value of 0.020. This is less than 0.05 level of significance ($p=0.020<0.05$). Thus, the null hypothesis is rejected. This means irrespective of sex the students perform higher in RWPSS.

Hypothesis 3

There is no significance difference on the extent of comprehension of Boarding and Day Biology students exposed to RWPSS and those exposed to CTM.

Table 6. t-test of independent sample on the mean comprehension scores of male and female students taught Biology using RWPSS and those taught using CTM

Gender Method	N	Mean	SD	T	Df	P	DEC
Boarding RWPSS	23	17.0100	0.5220	0.055	88	0.04	R
CTM	22	11.6550	0.5111				
Day RWPSS	22	20.0250	0.5324				
CTM	23	12.5750	0.5235				

The t-test of independent sample on the mean comprehension scores of boarding and day students taught Biology using RWPSS and those taught using CTM recorded t-test value of 0.055 with a p-value of 0.040. This is less than 0.05 level of significance ($p=0.040<0.05$). Thus, the null hypothesis is rejected. This means irrespective of school status the students perform higher in RWPSS.

4. Discussion of Findings

Result from Table 1 showed that the gained mean comprehension scores of students in the RWPSS group were higher than those of the gained mean comprehension scores of students in the CTM group. This was further confirmed by the t-test of independent sample results in Table 4 which confirmed that students taught biology with RWPSS performed better than those taught with CTM. This implies that RWPSS was more effective in enhancing and facilitating students' comprehension in Biology concepts than the conventional teaching methods. The findings of the study are in agreement with Kala, Isah and Yusuf (2023) whose findings upholds higher achievement of students in Biology through the use of Real-world Problem-Solving Strategy. The result in Table 2 indicated that the overall gained mean comprehension scores of male and female biology students taught with RWPSS is greater than the scores of those students taught with CTM. This is further confirmed by the t-test of independent sample result in Table 5 which showed significant difference in the mean comprehension scores of students taught with RWPSS and those taught with CTM. This implies that RWPSS gender friendly and has positive influences on students' comprehension towards biology. This finding is in consonant with Obochi (2021) who confirmed that real-world problem-solving strategy is gender friendly.

Results in Table 3 showed that the means comprehension scores of biology boarding and day students taught with RWPSS is higher than those taught with CTM. The high lost mean scores obtained by the conventional teaching method group showed that they had comprehend less compare to those of the RWPSS which had higher mean scores. This was further confirmed by the t-test of independent sample result in table 6 which revealed that the students taught with RWPSS comprehend more than those taught with CTM both in the boarding and day schools. This implies that RWPSS is more effective in enhancing and facilitating students' comprehension of biology concepts than CTM. The findings support that of Fernand et al. (2023), Godpower and Ihenko (2017) whose findings reported high students' comprehension through real-world problem-solving strategy.

5. Conclusion

The study concluded that Real-world problem-solving strategy is more effective in enhancing comprehension of biology students than conventional teaching method. Real-world problem-solving strategy is more effective in enhancing comprehension Biology students than conventional teaching method irrespective of gender. Real-world problem-solving strategy is more effective in comprehension of biology concepts by students in both boarding and day schools.

6. Recommendations

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

1) The government through the Ministry of Education and Ministry of Science and

Technology should ensure that real-world problem-solving strategy is used by teachers in enhancing comprehension of biology students irrespective of gender, boarding or day.

2) Ministries of Education and professional bodies such as STAN should organize workshops, seminars and symposia from time to time to popularize and sensitize Biology teachers on the integration of Real-world problem-solving strategy in biology instruction.

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Network Formation by Generative AI Assistant of Personal Adaptive Ethical Semantic and Active Ontology

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Abstract

In the process of life, a person forms and develops a three-level adaptive, thinking and ethical spatial intelligence. Adaptive intelligence is formed and developed in the environment, forming a spatial adaptive ontology. Thinking intelligence is formed and developed by multimodal communication, learning, problem solving and decision making, forming a spatial semantic ontology. Ethical intelligence is formed and developed according to ethical values, forming spatial ethical value ontology. Three-level adaptive thinking ethical spatial ontology participates in decision-making in real time at every moment of human activation in space. Three-level adaptive thinking ethical spatial personal ontology of knowledge and skills can be formed by a generative AI assistant network learning. By forming three-level personal ontology, it will be possible to effectively and efficiently develop relevant and promising scientific research education. Preparing specialist for research activities, teaching his research skills and skills becomes the most important task of modern education. Training a specialist who can think creatively, independently find solutions in problem situations, navigate the information space is a priority in modern research education. Research scientific education helps to prepare qualified specialists capable of independent scientific activity and innovation, which is especially important in the context of a rapidly changing world and global challenges. Consequently, research education allows for the development of practically effective research activities based on the latest trends and discoveries in science, as well as the formation of fundamental science leading to new practical results.

Keywords: network learning, generative AI assistant, personal ontology, scientific research education

1. Introduction to the Spatial Three-Level Ontology of Knowledge and Skills

Spatial three-level ontology captures the knowledge and skills in a multimodal format for perceiving, analyzing, and manipulating spatial relationships and objects. It includes the ability to visualize and represent three-dimensional objects, as well as perceive, understand, and create spatial schemes and models that facilitate the ability to:

- Visualize objects and their relative positions in space. This may include imagining how an

object will look from different angles or at different scales.

- Orient yourself in space, which is important for moving around in the environment. People with a high level of spatial ontology tend to remember routes well and can easily find their way.

- Create and modify objects in imagination or in practice. This can manifest itself in skills such as architecture, engineering, education, medicine, and other activities.

- Be involved in analyzing and solving spatial problems related to activities, and design-related tasks that require working with spatial concepts and objects.

Adaptive ontology captures physical, cognitive and social adaptation. Adaptive ontology promotes adaptation to changes in the environment, finding solutions in new and non-standard situations, depending on how their knowledge, skills and behavior adapt depending on various factors, such as social, cultural, environmental and technological conditions. It allows a person to effectively interact with the world and other people, relying on the processes through which a person changes their behavior, perception or knowledge in response to changes in the spatial environment. Human adaptive strategies change in response to changes in the spatial environment, and influence of cultural norms and values on the perception and use of space.

Thinking ontology is associated with the processes of logical and critical thinking that help analyze information, make informed decisions and develop behavioral strategies. It is based on the ability to synthesize information.

Ethical ontology, in turn, covers the understanding of moral norms and values, and promotes decision-making based on ethical principles. On its basis, responsibility and understanding of the consequences of one's actions for other people and society as a whole arise.

The formation of a three-level spatial ontology implies the creation of an internal model of the world, in which a person understands his interactions with the environment, other people and themselves. This includes understanding one's place in the world, as well as awareness of the interrelations and interactions of various elements of this environment (Gil C. Santos, 2015; Trofimov K.A. & Pyatiletova L.V., 2018; Leontiev D.A., 2019; E.E. Sapogova, 2019; Tapdyg Kerimov, 2022; Dmitry Yuryevich Pospelov, 2024; Skorodumov D. A. & Sukhanova E. V., 2025; Karpov A. O., 2025).

Ontologies serve for the systematic organization of knowledge, allowing to discover new facts, to identify the necessary interrelations between elements. Knowledge organization systems based on ontologies are already very widespread and are used in many industries. The ontology of reality reproduces those structural and attribute connections and relations that are inherent in reality (Evgeny Bryndin, 2022). The ontology of reality contains communicative sequences — associative acts marked with attributes. This allows, in the process of attribute automatic analysis of associative acts, to find similar associative acts of other communicative sequences leading to a rational decision. When forming an ontology, the following sequence of actions is distinguished: classification of basic concepts, selection of basic concepts, definition of relationships, a conceptual scheme of the ontology as a connected complex of concepts is formed, the ontology is supplemented with subject implementations of Individuals and data that have a physical meaning, a linguistic component is formed. The power of an ontology is manifested if the relationships between its elements are described in detail and qualitatively.

Thus, a spatial three-level adaptive, thinking and ethical ontology helps a person to more effectively navigate in a complex world, make informed decisions and act in accordance with moral principles. These are important aspects of personal and social development in the context of a constantly changing reality. A spatial three-level ontology helps develop strategies and solutions aimed at improving the quality of life of people in various spatial contexts.

2. Spatial Orientation of a Person to the Object of Attention

Focusing on an object activates human spatial orientation. Human spatial orientation to an object of attention is a complex process that involves perception, attention, memory, and motor skills. This process allows a person to evaluate surrounding objects and interact with them effectively. Let's consider the key aspects associated with this phenomenon:

(1) Human perception of space is associated with the use of various sensory systems, such as vision, hearing, and touch. These systems help a person determine the distance, direction, and size of objects.

(2) Attention plays an important role in spatial orientation. When a person focuses on a specific object, his or her attention helps to distinguish this object from the environment, which facilitates further navigation and interaction with it.

(3) Spatial orientation also includes motor skills such as movement, coordination, and balance. For example, to approach an object, a person needs to plan and execute movements correctly.

(4) The human brain is capable of creating ontological mental maps of space that help in orientation. These mental representations are based on previous experience and can include both visual and verbal elements.

(5) Spatial orientation can vary among individuals, depending on their spatial skills. Some may have high spatial skills, allowing them to navigate unfamiliar environments more easily, while others may have difficulty.

(6) People can use various strategies to improve spatial orientation, such as using landmarks, route planning, or forming ontological mental maps through learning.

(7) Spatial orientation is influenced by various factors, including age, cognitive ability, stress level, and even cultural aspects.

Thus, human spatial orientation to an object of attention is a multifaceted process that involves the interaction of different cognitive functions and sensory systems, allowing us to effectively perceive and interact with the world around us.

3. Generative AI Assistant Forms Human Ontology During the Learning Process

Formation of human ontology by generative artificial intelligence through learning is a complex and promising task (Evgeny Bryndin, 2021). Ontology includes various aspects:

(1) Education: knowledge and skills.

(2) Work experience: work history.

(3) Skills: professional and everyday skills that have been developed through education, work and social life.

(4) Team participation: participation in significant projects, achievements and contribution to teamwork.

(5) Goals and interests: professional goals, interests and areas in which a person wants to develop.

To form an ontology of a specific person by generative artificial intelligence in the learning process, the following approaches can be used:

- Automated collection of information from open sources and analysis of data on skills and experience.

- Algorithms that can analyze and update the profile based on new data and achievements.

- Individualized recommendations for development based on the created ontology.

- Implementation of a feedback system to assess the accuracy and completeness of the ontology.

- Ensuring the confidentiality and security of a person's personal information.

This approach helps in the overall development of professional and everyday skills.

4. Everything Is Determined by Current Information

Current information plays a key role in the modern world, in various areas of life, such as education, medicine, science, technology and others. Current information includes data that is constantly updated and changed, which allows you to make more informed decisions and adapt to new conditions.

(1) In the field of healthcare, current information about patients, their condition and reactions to treatment allows doctors to quickly adapt treatment methods and provide better care.

(2) Current scientific research data allows researchers to make new discoveries and adjust their hypotheses in accordance with the latest results.

(3) In economics and business, companies use live information to analyze the market, forecast demand and optimize their business processes.

(4) The introduction of technologies such as the Internet of Things allows you to collect and process data in real time, which opens up new opportunities for automation and increased efficiency.

(5) Live interaction of users on social networks creates a constantly updated flow of information that influences public opinion and marketing strategies.

Overall, having a live and up-to-date

understanding of data helps people and organizations respond more effectively to change and make informed decisions.

5. Network Search for New Knowledge and Skills by AI Assistant

Online search for new knowledge and skills with the help of AI assistants is a process in which artificial intelligence helps the user find, process and assimilate information from various sources on the Internet. Let's consider the key aspects of this process:

(1) AI assistants can search through large volumes of data, filtering results by relevance, timeliness and quality. This allows the user to quickly find the necessary knowledge and skills.

(2) Modern AI assistants can adapt to the user's preferences, taking into account their interests, level of knowledge and goals. This allows for more targeted recommendations.

(3) AI assistants can analyze information, highlighting key ideas and concepts. This may include creating a summary, highlighting main topics and presenting data in a convenient format.

(4) AI assistants can recommend training courses, articles, videos and other resources that will help the user develop new skills. They can also offer interactive forms of training, such as practical tasks.

(5) AI assistants can act as mentors, answering user questions, providing feedback, and helping to solve problems during the learning process.

(6) Some AI assistants can track the user's progress in learning, offering additional resources or adjusting the training program depending on the results achieved.

(7) AI assistants can integrate with various platforms and services, such as online courses, webinars, and communities, making the learning process more flexible and accessible.

As a result, using AI assistants to search for new knowledge and skills online contributes to more effective and targeted learning, allowing users to quickly adapt to changes in the world and develop the necessary skills.

6. Network Personal Education of a Person on the Formation of His Adaptive Semantic Ethical Ontology by Generative AI Assistants

Network personal education of a person in the context of the formation of his adaptive semantic ethical ontology with the help of generative AI assistants is a multi-level process that includes several key aspects:

Adaptive ontology implies the ability of an individual to adapt to rapidly changing environmental conditions. Generative AI assistants can contribute to the formation of an adaptive ontology:

- Personalized learning. Using AI to create individual learning plans that take into account the strengths and weaknesses of the student.

- Data analysis. AI can analyze the user's behavior and preferences, providing recommendations for improving skills and knowledge.

- Flexibility in learning. The ability to quickly change directions and approaches to learning depending on new data and changes in interests.

Thinking ontology concerns the development of cognitive thinking and analytical skills. Generative AI can help with this through:

- Interactive learning. AI can ask questions, suggest scenarios and conduct discussions, allowing students to develop their analytical abilities.

- Modeling and simulations. Using AI to create complex problems and scenarios that require deep analysis and critical thinking.

- Feedback. AI can provide timely and constructive feedback, which helps students improve their thinking skills.

Ethical ontology includes the formation of moral and ethical principles. In this context, generative AI assistants can:

- Discussion of ethical dilemmas. AI can offer scenarios that pose ethical questions to the user, facilitating discussion and reflection.

- Learning by example. Using stories and cases to illustrate complex ethical situations and the consequences of various decisions.

- Formation of values. AI can help users explore and form their own values and beliefs through reflection and dialogue.

Thus, the integration of generative AI assistants into networked personal education can significantly enrich the process of forming an adaptive, thinking and ethical ontology of a person. This requires the joint work of specialists in the fields of education, psychology and technology to create effective and ethical

learning tools that will contribute to the development of personality in modern conditions.

7. Human Intelligence Uses Information from the Ontology of Life

Human intelligence relies heavily on information that forms its ontology of life. The ontology of life in this context can be defined as a system of ideas, concepts, and knowledge about the world that is formed on the basis of personal experience, social interactions, and cultural influences. Let's look at several key aspects of how human intelligence uses the information of the ontology of life:

The ontology of life helps organize and structure knowledge. Human intelligence uses categories and concepts that allow it to classify information, draw conclusions, and build logical connections. For example, understanding social roles, moral norms, and cultural traditions allows a person to make informed decisions in various situations.

Ontological knowledge forms the basis for cognitive thinking. Human intelligence analyzes, interprets, and evaluates information based on its ideas about the world. This allows it to question existing beliefs, seek alternative points of view, and develop its own ideas.

The ontology of life includes knowledge of social interactions and emotional reactions. The human intellect uses this information to understand other people, which helps to form sympathy and improve interpersonal relationships. Awareness of cultural differences can help avoid misunderstandings and conflicts.

Human intelligence uses the ontology of life to adapt to new conditions. When faced with new situations, it draws on its previous knowledge and experience, which allows it to find effective solutions. This is also related to the learning process: integrating new knowledge into an existing ontology helps to strengthen and expand mental models.

Human intelligence uses the ontology of life to form its moral and ethical principles. Knowledge gained from culture, upbringing, and personal experience influences how a person perceives good and evil, justice and injustice. These principles then guide their behavior and decision-making in social contexts.

Thus, the information of the ontology of life serves as the basis for human intellectual activity. It not only structures knowledge and promotes critical thinking, but also influences emotional perception and moral attitudes. Intelligence based on this ontology becomes more flexible, adaptive, and capable of a deeper understanding of the world and interaction with it. Natural intelligence based on relevant information and ontology of life activates human behavior and life activity.

8. Create Generative AI Assistants with OpenAI's GPTs Builder

The GPTs constructor from OpenAI is an innovative platform that allows you to create AI assistants. By developers — for quick creation, as well as integration of AI into projects. By entrepreneurs — for process automation, improving customer experience. By content creators — for generating texts, scripts or ideas. By researchers — for processing data to find insights.

To do this, it is enough to define the behavior of the AI assistant, set tasks for it, and also upload the necessary data for training. The constructor allows you to adapt the AI assistant to specific tasks, change the communication style, and also train it on your own data. Deep integration with OpenAI products allows you to easily connect your model to other OpenAI solutions, such as DALL•E for image generation or Whisper for working with voice. Integration with other services makes it possible to connect the AI assistant to messengers, websites, CRM systems or other platforms via API. Customization for specific tasks allows you to adapt the AI assistant to work in any field with an ethical measure (Evgeny Bryndin, 2024a). The designer provides a set of tools for customization and training of the AI assistant, allowing to use it for almost any task. Using the designer, you can develop an AI assistant:

- for communication with clients and solving specific issues,

- for generating document texts — as a customer support tool that will automatically answer frequently asked questions,

- as an analytics system capable of processing data and generating useful insights.

One of the most useful advantages of the GPTs constructor is the ability to set a certain communication style for the AI assistant. It can be formal, friendly, playful or expert — it all depends on the audience for which you are creating it. The AI assistant can be trained on

your own data.

For complex scenarios, the constructor allows you to connect the AI assistant to external platforms via API. This makes it possible to integrate it with your website, application, order management system or CRM.

To understand the essence of a request to the AI assistant, it is important to imagine what components it consists of. A request consists of instructions, main content, examples, hints and auxiliary content. Instructions help the AI assistant understand what is required of it, the main content is the request that it needs to process, examples show the desired result, hints serve as a kind of "push" for generation, and auxiliary content is needed for fine-tuning — fine-tuning the response.

Successful training of an individual by an AI assistant ensures relevant data selection for the individual, optimization of work for specific tasks and continuous testing. Data quality is the basis for successful training by an AI assistant. The more relevant the data, the more accurate and useful the training of an individual by an AI assistant will be. Make a list of questions or tasks that users will face and test the AI assistant, carefully study the feedback. This will help to identify weaknesses and make adjustments. Regular improvement of the AI assistant is a continuous process that allows it to adapt to new requirements and provide the best user experience in the process of training and forming an individual ontology.

9. Conclusion

Formation of an individual ontology contributes to the optimal use of human resources. Individual ontology helps a person define their key values, goals, and priorities in life. This allows them to focus on those aspects that are most important and avoid empty or insignificant actions.

Formation of a personal ontology implies systematization of knowledge and experience, which helps to better navigate complex situations. A person can apply this knowledge to make more informed decisions and effectively solve problems. Individual ontology allows for a better understanding of oneself and the world around them, which helps to adapt to changes. In the context of rapidly changing information and circumstances, it is important to be able to respond to new challenges using one's internal resources.

A clear understanding of one's goals and values helps to allocate time and resources more effectively. This can lead to increased productivity and life satisfaction, since a person will be doing what is truly important to them. Formation of an individual ontology promotes self-awareness and personal growth. A person who understands their strengths and weaknesses, as well as their desires and aspirations, can work on their development, improving the quality of their life.

A clear individual ontology facilitates more effective interactions with other people. Understanding one's own needs and values helps establish healthy and harmonious relationships, which in turn facilitates the optimal use of human resources in a team. Thus, individual ontology not only helps a person better understand himself, but also optimizes the use of his intellectual resources, which ultimately leads to a fuller and more fulfilling life.

Global formation of individual ontology facilitates the optimal use of human resources on a national and international scale. It facilitates harmonious, synergetic, safe, peaceful organization of society's life (Evgeny Bryndin, 2023; Bryndin E. G., 2023; Evgeny Bryndin, 2025a).

The planetary formation of an ecological civilization requires the solution of problems of restoration and maintenance of ecology by the international community. Planetary environmental education based on network training by generative AI assistant of personal adaptive ethical semantic and active ontology can accelerate the planetary formation of an ecological civilization (Evgeny Bryndin, 2025b).

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The Impact of Technology on Scenario Planning for Crisis Management in Small Schools

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Abstract

This paper investigates the influence of technology in contingency planning and the success of scenario planning in preserving educational continuity in small institutions during unanticipated disturbances. Examining research from 1994 to 2024 across several academic databases using a comprehensive literature analysis, the report finds Results show that scenario planning improves institutional resilience. However, its application is still uneven because of policy-related, infrastructure, financial, and policy-related problems. The paper emphasizes how technology could enhance the results of scenario planning. It can be concluded that increasing crisis preparedness and guaranteeing sustainable educational continuity in small schools depend on adaptive leadership, digital transformation, and multi-stakeholder collaboration.

Keywords: scenario planning, educational continuity, small schools, crisis management, technology integration, resilience in education

1. Introduction

Scenario planning is a strategic foresight technique to predict disturbances and guarantee institutional resilience. In the framework of small middle schools, scenario planning is crucial in preparing for crises including natural disasters (Olympia et al., 2005), pandemics (Hulme et al., 2021; Head et al., 2020; Chatzipanagiotou & Katsarou, 2023; McAlpin & Slate, 2021; Rahman et al., 2020; Chatzipanagiotou & Katsarou, 2023). Good plans comprise proactive actions, reaction plans, and recovery procedures (Safaeian et al., 2024). While crisis plans center on evacuation, pandemic preparations may include remote learning and health practices (Martinez et al., 2021). Though crisis management is becoming increasingly important, little study exists on proactive scenario preparation in small schools. Studies underline reactive solutions (Safaeian et al., 2024), which solve issues instead of organized planning for educational continuity (Hulme et al., 2021; Martinez et al., 2021; Head et al., 2020). Olympia et al. (2005) also looked at school emergency readiness, pointing up areas where reaction plans were not followed. Though pertinent to crisis management, this study offers no structure for thorough scenario planning spanning several disturbances. There is a significant discrepancy in the absence of studies, especially addressing the part scenario planning plays in guaranteeing educational resilience in tiny middle schools.

By analyzing the advantages of scenario

planning in educational institutions—especially tiny middle schools—and its function in maintaining continuity in the face of disruptions, this study aims to close that gap. It looks at how various models alter depending on the size of the school to pinpoint the critical elements affecting the effective application of scenario planning. The study also examines how scenario planning affects the ability to continue administrative and instructional activities in times of emergency. Another goal is to create more robust and adaptable educational frameworks for future crises and look into how technology may improve contingency planning, especially in schools with little funding.

This project aims to address the following questions: What advantages does scenario planning offer educational establishments, especially small middle schools? What important elements need to be considered when a small middle school uses scenario planning? What kinds of scenario planning are frequently employed in educational settings, and how do they vary depending on the size of the school? What effect does scenario planning have on small middle schools' ability to continue their administrative and instructional activities during a crisis? In what ways does technology improve emergency preparation in underfunded schools?

2. Theoretical Framework

Grounded on contingency theory, resilience theory, and scenario planning theory, this study offers a disciplined framework for assessing how well scenario planning keeps pedagogical continuity in small middle schools intact during disturbances. According to contingency theory, organizational effectiveness depends on flexibility in response to outside uncertainty (Nyoni, 2021; Ambrosio & Denman, 2008). By encouraging adaptable decision-making for events including pandemics and technological breakdowns, scenario planning fits with this. Resilience Theory emphasizes the capacity of systems to withstand shocks and recover, thereby underlining the need of preparedness and adaptation in maintaining educational operations (Hillmann et al., 2018; Drew & Sosnowski, 2019). Using approaches including SWOT analysis and policy simulations (Cordova-Pozo & Rouwette, 2023; Hillmann et al., 2018), Scenario Planning Theory emphasizes foreseeing uncertainty and building reaction strategies. These ideas together support the goal of the study—that of examining the function of scenario planning in educational resilience and the incorporation of technology for improved contingency planning.

3. Research Hypotheses

In order to investigate the function and efficacy of scenario planning in small middle schools, the study puts forth five hypotheses. According to H1, scenario planning improves administrative and educational continuity in times of crisis, which has major advantages. According to H2, elements including leadership, resource availability, and institutional readiness are necessary for its successful implementation. According to H3, the best scenario planning techniques differ depending on the size of the school, with smaller institutions gaining more from cooperative and flexible methods. H4 postulates that in schools with limited resources, including technology into scenario planning improves results. Lastly, H5 claims that schools that involve a variety of stakeholders—such as legislators, teachers, and tech companies—achieve greater efficacy in scenario planning.

4. Methodology

4.1 Conceptual Framework and Evaluation of Scenario Planning in Small Middle Schools

To improve important elements of scenario planning for educational continuity in small middle schools, a conceptual framework was created using idea mapping and literature analysis (Conceição et al., 2017). The methodology identified best practices for contingency planning by looking at leadership tactics, technological integration, policy alignment, and institutional readiness. Using specific keywords, a systematic literature analysis based on PRISMA criteria examined studies from several scholarly databases (Margam & Pandey, 2025). Original research on resilience, crisis mitigation, and technology-driven contingency planning was given top priority in the review. Peer-reviewed studies on governance, stakeholder engagement, and scenario planning frameworks were incorporated into the qualitative synthesis to guarantee practical insights for creating scalable and long-lasting crisis management plans.

4.2 Article Selection and Screening Process

After being retrieved, 450 papers were filtered for relevancy using keywords and titles. Only

100 items were left after 200 ineligible records and 150 duplicates were eliminated. Abstracts that didn't fit the inclusion requirements were eliminated after a final screening. For qualitative synthesis, 21 papers were ultimately chosen (Figure 1).

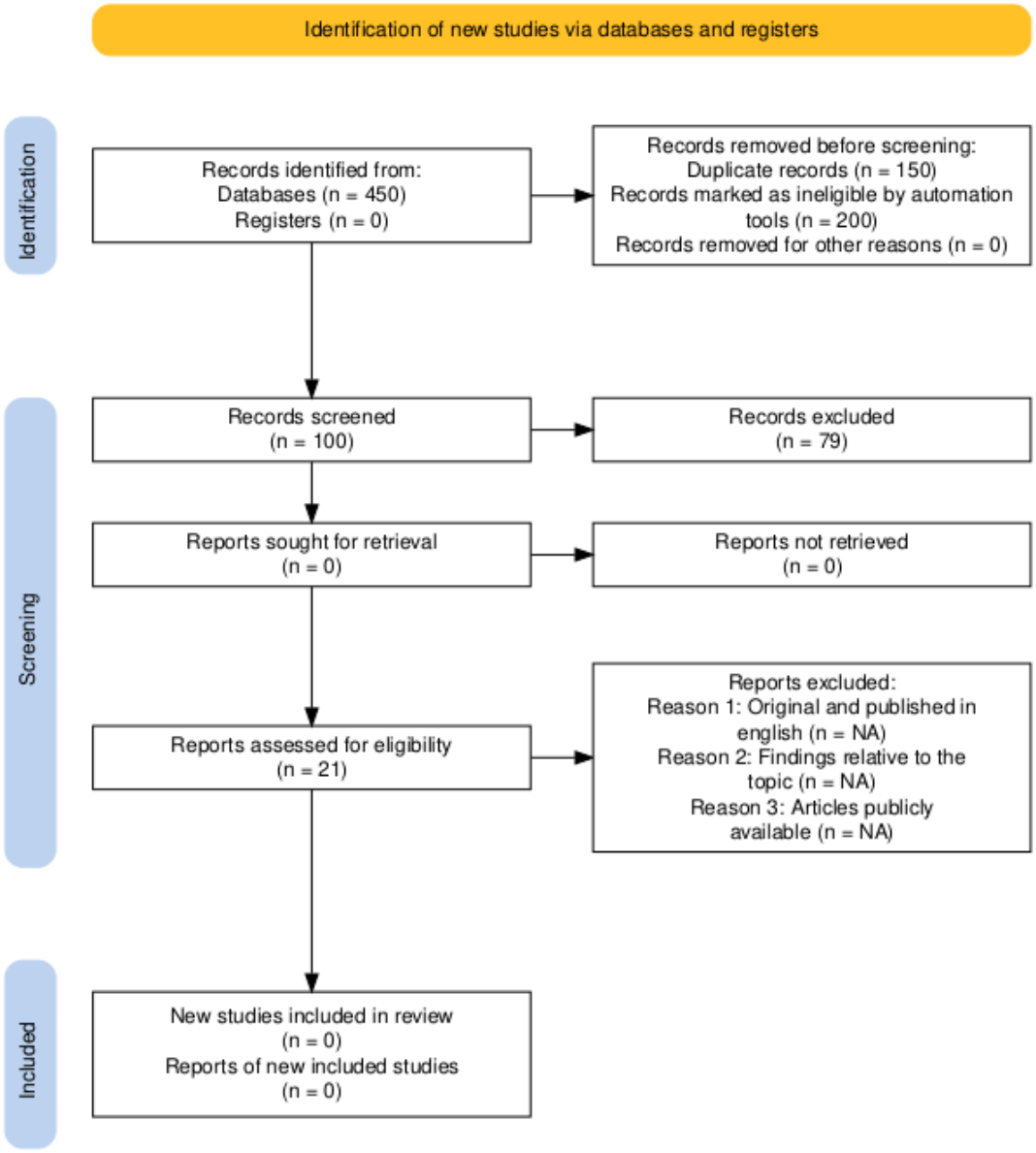

Figure 1. Identification of new studies via databases and registers (PRISMA diagram) (Haddaway et al., 2020)

4.3 Data Extraction, Analysis, and Ethical Considerations

Scenario planning in small middle schools was evaluated using a methodical data extraction procedure, which produced a structured Excel sheet with important information including authorship, methods, conclusions, and limitations. To find research trends, a mixed-methods methodology integrated bibliometric analysis with qualitative content analysis on technological integration, leadership, and crisis preparedness. Thematic examination looked at obstacles like infrastructure and budgetary limitations. Ethical considerations promoted equitable and sustainable contingency planning solutions in education by guaranteeing data privacy, academic integrity, and adherence to research ethics.

5. Findings

5.1 Trends in the Publication of Articles from 1994 to 2024

Figure 2 shows, from 1994 to 2024, the yearly publication count on scenario planning for educational continuity at small institutions.

Research activity stayed erratic until 2017, with just occasional single articles noted. Reflecting rising interest, a considerable increase happened in 2018 and 2020 each reaching three publications. 2019 had a fall; then, research exploded once more in 2020 and 2021. Reducing publications in 2022 and 2024 point to stabilization. Driven by the requirement of contingency planning and technology in education, especially in reaction to global disruptions and changing educational needs, the trend generally shows rising scholarly engagement (Figure 2).

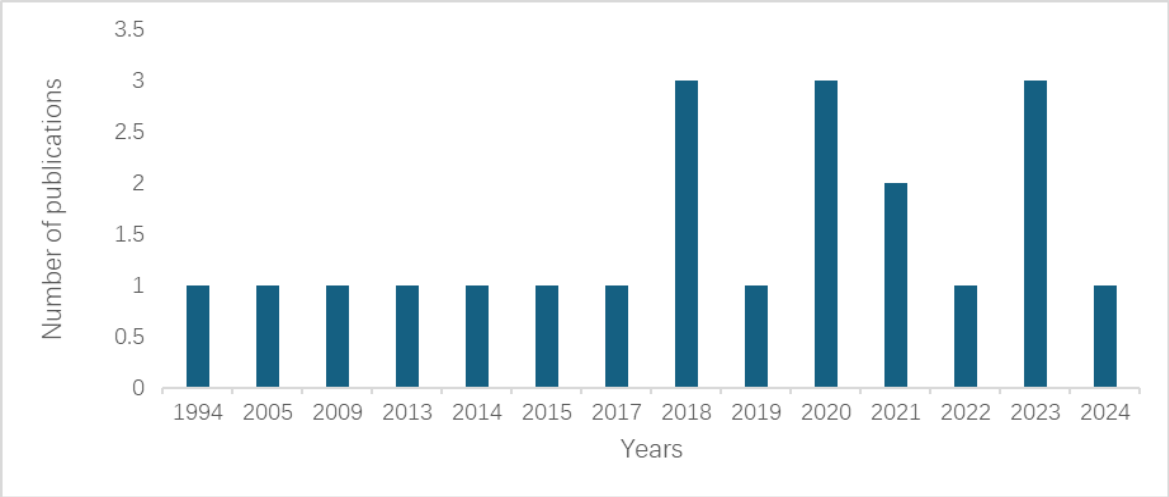

Figure 2. Annual Distribution of Publications on Scenario Planning for Educational Continuity in Small Schools (1994–2024)

5.2 Key Contributors to the Literature on Scenario Planning in Small Schools

Figure 3 shows the publication distribution by important authors supporting study on scenario planning for educational continuity in small institutions. The statistics show notable differences in publishing frequency: some authors generate a lot of work while several only contribute seldom. With the biggest publication effect among the most powerful contributors are Olympia et al. (2005) and Prasetia (1994). Ruocco and Proctor (2018), ASCO (2023), and Kanyasan et al. (2015), who show a continuous scientific curiosity in this topic, also notably contribute. The differences in publishing output imply that studies on scenario planning in education still remain scattered with occasional but significant contributions.

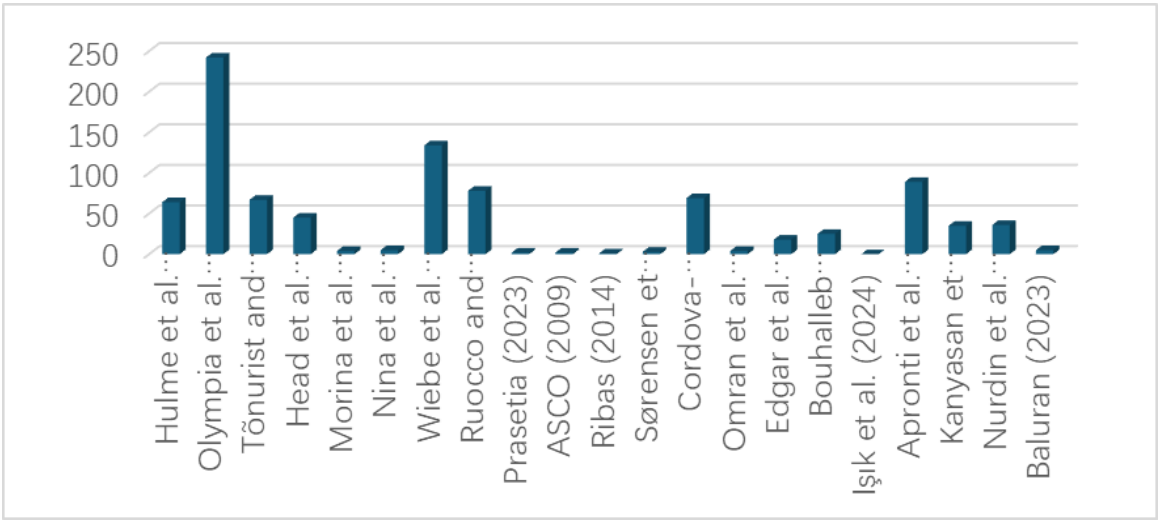

Figure 3. Key Contributors to the Literature on Scenario Planning for Educational Continuity in Small Schools

5.3 Methodological Approaches in Scenario Planning for Educational Continuity

The examined papers use several techniques, therefore reflecting a multimodal approach to scenario planning in education. Research terrain is dominated by qualitative approaches including case studies (Hulme et al., 2021; Prasetia, 2023); thematic analysis (Morina et al., 2021); literature reviews (Tõnurist & Hanson, 2020; Sørensen et al., 2020). Common mixed-methods approaches are also combining qualitative insights with quantitative research (Omran et al., 2019; Cordova-Pozo & Rouwette, 2023). For uses in scenario planning, experimental designs (Işık et al., 2024) and simulation models (Head et al., 2020) offer empirical validation. These methodological differences underline the difficulty of educational contingency planning and stress both theoretical models and pragmatic application techniques.

5.4 Key Findings on Scenario Planning for Educational Continuity in Small Schools

5.4.1 Leadership and Governance in Crisis Management

Though policy uncertainty and changing directions presented difficulties, Hulme et al. (2021) found that UK headteachers embraced adaptive leadership techniques including bridging and broking to handle school closures. Similarly, Tõnurist and Hanson (2020) underlined the shortcomings of conventional government in crises and argued for anticipatory innovation governance, which combines foresight and adaptive policymaking to properly negotiate uncertainty.

5.4.2 School Preparedness and Emergency Planning

According to Olympia et al. (2005), just 35% of schools routinely followed their Medical Emergency Response Plans (MERP), while 86% possessed one. Although they have staffing and communication difficulties, schools catering to special-needs students demonstrated greater readiness. Head et al. (2020) also underlined how school closures slowed COVID-19 spread, stressing hybrid learning and steady student cohorts as main mitigating measures.

5.4.3 Digital Transformation and Online Learning Challenges

Citing poor digital infrastructure and insufficient teacher preparation, Morina et al. (2021) underlined major obstacles in Kosovo's move to online learning. Teachers saw long-term advantages of digital learning despite these challenges. In higher education, Nina et al. (2022) also showed that organized scenario preparation improved academic continuity; standardized course templates raised student involvement and institutional readiness.

5.4.4 Scenario Planning and Strategic Decision-Making

Emphasizing the need of organized foresight approaches in decision-making, Wiebe et al. (2018) showed that including biophysical and socioeconomic modeling enhanced scenario planning frameworks. Using SWOT and TOWS analysis, Ruocco and Proctor (1994) underlined how methodically decisions made improved organizational resilience and market adaptation. Prasetia (2023) also discovered that while strategic planning raised educational quality, it presented difficulties like inadequate policy execution and financial restrictions.

5.4.5 Scenario Planning in Healthcare and Public Policy

With SWOT analysis helping healthcare practices match with market needs, ASCO (2009) underlined that strategic planning in oncology improved operational efficiency and flexibility. Comparably, Sørensen et al. (2020) showed how European health literacy policies were shaped via scenario planning. Their research underlined the success of a co-creation approach, in which cooperation between researchers and legislators raised stakeholder involvement and enhanced policy execution.

5.4.6 Disaster Risk Reduction (DRR) and Policy Implementation

Emphasizing the requirement of practical applications to improve student involvement, Apronti et al. (2015) discovered that DRR content in school curricula was poorly implemented due of insufficient teacher training and limited resources. Comparably, Kanyasan et al. (2018) drew attention to implementation flaws in DRR policies, especially in rural schools devoid of government funding and resources. In Indonesia, where inadequate teacher preparation and financial restrictions hampered policy efficacy, Nurdin et al. (2017) further found fragmented DRR and CCA education.

5.4.7 The Role of Technology in Enhancing Educational Resilience

With real-time feedback improving formative assessment, especially in resource-constrained institutions, Işık et al. (2024) discovered that a low-cost digital assessment system greatly raised student involvement and participation. In a similar vein, Baluran (2023) underlined how effectively organized foresight activities support strategic decision-making. To properly include scenario planning into educational policy frameworks and guarantee long-term resilience, the study underlined the need of cooperation across academics, business, and government.

6. Discussion

The increasing scholarly interest with scenario planning for educational continuity in small schools is highlighted in this systematic review. The results show that even while scenario planning is becoming popular, its application is still scattered and calls for a more ordered and sustainable strategy.

6.1 Trends in Research and Scholarly Contributions

Driven by technology developments and worldwide educational disturbances, the growing number of papers published from 2018 forward points to a greater interest in contingency planning for small schools. Still, the irregularity of donations points to a paucity of ongoing research initiatives. Strengthening the theoretical underpinnings of scenario planning calls for more longitudinal studies and multidisciplinary cooperation.

6.2 Methodological Considerations in Scenario Planning Research

The variety of techniques—from mixed-methods and experimental designs to qualitative case studies and theme analysis—showcases the complexity of scenario planning in education. While quantitative models give empirical support of intervention efforts, qualitative research offers in-depth understanding of leadership and policy issues. Mixed-methods approaches should take front stage in future studies to link theoretical and pragmatic uses.

6.3 Adaptive Leadership and Emergency Preparedness in Educational Crisis Management

Crisis management depends much on school leadership; headteachers use adaptive techniques to negotiate policy ambiguities (Hulme et al., 2021). Still, there is conflict between centralized decision-making and local sovereignty. Though they need institutional backing, anticipatory governance models combining foresight and adaptive policymaking present possible solutions (Tõnurist & Hanson, 2020). Furthermore, even although many institutions have emergency readiness strategies, their execution varies (Olympia et al., 2005). The COVID-19 epidemic underlined the need of organized contingency plans involving stable student cohorts and hybrid learning to reduce disturbance (Head et al., 2020). Schools should institutionalize emergency response drills and increase stakeholder cooperation to raise preparation, therefore guaranteeing a proactive approach to crisis management and instructional continuity.

6.4 Strategic Decision-Making and Policy Implementation in Scenario Planning

By combining structured foresight and decision-making tools, scenario planning increases institutional resilience (Wiebe et al., 2018). SWOT and TOWS evaluations among other tools help to increase strategic alignment and adaptation (Ruocco & Proctor, 1994). Their whole efficacy is hampered, nonetheless, by budgetary and execution issues (Prasetia, 2023). Including scenario-based decision-making into curricula helps to reduce long-term uncertainty and raise preparation. While scenario planning helps to shape health literacy policies highlights stakeholder cooperation, in healthcare it improves efficiency and policy alignment (ASCO, 2009). Particularly in rural areas, disaster risk reduction (DRR) education suffers uneven application even with policy integration (Kanyasan et al., 2018). Financial restrictions and limited teacher training (Nurdin et al., 2017) highlight the need of practical learning strategies and higher investments to improve school resilience against disasters.

6.5 Technology and Digital Transformation in Educational Resilience

Low-cost digital evaluation tools among other technologically driven methods improve student involvement and participation (Işık et al., 2024). To include technology into scenario planning systems, though, a more combined approach combining academics, businesses, and legislators is required (Baluran, 2023). Long-term educational continuity can be guaranteed by improving digital infrastructure and supporting policies motivated by innovation. Particularly in resource-limited settings, the move to online learning exposed notable flaws in digital infrastructure and

teacher preparation (Morina et al., 2021). Notwithstanding these difficulties, organized scenario planning in higher education helped to better student involvement and ease transitions (Nina et al., 2022). Long-term investments in teacher preparation and digital infrastructure must be given top priority by legislators if we are to guarantee fair access to online education and create a more inclusive and resilient learning environment.

7. Theoretical and Practical Implications of This Study

This study supports scenario planning theory by proving how it could improve small school educational resilience. It emphasizes the importance of adaptive leadership and technological integration in crisis management, therefore supporting ideas of contingency and resilience. Practically, the results support technological-driven contingency planning, stakeholder cooperation, and institutional preparedness, therefore providing actionable ideas for legislators and teachers. This study guarantees long-term educational continuity in challenging surroundings by removing implementation obstacles, therefore offering a road map for schools to create scalable, sustainable crisis response systems.

8. Conclusion, Limitations, and Future Research Directions

The efficiency of scenario planning in guaranteeing instructional continuity in small schools under crisis is underlined in this paper. Results highlight the part institutional readiness, leadership, and technology play in reducing disruptions. Limitations include, meanwhile, reliance on secondary sources, regional diversity, and few empirical case studies. Future studies should look at longitudinal case studies, evaluate technology-driven planning ideas, and look at policy alignment to help to better handle crises. Deeper insights derived from expanding studies on cross-regional comparisons and real-time scenario testing will guarantee more flexible, scalable, and robust instructional frameworks for small schools confronted with unanticipated disturbances.

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Smart Empowerment: Innovative Construction of a Multi-Modal Blended Teaching System for College English

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Abstract

Grounded in the theory of multi-modal discourse analysis, this paper conducts an in-depth exploration of the current challenges encountered in college English smart teaching. Leveraging the online smart teaching platform, it maximizes the exploitation and utilization of multi-modal teaching resources, seamlessly integrates multidisciplinary knowledge, and actively pursues the online and offline integration of the college English smart teaching system. Initiating from the four dimensions of smart teaching environment creation, teaching mode construction, teaching method innovation, and teaching evaluation enhancement, a comprehensive and systematic overall design for college English multi-modal smart teaching will be executed. The aim is to fully propel the profound integration of information technology and college English teaching, break through the crucial bottlenecks in the implementation of "Internet + Education", enhance the quality and effectiveness of college English teaching in an all-round and multi-level manner, furnish potent theoretical support and practical exemplars for the reform and development of college English teaching, and contribute to the realization of the talent cultivation objectives in higher education.

Keywords: smart teaching environment, college English teaching, multi-modal, online and offline mixed mode

1. Introduction

In the current era of globalization and rapid information technology advancement, the education domain is undergoing profound transformations. With the steady progress of the Education Informationization 2.0 Action Plan, the integration of information technology and education and teaching has entered a new phase, presenting both unprecedented opportunities and challenges to college English teaching.

On one hand, the vigorous development of modern technologies such as the Internet, big data, and artificial intelligence has given rise to a rich array of smart teaching platforms and tools. These online resources break the temporal and spatial constraints of traditional teaching, enabling more convenient and efficient knowledge acquisition. On the other hand, the theory of multi-modal discourse analysis offers

solid theoretical underpinnings for college English teaching innovation. Multi-modal teaching emphasizes the full mobilization of students' various senses and the transfer and interaction of knowledge through diverse symbolic resources such as text, image, audio, video, and action, rendering the teaching process more vivid, three-dimensional, and engaging. However, the traditional college English teaching mode still exhibits significant deficiencies in teaching content, methods, and evaluation, struggling to meet the educational requirements of the new era.

Against this backdrop, the construction of a college English multi-modal blended teaching system based on a smart teaching environment becomes particularly urgent and essential. This system endeavors to organically combine the advantages of the smart teaching environment with multi-modal teaching concepts, devising a comprehensive teaching model that integrates online and offline, as well as in-class and out-of-class teaching, thereby comprehensively elevating the quality of college English teaching. By fostering a rich and diverse smart learning environment, students' learning enthusiasm and initiative are stimulated; through the construction of a scientific and rational smart teaching mode, fine-grained management of the teaching process is achieved; via innovative and flexible smart teaching methods, students' higher-order thinking and innovative abilities are cultivated; and by improving the comprehensive and objective smart teaching evaluation system, students' learning outcomes are accurately fed back, and high-quality talents with a solid English language foundation, robust cross-cultural communication capabilities, and an innovative thinking spirit are nurtured for society. This not only facilitates the in-depth advancement of the reform of college English teaching but also represents a crucial measure to adapt to the development trends of education in the new era and meet the growth needs of students, carrying profound significance for enhancing the quality of personnel training in higher education in our country.

2. Theoretical Support: Multi-Modal Discourse Analysis Theory

Multi-modal discourse pertains to the phenomenon of transmitting information and expressing meaning through the comprehensive utilization of diversified symbolic resources such as language, text, image, sound, video, and action, leveraging multiple senses such as hearing, vision, and touch during the communication process. The application of multi-modal discourse in English language teaching scenarios offers notable advantages. It can capture the attention of the information recipient, enabling them to supplement information through various senses and channels, facilitating information acquisition and in-depth understanding, and conducive to the expression and transmission of emotions. Its core objective is to guide the information recipient to focus on the process of discourse communication, with the message sender attempting to influence the recipient's attitude and values to promote their own viewpoints and attitudes, thereby rendering the communication information more readily understood and accepted by the recipient and effectively reducing ambiguity and uncertainty.

The theory of multi-modal discourse analysis provides theoretical scaffolding for the construction of the college English smart teaching system. One of the key characteristics of smart teaching in college English lies in the multi-modal nature of classroom discourse. The concept of multi-modal teaching advocates that college English teachers employ a variety of teaching methods (encompassing verbal and non-verbal forms), diverse multi-modal symbols (such as sound, images, shapes, texts, etc.), and multimedia technologies to meticulously design various classroom tasks and activities. Participants in teaching activities should select appropriate modes based on their actual needs to achieve preset goals. Concurrently, teachers need to comprehensively comprehend the multi-modal characteristics of classroom discourse from multiple dimensions, deeply explore the internal connections among the various modes (including vision, hearing, touch, etc.), fully exploit the synergistic effect of the multiple modes, jointly shape the meaning of classroom discourse, and tap the potential effectiveness of the teaching effect, thus enhancing teaching quality.

3. Analysis of Existing Problems in the College English Smart Teaching System

3.1 Superficial Technology Application

In actual teaching scenarios, some teachers' utilization of information technology remains at a relatively shallow level. For instance, in a

college English course at a certain university, teachers often employ the smart teaching platform merely for simple attendance-taking operations during class, recording students' attendance via the platform's one-click roll call, a process that consumes only a few minutes and fails to fully exploit the platform's multiple functions. In the online testing process, exercises are mechanically assigned after class from textbooks, with question types being monotonous, predominantly multiple-choice and fill-in-the-blank questions, lacking innovation and expansibility, and making it challenging to effectively assess students' comprehensive language application abilities. In terms of courseware sharing, the traditional PPT is simply uploaded to the platform without any targeted and optimized adaptation to the characteristics of online learning, such as the addition of interactive links and the expansion of reading materials.

3.2 Limited Exploration of Teaching Content

Currently, the selection of materials in college English teaching is still largely confined to textbook texts, concentrating on the explanation of language knowledge, such as the analysis of grammar rules and the discrimination of vocabulary usage, while neglecting the diversity and expansion of knowledge. When explicating the text, most teachers primarily focus on the vocabulary, grammar, and sentence patterns within it, translating the text sentence by sentence to assist students in understanding the literal meaning, but seldom introduce interdisciplinary knowledge related to the text's theme. The unitary exploration of traditional teaching content dampens students' learning enthusiasm, hampers the construction of a comprehensive knowledge system, fails to meet the social demand for compound talents, and restricts students' future development potential.

3.3 Constrained Advancement of Teaching Mode

From the perspective of the overall implementation in colleges and universities, although the reform of the teaching mode is gaining popularity, it encounters numerous difficulties in implementation. On one hand, some teachers possess insufficient reserves of information technology knowledge and are not proficient in operating emerging smart teaching tools such as A+ Classroom and Rain Classroom, finding it arduous to manage online teaching segments. Worried about technical glitches affecting the teaching progress, they adopt a wait-and-see attitude towards reform. On the other hand, the lack of financial support also impedes the reform process. The construction of a smart teaching environment demands substantial capital investment, including hardware equipment upgrades, software platform procurement, and teaching resource development, resulting in the teaching mode reform being confined to a few pilot classes and difficult to be fully rolled out. Consequently, the majority of students cannot fully enjoy the reform dividends, and the improvement in teaching quality is limited.

3.4 Mediocre Teaching Evaluation

The traditional college English curriculum evaluation system suffers from multiple drawbacks. In terms of evaluation composition, excessive emphasis is placed on the end-of-course test, which predominantly focuses on the final written test score. The test paper content mainly consists of the memorization test of vocabulary, grammar, reading comprehension, writing, and other knowledge. For example, students are required to recite words, distinguish grammatical points, summarize the main theme of the article, and write according to a fixed template, neglecting students' comprehensive qualities such as independent learning ability, cooperation ability, inquiry ability, and innovative thinking ability during the learning process. Although the process evaluation encompasses attendance, class performance, and homework, the index settings are vague and general, making it difficult to objectively reflect learning differences and fully represent students' learning outcomes. This is not conducive to fostering students' personalized development nor can it provide precise guidance for teaching improvement, impeding the enhancement of teaching quality.

4. Construction of a Multi-Modal Blended Learning System for College English Based on Smart Teaching Environments

4.1. Creation of Smart Learning Environments

4.1.1 Integration and Utilization of Multi-Modal Resources

From a multi-modal perspective, text, visual, and auditory modes are synchronized, and a variety of symbolic resources are intertwined and overlapping, which is conducive to enhancing the information receiver's

understanding of the conveyed meaning. Accordingly, college English teachers should appropriately employ modal symbol resources such as text, pictures, decorative elements, colors, audio, and video in the text. For example, they can integrate multimedia materials such as documentaries, pictures, and videos, reorganize and arrange them to comprehensively reshape the teaching content, create an immersive experience, and immerse students in language learning situations. This can assist students in efficiently and rapidly capturing and understanding information, enhancing memory retention, and improving learning effectiveness.

4.1.2 Organic Collaboration Between Online and Offline

In the offline teaching setting, college English teachers should make full use of diverse teaching spaces such as multimedia classrooms, flipped classrooms, and language laboratories. In the online teaching dimension, with the aid of smart teaching platforms such as A + Classroom, WeChat, iSmart, Rain Classroom, and Super Star Learning Pass, college English teachers should promote the in-depth integration of online and offline smart teaching environments in an all-round manner, and effectively enhance classroom teaching efficiency. Actively implementing the online and offline hybrid smart teaching mode is of great significance for the in-depth promotion of teaching reform, playing a positive role in both depth exploration and breadth expansion. Digital teaching resources and information-based teaching platforms effectively reduce the implementation cost of smart teaching. The realization of smart teaching is not restricted to flipped classrooms. Even in conventional classroom environments, as long as Wi-Fi network conditions are available and PCs or mobile terminal devices are equipped, the goal of smart teaching can be achieved. Thus, a broader group of students can experience the advantages and charm of smart teaching, and promote the overall improvement and development of teaching quality.

4.1.3 Cross-Penetration of Multidisciplinary Knowledge

In college English teaching, the exploration of interdisciplinary resources is a crucial measure to enrich teaching content and broaden students' knowledge horizons. Using English news reports as a starting point, teachers can skillfully introduce multidisciplinary knowledge such as economics and sociology to create a comprehensive learning experience for students.

Through such interdisciplinary analysis, students are no longer confined to the study of English language knowledge but utilize English as a tool to deeply explore the diverse knowledge systems underlying international events, cultivate the ability to comprehensively analyze problems, and enhance cross-cultural communication literacy, thereby better adapting to the complex and changing social needs in the context of globalization.

4.2 Construction of a Smart Teaching Model

4.2.1 Horizontal Dimension: Closed Loop Before Class – In Class – After Class

Before class, in accordance with the teaching syllabus and students' learning situations, teachers meticulously design and push multi-modal preview tasks with the assistance of the smart teaching platform. In class, teachers adopt problem-oriented and participatory teaching as the core and rely on the smart teaching platform to create a smart classroom. For before-class feedback, focus on the explanation of key and difficult knowledge, organize interactive discussions on the theme, and students use tablets to look up information to support their viewpoints. After the group representative presents, the teacher uses the platform's voting function to organize the entire class to evaluate each group's viewpoints, stimulating the collision of ideas. Conduct skills training activities. For example, in oral English classes, use smart speech evaluation software to monitor the accuracy and fluency of students' oral expressions in real-time and provide timely correction and guidance. Finally, through the class summary function of the platform, guide students to evaluate and reflect, sort out the knowledge framework, and strengthen the learning effect. After class, teachers use the smart teaching platform to assign diversified consolidation tasks. On the one hand, assign extended assignments. For example, require students to write small English papers related to the course subject and analyze the problems in depth using what they have learned. Teachers will provide detailed feedback through online correction to improve students' writing abilities. On the other hand, encourage students to participate in discipline competitions, such as English speech contests and translation contests, to promote learning and exercise comprehensive

language skills. In addition, organize professional practice activities, such as arranging students to participate in the volunteer service of international exchange programs, testing learning outcomes in real contexts, internalizing knowledge into literacy, deepening and expanding after-school learning, constructing a tight teaching closed-loop connecting before-class, mid-class, and after-class, and comprehensively improving teaching quality.

4.2.2 Longitudinal Dimension: In-Class – After-Class Linkage Education

In class, teachers fully leverage the advantages of multi-modal and blended teaching to realize the organic integration of knowledge transfer and value guidance. In college English audio-visual courses, select English audio-visual materials with a sense of the times and educational significance, such as TED talks on environmental protection, where the speakers present the current situation of global environmental problems with vivid pictures and shocking videos and call for action in passionate English. Teachers guide students to watch, listen, analyze speech skills in class and inspire students to think about environmental issues. Cultivate students' global vision and sense of social responsibility, enable students to receive ideological and political education during the language learning process, realize the coordinated development of knowledge, ability, and quality, and implement the goal of comprehensive education under the background of the new liberal arts.

After class, teachers guide students to independently expand their learning with the help of the rich resources of platforms such as MOOCs in Chinese universities. Recommend personalized courses based on different students' interests and professional needs. At the same time, utilize the community function of the platform to encourage students to participate in the curriculum discussion area for communication, sharing learning experiences, and posing questions. Teachers regularly participate in the interaction, answer questions, and solve doubts, pay attention to students' extracurricular learning dynamics, achieve integrated education inside and outside the classroom, promote students' all-round growth, and cultivate high-quality composite talents for society.

4.3 Innovation of Smart Teaching Methods

Smart teaching furnishes expansive space and robust support for students' independent, cooperative, and inquiry-based learning. Regarding independent learning, taking college English vocabulary learning as an instance, students can utilize vocabulary applications to memorize words and independently formulate learning plans in accordance with their own vocabulary proficiency and the principles of forgetting. Meanwhile, the smart reminder function serves to prompt students to review punctually, thereby strengthening the memory effect. Moreover, students have the option to select English vocabulary extension courses on the MOOC platform of Chinese universities to further explore aspects such as word formation and the cultural connotations of vocabulary. This broadens the depth and scope of vocabulary learning and enables personalized and efficient independent learning.

In the context of cooperative learning, students collaborate in groups to conduct research activities. During the process of inquiry, they continuously identify and address problems, gain a profound comprehension of cross-cultural knowledge, enhance their inquiry and practical abilities, and achieve growth and progress within the framework of independent, cooperative, and inquiry-based learning. Additionally, teachers can integrate problem-oriented and task-driven teaching in the classroom setting, which can remarkably boost students' learning enthusiasm and learning outcomes. The combination of immersive and interactive teaching approaches can create an immersive English learning environment for students and effectively enhance the learning experience and its resultant effects.

4.4 Improvement of Smart Teaching Evaluation System: Construction of Multiple Evaluation Dimensions

4.4.1 Equal Emphasis on Knowledge and Ability

In the era of smart teaching, college English teaching evaluation ought to abandon the traditional single knowledge testing model and establish an evaluation system that accords equal importance to both knowledge and ability. On the one hand, online knowledge tests accurately assess students' memory and understanding of fundamental knowledge, including vocabulary, grammar, and text

content. Immediate feedback regarding their scores is provided to assist students in recognizing the gaps in their knowledge acquisition. On the other hand, attention is directed towards the evaluation of students' language application abilities. For instance, in terms of oral expression ability, through the use of smart voice evaluation software, students can read texts online, respond to questions, and promptly receive evaluation reports that guide them in making improvements. Regarding listening comprehension ability, online listening tests are conducted to analyze the accuracy rate of students' answers and the types of incorrect questions, thereby enabling an assessment of their listening skills, vocabulary, and background knowledge. Besides the traditional teacher's evaluation of writing ability, peer assessment is introduced. Students can evaluate each other's compositions on the platform, learn from the strengths of others, identify their own weaknesses, and thus promote the collective enhancement of writing levels. In this way, the organic integration of knowledge and ability evaluation is realized, comprehensively reflecting students' learning achievements.

4.4.2 Consideration of Comprehensive Literacy

Teaching evaluation should also encompass students' self-learning ability, cooperation ability, exploration ability, and ideological and political literacy. With respect to independent learning ability, taking the i-test smart assessment cloud platform as an example, by analyzing data such as students' learning time, their engagement with courseware or videos, their answering situations, and online interactions, a profile of students' independent learning can be constructed. This includes aspects like the periods of concentrated learning time, preferred learning content, and the progress of independent learning. The initiative, planning, and continuity of students' independent learning are then evaluated. The cooperation ability is gauged by observing students' participation in class group activities and the quality of their group assignments. This involves noting their speaking frequency, guiding roles, and coordination abilities during group discussions, as well as the rationality of the division of labor within the group and the innovation of the results. Evaluations from both teachers and fellow students are carried out to fully reflect students' cooperation levels. The ability to explore, analyze, and solve problems is evaluated by teachers based on questions raised, feedback provided, team contributions, and the completion of assignments. For example, in project-based English learning, students can proactively pose questions, gather information, design solutions, and flexibly adjust strategies to handle unexpected issues when confronted with complex project tasks. Ideological and political literacy evaluation permeates the entire evaluation process, focusing on students' emotional expressions, attitudes, strategies, and other process performances manifested during the learning process. For instance, in an English reading class, it is examined whether students adopt an open and inclusive attitude towards articles involving cultural comparisons and whether they can reflect correct values in their English writing. By integrating ideological and political education into language learning, students' all-round development is promoted.

5. Conclusion

In the backdrop of the Education Informatization 2.0 era, the construction of a smart teaching and learning environment characterized by human-computer interaction and the integration of multiple ecology has emerged as a regular developmental trend in the domain of college English teaching. With the assistance of diverse smart teaching platforms, in-depth exploitation of teaching resources spanning multiple modes and interdisciplinary areas can be achieved. This enables the creation of an interactive classroom that seamlessly integrates online and offline elements and makes full use of various interactive teaching tools. Consequently, students' immersive learning experiences can be enhanced, and the integration of "courses both inside and outside the classroom, as well as the before-, mid-, and post-stages" into the entire process of mixed teaching management can be realized. By establishing an interactive and integrated smart teaching evaluation system, a complete multi-modal, hybrid, and smart teaching system for college English courses can be formed. This will significantly enhance the effectiveness of college English teaching, facilitate the overall improvement and sustainable development of college English teaching quality, and better adapt it to the talent cultivation requirements of the current era. Ultimately, it lays a solid foundation for nurturing talents with an international perspective and comprehensive literacy.

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