



Improving the Reading Comprehension of Senior High School Students through Bionic Reading

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Abstract— This study aimed to improve the reading comprehension of Senior High School students through the implementation of Bionic Reading. Employing a one-group pre-test post-test experimental design, 75 Grade 12 HUMSS (Humanities and Social Sciences) students identified among 124 respondents as being at the frustration level were selected through non-probability purposive sampling to undergo the Bionic Reading intervention. The Phil-IRI reading comprehension assessment served as the research instrument, validated by experts. Data analysis was conducted using IBM SPSS Statistics, incorporating descriptive statistics and the Wilcoxon-Signed Rank Test. The results demonstrated significant post-intervention improvement, with a majority of students progressing to the instructional level. Bionic Reading effectively catered to diverse learning needs, emphasizing personalized learning pathways and interactive activities. These findings underscore the efficacy of Bionic Reading as an innovative educational tool for enhancing the reading comprehension skills of Senior High School students.

Keywords— Bionic Reading, reading comprehension, Senior High School, educational innovation.

INTRODUCTION

Reading comprehension is a vital skill required for interpreting essential documents, such as birth certificates, marriage contracts, or housing agreements, as well as for engaging with everyday tasks like understanding exam instructions and other written texts. This skill is fundamental to both personal and academic success, as it enables individuals to not only decode words but also derive meaning, analyze content, and apply knowledge effectively. Beyond basic word recognition, reading comprehension involves a cognitive process that develops over time, allowing individuals to construct ideas, make connections, and engage with material in a deeper, more meaningful way (K12 Readers, 2018).

Without comprehension, reading becomes a frustrating exercise in word calling, where individuals may be able to recognize words but fail to understand or connect their meaning (Lenz, 2013). The concept of reading comprehension, first introduced by Francis Pleasant Robinson in his 1948 book *Effective Study*, has evolved through numerous theories to explain this complex process. Although no single theory fully explains it, reading comprehension remains a foundational skill that is essential for academic success and overall literacy development.

Furthermore, reading comprehension encompasses an individual's capability to rephrase sentences using their own words and apply the text's content to their personal experiences. An integral facet of reading comprehension comes to life when an individual articulates their life encounters and connects them to the written text, signifying a deep personal connection with the material (Wilhelm, 2018).



The development of reading comprehension skills is not only vital on an individual level but also has broader implications for educational systems and national progress. When students can effectively rephrase and connect textual content to their experiences, they engage in higher-order thinking that enhances academic achievement. However, gaps in these skills can hinder learners' ability to process and analyze complex texts, which significantly affects their performance in standardized evaluations. These deficiencies underscore the need to strengthen reading comprehension instruction to equip students with the competencies required for both academic success and global competitiveness.

In the context of international assessments, the Program for International Student Assessment (PISA) serves as a critical tool for assessing the academic performance of students across various nations. The results of the 2018 PISA assessment for the Philippines were notably concerning, as the country ranked at the lowest level in Reading Comprehension, with a score of 340, the lowest among all participating nations. This outcome highlighted persistent and significant challenges within the Philippine education system. In response to these findings, efforts were made to address the identified weaknesses. However, a comparison with the 2022 PISA results reveals only modest improvements, as the Philippines' score rose to 347. Despite this slight increase, the data continues to underscore ongoing struggles in reading comprehension, indicating that the challenges in this area have not been fully overcome. This comparative analysis between the 2018 and 2022 PISA results highlights the need for continued focus on addressing these issues and underscores the importance of targeted interventions to improve reading comprehension outcomes in the Philippines.

Meron (2018) argues that poverty significantly hinders students' academic performance, especially within the Philippine education system. Students from low-income families often prioritize work over formal schooling at an early age, limiting their time and energy for academic pursuits. This economic hardship, compounded by a lack of academic resources, disrupts their cognitive development and social integration in the classroom. Consequently, these students frequently struggle with essential skills, including reading comprehension, which perpetuates the cycle of educational disadvantage.

In light of these challenges, research by the Philippine National Center for Education Statistics highlights a concerning correlation: 43% of adults with low reading comprehension and literacy levels live in poverty (Bales, 2018). This statistic underscores the broader societal implications of literacy struggles, revealing that poverty and limited literacy are intricately connected.

This interconnection between poverty and literacy issues highlights the importance of focusing on enhancing reading comprehension skills to break the cycle of socio-economic disadvantage. Students from lower-income backgrounds are often at a disadvantage due to a lack of exposure to language-rich environments and academic resources. As a result, they may struggle to develop foundational skills such as vocabulary and text comprehension, which are essential for academic success. Gunn (2018) also emphasizes how low literacy levels lead to diminished self-esteem and fear, creating a barrier to both educational and professional success. Addressing these gaps early can improve not only academic performance but also the students' ability to overcome social and economic barriers in the long run.



Furthermore, reading comprehension comprises two essential elements: vocabulary knowledge and text comprehension. Vocabulary knowledge entails a deep understanding of words, encompassing their precise definitions, pronunciation, written form, spelling, and synonyms (Moghadam et al., 2012). On the other hand, text comprehension materializes when readers integrate the context of the written text into their own lives. This aspect comes to life when readers can vividly visualize or mentally recreate scenes from the text, thus comprehending its message. As stated in a Malaysian journal article by Sidek et al. (2015), students with deficient vocabulary knowledge scores often struggle to grasp the text's overall message. This deficiency in vocabulary knowledge hampers their ability to appreciate the narrative and respond to questions. Additionally, text comprehension is facilitated when readers reflect on their personal experiences during or after reading. Another dimension of honing text comprehension is when readers gain insights or predict the narrative's progression due to their emotional connection with the material (National Institute for Literacy, 2013).

To further elaborate on the factors influencing reading comprehension, it is essential to consider the key components that contribute to a student's success in this area. Research indicates that five pivotal components are necessary for becoming an adept reader: phonics, phonemic awareness, vocabulary, fluency, and comprehension (Learning Point Associates, 2014).

Phonics, a fundamental skill, involves linking written words to their corresponding sounds. It forms the basis of the "alphabetic principle" and enables students to understand how words are spelled and pronounced. Additionally, Phonics aids in memory retention, serving as a cue for reflexively reproducing specific letter sounds (Starrette, 2016). While phonics and phonemic awareness share similarities, they differ in their focus. Phonics pertains to the sounds of individual letters, whereas phonemic awareness deals with manipulating these sounds, or phonemes, to construct new words. This is a potent tool for reading, allowing students to, for example, recognize the word "smile" even if the letter "s" is removed by using letter manipulation (Ropp, 2018).

Vocabulary, while distinct from other components, plays a critical role in reading comprehension. It serves as a mental repository of words that expand as individuals encounter new terms throughout their lives. A strong vocabulary enhances reading comprehension by allowing students to infer the meanings of unfamiliar words from context, improving both their understanding of the text and their ability to communicate effectively, including in public speaking. Research suggests that vocabulary knowledge is one of the strongest predictors of reading success and is integral to overall literacy development (Snow, 2010).

Fluency entails the seamless flow of words during reading, facilitating comprehension even when reading silently. It encompasses the emotional aspects of reading, appropriate punctuation, and the ability to read at a consistent pace. Fluency acts as a bridge between word recognition and comprehension, enabling readers to focus on the content rather than the mechanics of reading (Cotter, 2012).

Finally, comprehension represents the ultimate objective of reading. It involves visualizing the text and posing questions like "what," "how," "when," "who," and "why." Reading comprehension assessments typically include questions that assess a student's ability to understand and interpret a text. Furthermore, comprehension examines the reader's capacity to summarize the story using their own words, covering aspects such as plot, theme, setting,



and character attitudes and behaviors (Allen et al., 2014). These components collaboratively enable readers to become skilled, discerning, efficient, and critical thinkers, making them essential elements for effective reading materials.

As the K to 12 Basic Education Program in the Philippines is designed to address diverse learning needs, understanding these core components of reading comprehension becomes particularly important in ensuring that students acquire the necessary skills for success within the program. The implementation of the K to 12 Basic Education Program in the Philippines represents a significant overhaul, introducing Senior High School (SHS) comprising Grades 11 and 12 within a revamped 6-year secondary education structure. While prior curricula primarily aimed at readying students for postsecondary education, the SHS curriculum is tailored to equip learners for further academic pursuits or entry into the workforce.

The overarching objective of the K-12 Basic Education Program is to establish a strong basic education system that nurtures competent and responsible citizens capable of lifelong learning and meaningful employment. This initiative resonates with the vision championed by the late President Benigno Aquino III, who viewed quality education as a foundational long-term solution to poverty (DepEd, 2020).

Within the Academic Track, designed for SHS students aspiring to pursue higher education or careers, four specialized strands are available: (a) Accountancy, Business and Management (ABM) Strand; (b) Science, Technology, Engineering and Mathematics (STEM) Strand; (c) Humanities and Social Sciences (HUMSS) Strand; and (d) General Academic (GA) Strand (Official Gazette, 2013).

The HUMSS strand, characterized by its emphasis on communication and social engagement, places a strong focus on honing students' reading, writing, and verbal communication skills, making reading comprehension a key focus. Individuals opting for this strand typically envision careers involving extensive interpersonal interaction, such as teaching, psychology, or law. Consequently, effective communication skills are deemed indispensable for their future professional endeavors. Hence, a significant portion of the HUMSS curriculum is dedicated to language and speech development (De Vera & De Vera, 2018).

Despite the emphasis on communication skills within the HUMSS curriculum, numerous students encounter difficulties with reading comprehension. Despite their aspirations for roles necessitating strong communication abilities, a notable portion of HUMSS students struggle to effectively comprehend written texts. This disparity underscores a critical area for improvement in their educational journey and skill development. Addressing these challenges in reading comprehension is pivotal to ensuring that HUMSS students are adequately prepared for their chosen career paths and future academic pursuits.

Furthermore, a recent study by Caraig and Quimbo (2022) sheds light on the reading comprehension challenges faced by Senior High School HUMSS students, particularly within their core subjects. The study findings reveal a concerning disparity in reading comprehension skills among the senior high school students surveyed. Only a meager 7% of the respondents demonstrated mastery-level reading comprehension, while 49% fell into the near mastery level, and a substantial 44% were classified as having poor mastery level. This discrepancy underscores



the pressing need to address reading comprehension difficulties, particularly in core subjects, to ensure that students are adequately equipped with the necessary literacy skills to excel academically.

A recent noteworthy commercial endeavor is the "Bionic Reading" project by Swiss designer Renato Casutt, which has garnered significant attention. This approach involves highlighting the initial letters of each word to guide readers through a text. "Bionic Reading" utilizes word segments directly tied to their meanings to expedite word recognition in the brain and improve comprehension (Casutt, 2022).

Bionics, a fascinating fusion of biology and technology, has revolutionized diverse fields such as science, medicine, and engineering. In simpler terms, it involves using technology inspired by nature's designs. For instance, think of prosthetic limbs that function similarly to real arms and hands. Now, bionics is delving into the realm of reading, aiming to enhance reading experience and comprehension.

In today's digital age, where information abounds, and the pace of life continuously accelerates, the skill of effective reading comprehension remains paramount. The capacity to read and grasp written content is fundamental for learning, communication, and personal development. However, traditional reading methods may no longer suffice as the volume of daily text encounters multiplies exponentially. In response to this challenge, the innovative approach of "Bionic Reading" has emerged as a potential game-changing solution in the realm of reading comprehension.

According to statistics from the Dyslexia Center of Utah, approximately 20 percent of individuals, or one in every five children, struggle with reading due to a language-based learning disability (Ricard, 2022). However, feedback from audiences following the introduction of the Bionic Reading system suggests that dyslexic individuals were able to grasp information accurately upon their initial reading, a feat that was previously challenging without the aid of Bionic Reading. This feedback underscores the potential benefits of Bionic Reading for individuals seeking both quick and focused reading experiences. While Bionic Reading may not represent a revolutionary breakthrough, it undoubtedly signifies an evolutionary advancement in enhancing the reading experience, enabling learners to reach levels of comprehension they may not have thought possible.

Moreover, a recent study by Thompson (2023) shed light not only on the intersection of dyslexia and Bionic Reading but also on its potential benefits for individuals with other neurodevelopmental disorders, such as Attention-Deficit/Hyperactivity Disorder (ADHD). Individuals with ADHD often struggle with attention challenges, impulsivity, and hyperactivity, which can significantly impact their reading comprehension. However, Thompson's exploration suggests that Bionic Reading holds promise as a valuable tool for individuals with ADHD as well. By employing visual modifications to emphasize essential textual elements, Bionic Reading provides a structured and engaging reading experience that may help individuals with ADHD overcome attention deficits and enhance comprehension. Similar to its application in addressing the needs of dyslexic readers, Bionic Reading for individuals with ADHD involves techniques such as highlighting key phrases or sentences and utilizing rapid serial visual presentation to guide attention and promote active engagement with the text.



Building upon these insights, Ariyani (2023) from the University of Mataram conducted Classroom Action Research (CAR) aimed at improving students' reading proficiency using the Bionic Method. The study, conducted with 10th-grade students with ADHD, demonstrated significant improvement in students' reading scores through the implementation of Bionic Reading techniques. These findings underscore the potential of Bionic Reading not only in addressing the needs of individuals with dyslexia but also in supporting the reading comprehension skills of individuals with ADHD, highlighting its versatility and effectiveness across diverse learning contexts.

Bionic Reading, with its innovative approach that combines technology and cognitive strategies, holds the potential to significantly enhance reading comprehension among students. By leveraging techniques such as rapid serial visual presentation (RSVP) and the utilization of highlighting and annotation tools, Bionic Reading can help students overcome common reading hurdles, such as subvocalization and distractions. This approach not only promotes faster reading but also encourages active engagement with the text, enabling students to grasp key concepts, make connections, and retain information more effectively. Moreover, the adaptability of Bionic Reading to digital platforms aligns with the tech-savvy nature of today's students, making it a relevant and engaging tool that can contribute to improved reading comprehension outcomes in the school setting.

Another study conducted by Zubayer (2023) compared the effectiveness of bionic reading with traditional reading methods, revealing several noteworthy findings. Bionic reading resulted in a shorter reading duration and reduced fixation time compared to conventional texts, indicating enhanced lexical access and quicker word processing. Particularly, non-native speakers demonstrated improved comprehension with bionic reading, suggesting potential benefits for language learners. Building on previous research, the study optimized paragraph structures to enhance reading experiences, aligning with optimal reading conditions. Moreover, the study explored individual differences in reading speed and comprehension, highlighting the role of language proficiency. The implications of the study extend to educational and professional domains, suggesting the integration of bionic reading technology to enhance comprehension and information processing. However, the study acknowledges limitations such as sample size restrictions and the need for further research to comprehensively understand the effects of bionic reading.

Considering the recent studies that have presented compelling evidence about reading comprehension, the researcher must delve deeper into the efficacy of Bionic Reading in enhancing the reading comprehension skills of a specific demographic – Senior High School students. These recent studies have brought to the forefront the significance of improving reading comprehension, a crucial skill that underpins academic success and cognitive development. Consequently, the motivation to undertake this research stems from the realization that an innovative approach like Bionic Reading may hold the potential to address the unique challenges faced by Senior High School students in their journey to becoming proficient readers and learners.

The literature and studies presented offer a comprehensive overview of reading comprehension, emphasizing its crucial role in various contexts such as education, professional development, and personal empowerment. They underscore the multifaceted nature of reading comprehension, which involves not only the recognition of words but also the ability to dissect, interpret, and apply textual content to personal experiences.



Key components of reading comprehension, including vocabulary knowledge, text comprehension, phonics, fluency, and comprehension, are highlighted as essential for developing proficient reading skills. Additionally, the challenges faced by individuals with low literacy levels, particularly those from low-income backgrounds, are addressed, emphasizing the social and economic impacts of poor reading comprehension.

The implementation of educational programs, such as the K-12 Basic Education Program in the Philippines, aims to address reading comprehension difficulties by providing a structured curriculum tailored to equip students with necessary literacy skills. However, despite such initiatives, disparities in reading comprehension skills among students, particularly within specialized strands like HUMSS, persist.

The introduction of innovative approaches like Bionic Reading offers promising solutions to enhance reading comprehension, particularly for individuals with learning disabilities such as dyslexia and ADHD. Bionic Reading utilizes technology and cognitive strategies to expedite word recognition and improve comprehension, potentially revolutionizing the reading experience for diverse learners.

While the literature presents compelling evidence regarding the effectiveness of Bionic Reading in improving reading comprehension, it also highlights the need for further research to fully assess its impact, particularly among specific groups like Senior High School students. The existing body of work reflects ongoing debates concerning the relative effectiveness of traditional reading methods versus innovative approaches such as Bionic Reading, pointing to the need for continued exploration in educational research.

In conclusion, the reviewed literature underscores the necessity of addressing reading comprehension challenges through a multifaceted approach that integrates traditional teaching methods with technological innovations. A thorough understanding of reading comprehension's complexities, coupled with a diverse range of interventions, is crucial for fostering proficient readers who are well-prepared for both academic success and lifelong learning. The academic landscape is continuously evolving, with educators exploring novel approaches to improve pedagogical practices. One such approach, Bionic Reading, presents a unique technological intervention that warrants closer examination, particularly as reading comprehension remains a fundamental skill for academic achievement and cognitive development.

Despite various efforts to improve reading comprehension in the Philippines, numerous students still struggle with this essential skill, as revealed by the PISA assessments of 2018 and 2022. These assessments highlight the persistence of the problem, signaling the need for further research into effective interventions. While several studies have attempted to enhance reading comprehension, the ongoing challenges suggest that traditional approaches have not fully resolved the issue.

Moreover, there is a notable lack of research on Bionic Reading within the Philippine context. Although this approach has garnered global attention, its potential to improve reading comprehension in the Philippines remains underexplored. Additionally, while existing studies have assessed the effectiveness of Bionic Reading, there is a gap in understanding its specific impact on the Philippine education system.



Furthermore, despite the increasing interest in Bionic Reading, there is a significant gap in research involving the application of an intervention approach. Few studies have implemented Bionic Reading through a structured intervention process, underscoring the need for research that not only explores its theoretical potential but also evaluates its practical effectiveness in real-world educational settings.

Addressing this research gap is critical for advancing our understanding of effective reading comprehension interventions and informing educational policies aimed at improving literacy outcomes among Senior High School students in the Philippines. By bridging this gap, researchers can provide valuable insights into enhancing reading comprehension skills, ultimately contributing to the academic success of secondary students.

This research seeks to fill the existing gaps in the literature by critically assessing the impact of Bionic Reading in the specific context of Senior High School education in the Philippines. The study aims to offer valuable recommendations that can inform teaching strategies, curriculum design, and the integration of advanced technologies into educational practices. Ultimately, the findings will enhance the educational outcomes and cognitive development of Senior High School students, advancing the ongoing discourse on improving reading comprehension in secondary education.

Conceptual Framework

This conceptual framework is designed to examine the influence of Bionic Reading on the reading comprehension skills of Senior High School students, employing a one-group pre-test and post-test design. The framework consists of three primary components: participants, reading comprehension, and Bionic Reading, which interact to assess the effectiveness of this innovative approach.

The participants in this study are exclusively Senior High School students. By focusing on this specific group, the study aims to explore how Bionic Reading influences their reading comprehension abilities, providing context for the results within the Senior High School student population.

Reading comprehension serves as the dependent variable in this study, representing the cognitive ability of Senior High School students to understand and interpret written texts. The level of reading comprehension serves as a key indicator of academic success and is the central focus of the research. In this study, reading comprehension is assessed before and after the intervention to evaluate any changes or improvements as a result of the Bionic Reading approach.

Bionic Reading is the independent variable in this study. Participants first complete a pre-test to assess their baseline reading comprehension, followed by exposure to the Bionic Reading method. After the intervention, they take a post-test to measure any changes in their comprehension skills. Both tests consist of 20 items based on distinct reading selections. The pre-test includes five different reading passages, providing a broad evaluation of the participants' initial comprehension abilities.

The post-test features four new selections, presenting a variety of genres, such as articles and excerpts, to assess comprehension across different topics and writing styles. This diversity enhances the robustness of the assessment by evaluating the participants' ability to understand various types of written material. Both tests

employ silent reading, ensuring that the participants' ability to focus, process, and interpret text is accurately measured without external distractions or auditory influence. The use of unique readings in each test maintains content diversity while providing a reliable gauge of reading comprehension skills.

By comparing the results of the pre-test and post-test, this framework aims to determine whether Bionic Reading has a measurable effect on the reading comprehension skills of Senior High School students, providing valuable insights into the potential of this approach to enhance academic performance.

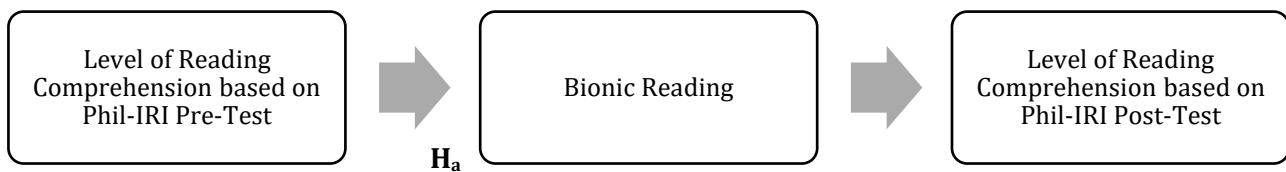


Figure 1. Improving the Reading Comprehension of Senior High School Students through Bionic Reading

Statement of the Problem

This one-group pre-test post-test experimental study aimed to improve the reading comprehension of Senior High School Students through Bionic Reading.

Specifically, this study sought to provide answers to the following questions:

1. How may the level of reading comprehension of the respondents be described based on their pre-test ratings?
2. How may the level of reading comprehension of the respondents be described based on their post-test ratings?
3. Is there a significant difference in the reading comprehension level of the respondents based on the pre-test and post-test ratings?

Alternative Hypothesis

Anchored to the research problems stated, the following hypothesis was made:

H_a . There is a significant difference between the pre-test and post-test ratings of the respondents.

Significance of the Study

The results of this study are hoped to be beneficial to the following:

- Department of Education. The Department of Education can use the study's results to shape national policies and educational initiatives. Insights from the study may help in developing curriculum standards and guidelines to improve reading comprehension levels across various educational institutions.
- School Administrators. School administrators play a pivotal role in implementing research findings within their institutions. They can refine curriculum plans and educational programs based on the study's outcomes to better meet the needs of their students. By incorporating Bionic Reading techniques into their teaching strategies, administrators can potentially enhance reading comprehension levels among students, thus improving the overall educational experience.



- Teachers of English. English educators stand to benefit significantly from the study's insights. The study sheds light on the effectiveness of Bionic Reading as a teaching tool, providing valuable guidance for teachers. Armed with this knowledge, teachers can adapt their instructional approaches to deliver more tailored and effective instruction, ultimately fostering improved reading comprehension skills among their students.
- Students. Students are central to the study's focus, and they are expected to derive substantial benefits from its findings. Through participation in the study, students gain insights into their own reading comprehension abilities. The exploration of Bionic Reading techniques offers students an opportunity to enhance their academic performance, deepen comprehension skills, and engage more meaningfully with complex texts, thereby equipping them for future academic and professional pursuits.
- Future Researchers of Bionic Reading. The study serves as a foundational piece of research in the field of education, particularly concerning Bionic Reading. Future researchers can build upon the methodologies and findings presented here to deepen the understanding of how Bionic Reading influences reading comprehension processes and instructional interventions. By serving as a catalyst for further inquiry and innovation, this study has the potential to contribute significantly to advancements in educational research and practice, particularly in refining and expanding the use of Bionic Reading in diverse educational settings.

Scope and Delimitation

This study was conducted solely within the area of San Juan High School, Mexico, Pampanga, aiming to determine a potential effect of Bionic Reading in improving the reading comprehension of Senior High School students. To comprehensively assess the impact of Bionic Reading, the research incorporated both pre-test and post-test measures.

The reading method employed in this study was silent reading, ensuring that all participants engaged with the texts in a consistent manner.

The researcher adopted the Philippine Informal Reading Inventory (Phil-IRI) Reading Comprehension Assessments, originally designed by the Department of Education – Division of Pampanga. These tests served the purpose of assessing the students' Reading Comprehension levels, with the pre-test offering a baseline measure before the implementation of the Bionic Reading intervention.

The subsequent post-test then measured the changes in reading comprehension, allowing for an evaluation of the effectiveness of Bionic Reading in enhancing the reading comprehension skills of Senior High School students.

The assessment rubric utilized in this study was the Philippine Informal Reading Inventory (Phil-IRI) Assessment Rubric in Comprehension, specifically designed to evaluate reading comprehension levels among Senior High School students. This rubric categorized comprehension levels into Independent, Instructional, and Frustration Level.

A significant limitation of this study is the absence of a control group. This absence affects the ability to determine whether the observed improvements in reading comprehension can be attributed specifically to the Bionic Reading intervention or if other external factors may have contributed to the results.



METHOD

Type of Research

This study utilized a one-group pre-test post-test experimental design. This design facilitated the assessment of the effectiveness of Bionic Reading as a specific intervention or treatment within a single group of participants. Unlike traditional experimental designs, where there are separate control and experimental groups, this design focused on measuring changes within the same group before and after the intervention. This approach enabled the examination of cause-and-effect relationships while accommodating real-world constraints and providing valuable insights into the impact of Bionic Reading on reading comprehension skills among Senior High School students.

Participants and Sampling Technique

This study was conducted among Grade 12 students enrolled in the Humanities and Social Sciences (HUMSS) strand at San Juan High School in Mexico, Pampanga, comprising a total population of 124 students.

Participants were selected from students who demonstrated frustration-level reading comprehension skills, as determined by the Philippine Informal Reading Inventory (Phil-IRI) Assessment Rubric during the pre-test phase. Among the 124 participants, 75 were identified to be in the frustration level. These identified students then underwent the Bionic Reading intervention as part of the study. Subsequently, participants completed a post-test assessment to evaluate any improvements in their reading comprehension skills following the intervention.

Therefore, the sampling technique employed in this study was non-probability purposive sampling. Specifically, participants were selected based on specific criteria related to their reading comprehension levels, as indicated by the PHIL-IRI Assessment Rubric. This approach facilitated the deliberate selection of participants who were most in need of support in reading comprehension, aligning with the study's objective of evaluating the effectiveness of the Bionic Reading intervention among students with frustration-level reading comprehension skills.

Research Instrument

The research instrument used in the study for both the pre-test and post-test was the Philippine Informal Reading Inventory (Phil-IRI) reading comprehension assessment for Senior High School students, originally designed by the Department of Education – Division of Pampanga to assess the students' reading comprehension levels. The pre-test consisted of 20 items based on 5 reading selections, while the post-test also comprised 20 items but was based on 4 distinct reading selections. The genres of the reading selections for both the pre-test and post-test were articles or excerpts. Each test featured unique selections, ensuring a diverse range of content and enhancing the comprehensiveness of the assessment.

To enhance the validity and efficacy of the instrument, a pilot testing phase was implemented. This preliminary trial was crucial for identifying potential issues, refining the test's clarity, and ensuring its suitability for widespread application in the main study. Moreover, the questionnaires and materials used in this study were subjected to rigorous validation by three experts in the field of education, specifically Masters of Arts in Education with a major in English and extensive teaching experience. Their expertise ensured the appropriateness, relevance,



and clarity of the instruments employed in assessing reading comprehension levels among Senior High School students.

Additionally, the results obtained from the pilot testing phase, which included both the pre-test and post-test administrations, were submitted to the Research and Development Center for thorough reliability testing. The analysis concluded that the instruments exhibited reliability, indicating consistency and stability in their measurement of reading comprehension levels. This validation process further ensured the accuracy and credibility of the study's findings.

The assessment rubric employed in this study was the Phil-IRI Assessment Rubric in Reading Comprehension, which categorized comprehension levels into three distinct levels:

- Independent Level (90-100% correct answers): Students at this level demonstrate a high degree of autonomy and proficiency in comprehending written texts. They exhibit advanced comprehension skills, effectively extracting and analyzing information, making inferences, and synthesizing ideas. They display a comprehensive understanding of the text's main ideas, details, and nuances, and can effectively apply critical thinking skills to interpret and evaluate the content.
- Instructional Level (75-89% correct answers): Students at this level exhibit competence in comprehending written texts but may require some guidance and support to fully grasp complex or nuanced concepts. They demonstrate an understanding of the text's main ideas and key details but may struggle with more abstract or inferential aspects. While they can comprehend the text with assistance, they may still encounter challenges in independently analyzing and synthesizing information.
- Frustration Level (74% and below correct answers): Students at this level experience significant difficulty comprehending written texts, often struggling to understand even basic information or concepts. They may exhibit limited comprehension skills, struggling to extract meaning from the text or comprehend its main ideas and details. These students may require intensive support and intervention to improve their reading comprehension abilities.
- This rubric served as a standardized and objective tool for evaluating participants' reading comprehension abilities, offering valuable insights into the impact of Bionic Reading on reading comprehension skills among Senior High School students at San Juan High School.

Data Collection Procedure and Ethical Considerations

To initiate the data gathering procedure for the research, the first step involved seeking permission from both the school principal of San Juan High School, Mexico, Pampanga, and the schools division superintendent of Department of Education (DepEd) - Division Office of Pampanga. A formal request was submitted, outlining the research purpose, methodology, and potential benefits. Participation in the study was voluntary. Upon obtaining approval, the next phase focused on securing informed consent from the respondents. This ensured that participants were fully aware of the study's objectives, procedures, and that participation was voluntary, with potential impacts on their learning experience.



Following the consent process, parental consent was secured for participants under the age of 18. A pilot testing was conducted to identify any potential issues with the research instruments, fine-tune the intervention process, and ensure that the overall methodology was clear and effective.

The reading method used in this study was silent reading. The pre-test consisted of 20 items based on 5 distinct reading selections, while the post-test also comprised 20 items but was based on 4 different reading selections. The genres of the reading selections for both the pre-test and post-test were articles or excerpts. Each test featured unique selections, ensuring a diverse range of content and enhancing the comprehensiveness of the assessment.

The pre-test administration took place to establish a baseline measure of the participants' reading comprehension skills before the intervention. It served as a benchmark for evaluating the effectiveness of the Bionic Reading method.

Moving on to the intervention phase, 75 participants who were identified as being in the frustration level of reading comprehension underwent the two-week intervention period. The intervention was facilitated by the researcher, who manually prepared the Bionic Materials using a Bionic Converter (10015.io).

The lessons for each week were carefully designed to cover specific aspects of creative non-fiction, with varied reading selections that aligned with the chosen theme for each day. Each session during the two-week intervention lasted 45 minutes.

Before the intervention began, participants were briefed on what to expect and provided with the necessary materials. During the intervention, participants were closely monitored to ensure they were comfortable and engaged. After the intervention, participants were debriefed and offered any additional support or information they needed.

Week 1 focused on themes such as "Theme as an Element of Creative Non-Fiction," "Using Sensory Images," and "Analyzing Factual/Nonfactual Elements." Week 2 delved into "Plot, Character, Characterization," "Angle and Grammatical Point of View," and "Setting and Atmosphere." Each day involved a specific reading selection related to the day's theme, ranging from synopses and essays to poems and excerpts.

Week 1 Lessons: "Theme as an Element of Creative Non-Fiction," "Using Sensory Images," and "Analyzing Factual/Nonfactual Elements."

- Day 1: Participants were introduced to a synopsis of the story "Morning in Nagrebcan" by Manuel E. Arguilla, setting the tone for exploring themes within creative non-fiction.
- Day 2: Participants engaged with a reading selection centered around how families enjoy spending precious time together, creating wonderful memories during difficult times, aiming to evoke emotional responses and enhance comprehension.
- Day 3: Participants explored poetic elements by reading the poem "Moonset at Central Park Station of St. Paul Subterranean River National Park" by John Iremil E. Teodoro, introducing a different genre within creative non-fiction.



- Day 4: Participants delved into the history of tattoos with a reading selection offering a simple yet fascinating account, aiming to diversify the content and test comprehension across various subjects.
- Day 5: The week concluded with a piece titled "I am a Filipino" by Carlos Peña Romulo, encouraging participants to reflect on identity within the context of creative non-fiction.

Week 2 Lessons: "Plot, Character, Characterization," "Angle and Grammatical Point of View," and "Setting and Atmosphere."

- Day 6: The second week began with a synopsis of the essay "Mommy J. At San Vicente Ward" by Alice M. Suncua, providing a different perspective on creative non-fiction.
- Day 7: Participants explored another piece, "Longing for Lagen" by John Iremil E. Teodoro, emphasizing different elements within creative non-fiction to deepen comprehension.
- Day 8: Participants were presented with an excerpt from "Kamarikutan Jam" by Yasmine D. Arquiza, challenging them with varied writing styles and perspectives.
- Day 9: A poem, "My Heart Leaps Up When I Behold" by William Wordsworth, was introduced to incorporate classic literary elements into the understanding of creative non-fiction.
- Day 10: The intervention concluded with a reading selection titled "The Sea" by James Reeves, summarizing and reinforcing key elements covered throughout the two-week period.

Following the intervention, a post-test was conducted to evaluate the impact of the Bionic Reading Method on improving reading comprehension. This final assessment allowed for a comparison between the pre-test and post-test results, providing insights into the effectiveness of the intervention.

Throughout the entire process, ethical considerations, participant confidentiality, and the overall validity of the research were closely monitored to ensure the reliability of the gathered data. Adherence to the data privacy act was strictly followed to maintain confidentiality and privacy.

Participants were handled with care and respect before, during, and after the experiment. Consent forms provided to participants and their parents or guardians stated that there were no risks associated with this study.

Moreover, participants were informed that by participating in this study, they may experience improved reading comprehension skills through the application of Bionic Reading techniques. Additionally, the findings of this research could contribute to the development of more effective reading strategies for Senior High School students in the future.

After the completion of the study, data were securely stored in electronic format on password-protected devices accessible only to authorized personnel involved in the research. Any physical documents containing sensitive information were stored in locked filing cabinets in a secure location.

Data collected were used solely for the purpose of analysis and reporting results related to the research objectives. Only aggregated and anonymized data were used in any publications or presentations resulting from the study to ensure the confidentiality of participants.



Once the research objectives were met and the data analysis was complete, all personally identifiable information was removed from the dataset. Any remaining data were securely stored for a period specified by institutional guidelines and then destroyed in accordance with data protection regulations.

Procedures for data destruction involved the secure deletion of electronic files and the shredding of physical documents to ensure that no sensitive information remained. All data destruction activities were documented and conducted under supervision to maintain confidentiality and comply with data privacy regulations.

Data Analysis

The data gathered were analyzed using the Licensed IBM SPSS Statistics version 25 to answer the specific questions stated in the statement of the problem.

The process of determining the comprehension level of respondents followed the methodology outlined in the Phil-IRI manual. This involved computing the comprehension percentage for each respondent, achieved by dividing the number of correct answers by the total number of questions and then multiplying the result by 100.

Moreover, the pre-test and post-test scores of the respondents in Phil-IRI Reading Comprehension Assessment were categorized and presented using frequency (f) and percentage (%) distribution with the following descriptions:

Independent Level (90-100% correct answers): Students at this level demonstrate a high degree of autonomy and proficiency in comprehending written texts. They exhibit advanced comprehension skills, effectively extracting and analyzing information, making inferences, and synthesizing ideas. They display a comprehensive understanding of the text's main ideas, details, and nuances, and can effectively apply critical thinking skills to interpret and evaluate the content.

Instructional Level (75-89% correct answers): Students at this level exhibit competence in comprehending written texts but may require some guidance and support to fully grasp complex or nuanced concepts. They demonstrate an understanding of the text's main ideas and key details but may struggle with more abstract or inferential aspects. While they can comprehend the text with assistance, they may still encounter challenges in independently analyzing and synthesizing information.

Frustration Level (74% and below correct answers): Students at this level experience significant difficulty comprehending written texts, often struggling to understand even basic information or concepts. They may exhibit limited comprehension skills, struggling to extract meaning from the text or comprehend its main ideas and details. These students may require intensive support and intervention to improve their reading comprehension abilities.

To further describe the pre-test and post-test scores of the respondents, the descriptive statistical tools such as minimum, maximum, median, and interquartile range were utilized as the scores were found as not normally distributed with the $p < .05$ level of significance using Shapiro-Wilk test.

The Wilcoxon-Signed Rank Test was used in determining the significant difference between the pre-test and post-test scores of the respondents. The p value $\leq .05$ is considered significant.

RESULTS

The data gathered were organized and processed using the appropriate statistical tools which revealed the following results:

Pre-test Ratings of the Respondents

The result of the analysis of the pre-test scores in Phil-IRI Reading Comprehension Assessment revealed that 75 respondents belonged to a frustration level of comprehension. The general score of the respondents in the 20-item reading comprehension assessment has the lowest score of 45 and highest score of 70 with a median of 60 and interquartile range of ± 15 which showed that the overall score of the respondents is from 45 to 75 with a description of frustration level. This means that students at this level experience significant difficulty comprehending written texts. They struggle to understand even basic information or concepts, find it challenging to extract meaning from the text, and have trouble grasping its main ideas and details.

Table 1. Pre-test Ratings of the Respondents

Comprehension Level	f	%
Frustration (<75%)	75	61%
Instructional (75% - 89%)	41	33%
Independent (90% - 100%)	8	6%
Total	124	100%
Descriptive Statistics for Frustration Level		
Central and Dispersion	Median	IQR
Minimum	60	± 15
Maximum	45	
	70	

Post-test Ratings of the Respondents

The result of the analysis of the post-test scores in Phil-IRI Reading Comprehension Assessment after the implementation of the Bionic Reading intervention revealed that the majority of the respondents belonged to the instructional level (54 or 72%). There were also 14 or 18.7% of the respondents who remained in the frustration level, however, there were seven (7) or 9.3% of them improved to independent level. The general score of the respondents in the 20-item reading comprehension assessment has the lowest score of 40 and highest score of 90 with a median of 75 and interquartile range of ± 5 which showed that the overall score of the respondents is from 70 to 80 with a description of frustration to instructional levels.

Table 2. Post-test Ratings of the Respondents

Comprehension Level	f	%
Frustration (<75%)	14	18.7
Instructional (75% - 89%)	54	72.0
Independent (90% - 100%)	7	9.3
Total	75	100%



	Median	IQR
Central and Dispersion	75	±5
Minimum	40	
Maximum	90	

Comparison of the Pre-test and Post-test Ratings of the Respondents

The comparison of the pre-test and post-test scores of the respondents in the 20-item reading comprehension assessment showed that there were three (3) respondents in the negative ranks who have higher pre-test scores as compared to their post-test scores with a mean rank of 8.17.

However, there were 68 respondents in the positive ranks who have higher post-test scores as compared to their pre-test scores with a mean rank of 37.23, while there were four (4) who have the same scores in their pre-test and post-test. In general, there is statistically significant difference in the pre-test and post-test scores of the respondents 20-item reading comprehension assessment ($Z = -7.232$, $p < .001$). The mean rank indicates that the post-test score of the respondents is significantly higher than their pre-test score.

Table 3. Test of Difference in the Pre-test and Post-test Ratings of the Respondents

Paired Group	N	Mean Rank	Z	Wilcoxon Signed Rank Test (2-tailed)
Post-test Percentage – Pre-test Percentage	Negative Ranks	3a	8.17	-7.232d <.001** (Significant)
	Positive Ranks	68b	37.23	
	Ties	4c		
	Total	75		
a. Post-test Percentage < Pre-test Percentage				
b. Post-test Percentage > Pre-test Percentage				
c. Post-test Percentage = Pre-test Percentage				
d. Based on negative ranks.				

** . Difference is significant at the 0.1 level (2-tailed) $p < .01$

DISCUSSION

The findings of this study shed light on the effectiveness of Bionic Reading in improving the reading comprehension of Senior High School Students. The analysis of pre-test scores indicated that among the 124 respondents, 75 or 61% belonged to the frustration level of comprehension.

This suggests that prior to the intervention, students struggled significantly with comprehending reading materials. However, following the implementation of the Bionic Reading intervention, a substantial improvement was observed in the post-test scores. The majority of respondents (72%) transitioned to the instructional level, indicating a significant enhancement in their comprehension abilities.



Moreover, the comparison between pre-test and post-test scores revealed a statistically significant difference, with the post-test scores being significantly higher than the pre-test scores.

This indicates that the Bionic Reading intervention had a positive impact on the reading comprehension skills of the students. Despite a portion of respondents remaining in the frustration level post-intervention, it is noteworthy that a considerable number of students (9.3%) progressed to the independent level, signifying a remarkable improvement.

The improvement in reading comprehension levels observed following the intervention can be attributed to the meticulous implementation of specific strategies inherent in Bionic Reading.

These strategies facilitated increased engagement and comprehension of reading materials among the students. Additionally, the personalized approach of the intervention played a crucial role in effectively addressing individual learning needs, resulting in a variety of positive outcomes.

In summary, the noticeable progress in reading comprehension levels post-intervention aligns with the findings of previous research conducted by Ricard (2022), Thompson (2023), Ariyani (2023), and Zubayer (2023). Through the integration of innovative technologies and cognitive strategies, Bionic Reading emerges as a promising intervention for enhancing reading comprehension among students. Its capacity to cater to diverse learner needs and promote more efficient reading experiences underscores its potential as an effective educational tool.

Furthermore, the success of Bionic Reading can be attributed to its ability to engage students through interactive activities and personalized learning pathways. By tailoring content to individual learning styles and proficiency levels, it creates a conducive learning environment conducive to better absorption and understanding of the material.

The positive outcomes observed post-intervention highlight the effectiveness of Bionic Reading in enhancing reading comprehension skills. Beyond its immediate impact, it holds a promise for addressing a broader spectrum of learners' needs. Its adaptability ensures inclusivity and advocates for a holistic approach to literacy development.

To sum up, Bionic Reading represents a significant advancement in literacy education, offering a pathway towards more engaging, personalized, and impactful learning outcomes for students. Through its innovative integration of technology and tailored strategies, it signifies a shift in enhancing reading comprehension and fostering effective learning experiences.

On the other hand, one potential limitation of this study is the relatively small sample size. Although the findings show significant improvements in reading comprehension among Senior High School Students, the generalizability of these results may be limited due to the size of the sample. Future research with larger and more diverse samples could provide a broader understanding of the effectiveness of Bionic Reading across different populations.



Additionally, external factors such as individual motivation levels, prior exposure to similar interventions, or variations in teaching methods could have influenced the outcomes. While efforts were made to control for these factors, it is essential to acknowledge that they may have still played a role in the observed results. Conducting further studies with more rigorous control measures could help mitigate these potential confounding variables.

Furthermore, the duration of the intervention and the follow-up period for assessing long-term effects were limited in this study. Longer-term studies that track the progress of students over extended periods would provide valuable insights into the sustainability of the improvements observed with Bionic Reading.

By addressing these limitations, future research can build upon the findings of this study and offer a more comprehensive understanding of the impact of Bionic Reading on reading comprehension skills among students.

CONCLUSION

Based on the results obtained from this one-group pre-test post-test experimental study, the following conclusions are drawn:

- The level of reading comprehension of the respondents based on the pre-test ratings is in the frustration level.
- The level of reading comprehension of the respondents based on the post-test ratings is in the instructional level, with a notable percentage showing progress to the independent level.
- There is a significant difference between the pre-test and post-test ratings of the respondents which indicates the effectiveness of Bionic Reading.

RECOMMENDATION

Based on the findings of this study, the following recommendations are provided:

- School administrators are encouraged to integrate Bionic Reading interventions into the curriculum to enhance the reading comprehension skills of Senior High School students.
- Educators or Reading Teachers are encouraged to learn how to apply the Bionic Reading method, as this knowledge can significantly enhance their ability to support students, particularly those at the frustration level, in improving their reading comprehension skills. By gaining a thorough understanding of Bionic Reading techniques, educators will be better equipped to implement these strategies effectively in their classrooms, leading to more meaningful advancements in students' reading abilities.
- Senior High School students are also encouraged to learn the Bionic Reading method, as the results of this study suggest that it can help improve their reading comprehension skills.

Future researchers are encouraged to conduct further research to explore the long-term effects of Bionic Reading interventions on reading comprehension outcomes among Senior High School students, as well as examining its potential benefits beyond academic performance, such as in critical thinking or information retention.

Additionally, studies investigating the effectiveness of Bionic Reading across different educational settings and student populations would provide valuable insights into its potential applications and benefits. Researchers may use the results of this study as a benchmark to explore other ways to improve students' reading comprehension.



REFERENCES

- [1] Allen, L. K., Snow, E. L., Crossley, S. A., Tanner Jackson, G., & McNamara, D. S. (2014). Reading comprehension components and their relation to writing. *L'Année Psychologique*, 114(04), 663–691. <https://doi.org/10.4074/s0003503314004047>
- [2] Ariyani, E. (2023, December 27). Improving students reading proficiency using bionic method (A Classroom Action Research At 10th Grade Students). <https://bajangjournal.com/index.php/JOEL/article/view/7133>
- [3] Bales, K. (2018). How to assess and teach reading comprehension. ThoughtCo. <https://www.thoughtco.com/reading-comprehension-4163099>
- [4] Caraig, R., V., & Quimbo (2022). Assessing reading comprehension difficulties in core science subjects of senior high school students in a private school in Calamba City, Philippines. <https://eric.ed.gov/?id=EJ1364296>
- [5] Casutt, R. (2022). Did You Know Your Brain Reads Faster Than Your Eyes?. Bionic Reading. <https://bionic-reading.com/br-method/>.
- [6] Cotter, J. (2012). Understanding the relationship between reading fluency and reading comprehension: Fluency strategies as a focus for instruction. https://fisherpub.sjf.edu/cgi/viewcontent.cgi?article=1225&context=education_ETD_masters
- [7] De Vera, J. S., & De Vera, P. V. (2018). Oral communication skills in English among grade 11 humanities and social sciences (HUMSS) students. *The Asian ESP journal*, 14(5). <https://files.eric.ed.gov/fulltext/ED604403.pdf>
- [8] Department of Education (2020). Basic Education Learning Continuity Plan – DepEd. https://www.deped.gov.ph/wp-content/uploads/2020/07/DepEd_LCP_July3.pdf
- [9] Gunn, J. (2018). The Serious, Lifelong Impacts of Illiteracy | Resilient Educator. ResilientEducator.com. <https://resilienteducator.com/classroom-resources/illiteracy-impacts/>
- [10] K12 Readers. (2018). What is Reading Comprehension?. <https://www.k12reader.com/what-is-reading-comprehension/>
- [11] Learning Point Associates. (2014). A Closer Look at the Five Essential Components of Effective Reading Instruction: A Review of Scientifically Based Reading Research for Teachers. <https://files.eric.ed.gov/fulltext/ED512569.pdf>
- [12] Lenz K. (2013). Reading Comprehension. University of Kansas: Kansas. https://specialconnections.ku.edu/instruction/reading_comprehension
- [13] Manlapig, M. (2020). What's to blame for the low reading comprehension of the Filipino youth? CNN. <https://www.cnnphilippines.com/life/culture/2020/4/21/reading-comprehension-problem.html>
- [14] Meron N., (2018) How poverty affect the education in the Philippines. <https://www.truevolunteer.org/how-poverty-affects-education-in-the-philippines/>
- [15] Moghadam, S. H., Zainal, Z., & Ghaderpour, M. (2012). A Review on the Important Role of Vocabulary Knowledge in Reading Comprehension Performance. *Procedia - Social and Behavioral Sciences*, 66, 555–563. <https://doi.org/10.1016/j.sbspro.2012.11.300>



- [16] National Institute for Literacy. (2013). Key Literacy Component: Text Comprehension. <http://www.adlit.org/article/27882/>
- [17] Official Gazette (2013). Department of Education. What is K-12?. <https://www.mirror.officialgazette.gov.ph/k-12/>
- [18] Program for International Student Assessment. (2023). PISA 2023 Assessment and Analytical Framework. OECD. <https://doi.org/10.1787/b25efab8-en>
- [19] Ricard, J. (2022). Bionic Reading – Taking the Reading Experience To a Higher Dimension. Retrieved from <https://klizos.com/bionic-reading-reading-experience-tohigher-dimension/>
- [20] Ropp, N. (2018). The 5 Components of Reading Explained. 3PLearning. <https://www.3plearning.com/blog/reading-proficiency-with-5-essential-components-of-literacy/>
- [21] Sidek, H. M., & Rahim, H. Ab. (2015). The Role of Vocabulary Knowledge in Reading Comprehension: A Cross-Linguistic Study. *Procedia - Social and Behavioral Sciences*, 197, 50–56. <https://doi.org/10.1016/j.sbspro.2015.07.046>
- [22] Snow, C. (2010). Academic language and the challenge of reading for learning about science. Harvard. https://www.academia.edu/27503291/Academic_Language_and_the_Challenge_of_Reading_for_Learning_About_Science
- [23] Starrett, E. V. (2016). Teaching Phonics for Balanced Reading. Second Edition. In ERIC. Corwin Press, A SAGE Publications Company. <https://eric.ed.gov/?id=ED495588>
- [24] Thompson, E. (2023a, September 19). Bionic Reading for ADHD: Harnessing the power of visual cues to aid focus and comprehension - Start teaching. Start Teaching. <https://start-teaching.com/bionic-reading-for-adhd-harnessing-the-power-of-visual-cues-to-aid-focus-and-comprehension/#:~:text=Bionic%20Reading%20as%20a%20Tool%20for%20ADHD,-Guiding%20Attention%20with&text=As%20the%20reader's%20attention%20is,serve%20as%20a%20memory%20aid.>
- [25] Thompson, E. (2023b, September 19). Bionic Reading for Dyslexia: A Potential bridge to Enhanced Comprehension - Start teaching. Start Teaching. <https://start-teaching.com/bionic-reading-for-dyslexia-a-potential-bridge-to-enhanced-comprehension/>
- [26] Wilhelm J. (2018). Understanding Reading Comprehension. <https://www.scholastic.com/teachers/articles/teaching-content/understanding-reading-comprehension/>
- [27] Zubayer I. (2023) A Comparative Analysis of Bionic and Traditional Reading. Izaz Zubayer. <https://www.izazzubayer.com/a-comparative-analysis-of-bionic-and-traditional-reading>