Enhancing Phonemic Awareness and Letter-Sound Correspondence in 5-Year-Old Children through Interactive Smartboard Games: Assessing the Impact of Technology- Enhanced Phonics Instruction

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ABSTRACT

A research analysis investigates how the Phonics Explorer tool succeeds as an interactive smartboard game to improve phonemic awareness and letter-sound connection in 5-year-old preschool students. The research investigates Sendayan Matrix Global School participants through both quantitative tests PAT-2, CTOPP-2, and DIBELS pre and post-intervention measures and qualitative observations made by three preschool teachers. The Phonics Explorer implements cognitive learning theories together with gamification strategies to create an interactive system that drives better student participation and education achievement. Research results indicate participants will rural areas marked progress in phonemic awareness and letter-sound skills to enable the broad adoption of technology-based phonics education in early childhood literacy curriculums. The study delivers important knowledge about gamified skill development in phonology and delivers key strategy recommendations for preschool curriculum development.

Keywords: Phonemic Awareness, Letter-Sound, 5-Year-Old Children, Smartboard Games, Impact of Technology

INTRODUCTION

The strategic paper known as the Malaysia Education Blueprint (2013-2025) targets to improve preschool education services to achieve the universalization of preschool education by the year 2025. In the first stages, concentration was done on the goal of enhancing enrollment and implementing the use of teaching aids, for example, smart boards to make learning more interactive and thus improve the literacy level of preschool children. Against this background, the study of the current paper aims to determine the effect of Phonics Explorer, a game that is played on the smartboard, on the phonemic awareness and letter-sound correspondence of 5-year-old students in Seremban, Malaysia.

Even now the applicative coherence and regularity of ICT and the gap created by ages and income levels between the students affect phonics education. These questions form the basis of the present study as a way of filling the following research gaps in the field: Thus, the study will investigate the use of interactive technology by the study to improve on use of curriculum in preschool with an effort to eliminate disparities in education as well as introducing more animated teaching methodologies.

To enhance learners' interest and achievement, the research is based on cognitive learning theory and uses instructional games in its idea. In addition to the measurement of module outcomes in terms of phonemic awareness and literacy, this study also brings knowledge to future research that is related to the use of advanced tools in learning in the context of Early Childhood Education.

LITERATURE REVIEW

Definitions of Phonemic Ability

Phonemic awareness is the initial step in reading as it entails the ability to identify the smallest sound units in speech [22]. One of the subskills of phonological awareness is that children learn to not only recognize but also to segment as well as blend phonemes to form whole words [14]. This fundamental component supports the decoding process that is used during reading to transform the novel words into comprehensible forms, therefore helping the child in reading mastery.

Phoneme ability comprises phoneme identification, blending, segmentation, deletion as well as substitution [17]. They all have significant functions in the language learning process which assist children in their tasks regarding language learning, which is a prerequisite to reading as well as proper communication. For instance, the Simple View of Reading (SVR) implies the interaction between decoding with the ability to understand the text and phonemic awareness due to the correlation with reading comprehension [14]. The Phonological Awareness Continuum also shows the developmental line of the phonemic skills from simple phonological activity to those of more intricate phonemic activities [17].

TABLE 1: Models of Phonemic Ability For Preschoolers

Author, Year	Model	Methodology
Bennett et al., 2023	Simple View of Reading (SVR)	Phonemic awareness is taught by focusing on decoding. Teachers might present a word like ‘cat,’ emphasizing the individual sounds /k/, /a/, and /t/. Children are then guided to blend these sounds to form the word.
Golubović et al., 2019	Phonological Awareness Continuum	After building syllable awareness, children move to more complex tasks, such as breaking down words into individual phonemes and then rearranging them to form new words. For example, ask children to change the first sound in ‘bat’ to /k/ to make ‘cat.’ This method helps with phonemic manipulation.

To measure phonemic ability, educators use the Phonological Awareness Test 2 (PAT-2) and the Comprehensive Test of Phonological Processing 2 (CTOPP-2) [22]. These check-ups allow identifying needs for further interventions and measuring the efficiency of methods used in teaching phonemic awareness at schools.

Besides phonemic ability that has just been explained, the letter-sound relationship is another critical component of reading instruction. This comprises engendering knowledge of associations between letters and sounds, a process referred to as the alphabetic principle [9]. It had been established that letter-sound relationships are the primary and most basic element of both reading and writing. Other techniques like multisensory learning like in Itchy’s Alphabet ensure that there is the creation of such connections which makes the learning process enjoyable [9].

Quantitative measures for a child’s ability in the letter-sound relationship can be obtained from tests such as the Dynamic Indicators of Basic Early Literacy Skills (DIBELS) [24]. These assessments are very useful in determining children who may experience difficulties with reading and also in confirming the efficiency of teaching methods.

The concept of the theory of phonics acquires another dimension which is the mental process connected with reading. Regarding skill in reading, this theory goes further and implies that it comprises not only the technical identification of written words but also how phonemes and graphemes map within a language [16]. The important concepts of the cognitive theory are phonological awareness, cognitive shift, and metalanguage, which enhance the general view of reading education [16].

Other theories and frameworks like the Cognitive Strategy Intervention (CSI) and the ACT-R cognitive architecture reveal how effective analyst intervention can promote a child's phonemic awareness and decoding abilities [31], [23]. These models call for direct teaching of phonemes as the key to a learner's ability to read fluently.

Gamification of phonics learning in classrooms brings motivational dimensions of game design into focus and aligns it with the mailing goals and objectives [13]. Unlike in a traditional learning process, gamification uses features such as points, ratings, and other activities to make students focused and motivated. It makes learning fun in addition to being in congruity with the developmental stages; thus, it can be regarded as an effective strategy for enhancing phonics learning among young children [34].

Last but not least, the field of ID provides a systematic method for planning, developing, and delivering instruction that enhances learning returns [33]. Having been prompted by the necessity of developing effective training programs during the Second World War; instructional design has now adopted several models of which is the ASSURE model that adopts the use of technology in teaching [11]. This evolution proves that education is dynamic and has adopted new trends in the ever-evolving world to meet the needs of learners and embrace ways that enable the incorporation of technology in education.

Previous studies state that these instructional design models used in learning environments improve not only the instructional delivery but also students' interaction and performance, thus offering the tool for leveraging innovative techniques of teaching, including phonics [11].

This theoretical research focuses on the description of phonemic awareness and letter-sound correlation and the practical use of these concepts as well as program design in one consolidated summary of the approaches that are used in teaching reading.

TABLE 3: Cognitive Theories implemented in phonics teaching for preschoolers

Author, Year	**Cognitive Theory Implemented**	**Example**
Sucena, Silva, & Marques, 2023	Phonological Awareness Development Intervention	Implementation of a phonological awareness program in preschool, including daily activities like rhyming and sound segmentation to prevent reading difficulties.
Nishikawa & Morita, 2022	ACT-R Cognitive Architecture Model	Using the Shiritori game to simulate phonological unit learning and error correction in language acquisition.
Thangarajathi & Menaha, 2020	Cognitive Strategy Intervention	Structured reading sessions employ guided reading and phoneme segmentation to help children with dyslexia.

METHODOLOGY

Research Design

Research Objectives	**Research Questions**
To assess the need for developing and implementing the Phonics Explorer module	a) What is the current level of phonemic awareness and letter-sound correspondence mastery among preschool students?
	b) What challenges do preschool students face in developing phonemic awareness and letter-sound correspondence during traditional phonics teaching methods
To design and develop the Phonics Explorer module using game-based instruction	a) How are the learning objectives for improving phonemic awareness and letter-sound correspondence established in the Phonics Explorer module?
	b) How is the content of the Phonics Explorer module structured and developed to enhance phonemic awareness and letter-sound correspondence?

	c) How is cognitive learning theory integrated into the design and development of the Phonics Explorer module?
	d) How is the gamifying learning approach incorporated into the design and development of the Phonics Explorer module?
To implement the Phonics Explorer module	a) How is the Phonics Explorer module, using interactive smartboard games, implemented in classroom learning?
To evaluate the Phonics Explorer module	a) What is the level of phonemic awareness and letter-sound correspondence mastery achieved by students after using the Phonics Explorer module?
	b) Is there measurable improvement in phonemic awareness and letter-sound correspondence mastery among preschool students before and after the implementation of the Phonics Explorer module?

Category	**Research Focus**	**Participants**	**Data Collection Method**	**Data Analysis**
Needs Assessment	Current phonemic awareness and letter-sound correspondence mastery	5-year-old preschoolers from urban and rural areas	Pre-test (PCT-2, COPT-2 & DIBELS)	Statistical Analysis
Challenges in Traditional Methods	Issues faced in conventional phonics instruction	Preschool Teachers (Public & Private)	Observational comments	Thematic Analysis
Module Development	Structuring and implementing Phonics Explorer	Educators, Parents, School Administrators	Development of Explorer Module	NULL
Implementation	Integration of smartboard games in learning	Teachers, Preschool Students,	Interactive classroom observations	Engagement Analysis
Evaluation	Measuring post-intervention progress	Preschoolers, Teachers, Parents, School Stakeholders	Post-test (PCT-2, COPT-2 & DIBELS)	Statistical Analysis

Based on the present study, quantitative tests and analyses were used in combination with qualitative observations of the outcome of the Phonics Explorer module in improving phonemic awareness and letter-sound correspondence among preschool children. The quantitative aspect entailed pre- and post-intervention assessments of different aspects of literacy using tests such as PAT-2, CTOPP-2, and DIBELS to get measurable data from the students. The qualitative aspect incorporated the opinions of the teachers, parents of the children, as well as the school authorities to get an overall view of the effect of the intervention.

About participants, all the attempts were made to involve children in a school with a mix of low or high socio-economic status, educational level, and various language abilities. In addition to this, teachers from both private and public settings involving preschools were also targeted to include a comparison of various teaching strategies and classroom environments. Structured interviews and questionnaires were also administered to the parents with a view of assessing their and their child's engagement in literacy activities at home while school administrators also shed light on the possibility of incorporating the use of gamified phonics instruction in their institution.

The collected data was analyzed using statistical tools such as paired t-tests to establish the difference in phonemic awareness. The qualitative data were analyzed thematically to identify and understand the learning outcomes that teachers, parents, and other stakeholders at the school have come up with. This helped in

building reliability in the current study since both the quantitative and qualitative analyses of the module's effectiveness of the Phonics Explorer were captured.

Ethical Approval

This study was conducted with the informed consent of all preschool students' parents and teachers involved.

DATA PRESENTATION AND ANALYSIS

In order to determine the impact of the Phonics Explorer module on preschool children's phonemic awareness and letter-sound correspondence skills, the study utilized superior descriptive analysis. The data collection tools used were the Comprehensive Test of Phonological Processing (CTOPP), the Dynamic Indicators of Basic Early Literacy Skills (DIBELS), and the Phonological Awareness Test (PAT) pre and post-intervention.

CTOPP Proof: About the results of the CTOPP, there were significant changes in the phonological processing subtest area. The mean of the blending sounds test was 6.80 with an SD of 2.48 before the implementation of the intervention and it raised to 7.93 at the end of the implementation of the intervention, as seen in picture I. This is also an increase and the analysis of the results corroborates that the improvement is statistically significant ($p < 0.05$).

Measure	Comprehensive Test of Phonological Processing Assessment (CTOP)			
	CTOP-PRE MATCHING SUBSET	CTOP-PRE BLENDING SUBSET	CTOP-POST MATCHING SUBSET	CTOP-POST BLENDING SUBSET
Mean	6.80	7.57	8.03	8.63
Standard Deviation (Std)	2.48	2.47	2.51	2.68
Min	1	2	2	3
Max	12	13	14	15
25% (Q1)	5.25	6.25	6.25	7
50% (Median)	7	8	9	9
75% (Q3)	9	9	10	11

Figure I Shows the summary of the descriptive analysis of CTOP results of the pre and post-intervention

DIBELS Results: Likewise, the DIBELS contributed to the achievement of early literacy skills in the same regard. The overall average of ISF increased from 2.13 to 2.53 whereas the overall average of PSF increased from 2.40 to 2.80. Paired with this, the scores for Nonsense Word Fluency (NWF) were also steeply raised from 2.63 to 3.20 as depicted in Figures II and III. There are clear indications that the module has positively contributed to the improvement of the student's phonemic awareness.

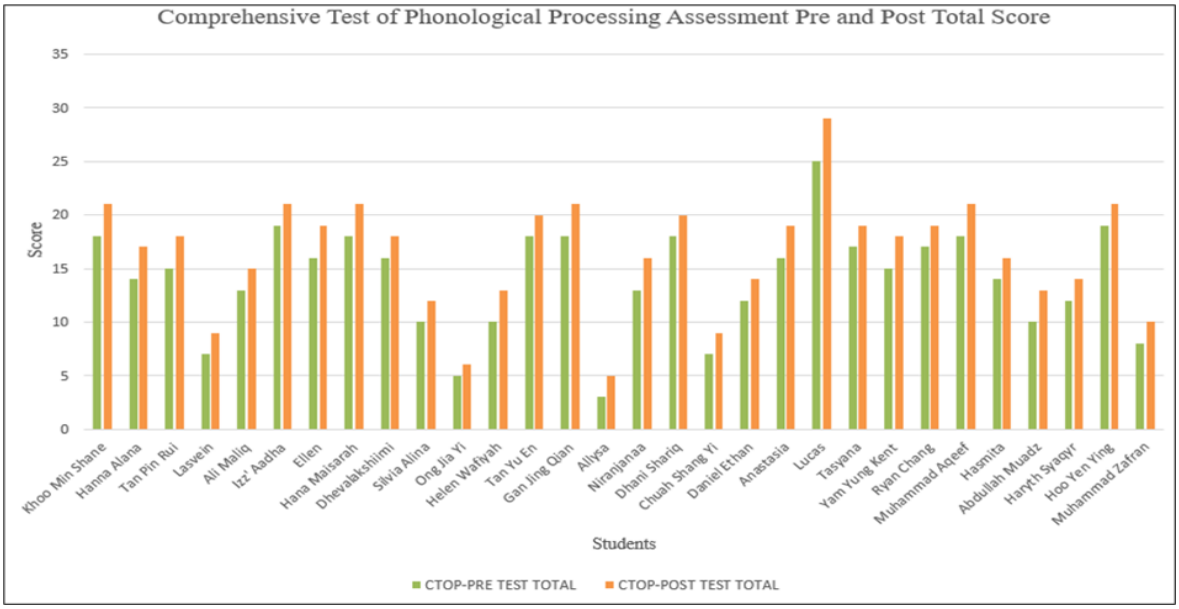

Figure II Dynamic Indicators of Basic Early Literacy Skills (DIBELS)

PAT Results: The PAT scores supported results from other test, so this area of the test was valid. Concerning specific phonemes, scores in phoneme isolation tasks also increased from an average of 2.90 to 3.20. The overall outcome is discussed in Figures IV and V, presenting the changes in all the phonemic awareness abilities provided by L2.

Descriptive statistics used in combining all the above results provide clear evidence of the Phonics Explorer module. However, paired t-tests were run to prove the significance of the documented improvements across all the facets, affirming that the module raised the basics of literacy standards effectively.

Measure	Dynamic Indicators of Basic Early Literacy Skills (DIBELS)					
	DIBELS-PRE ISF	DIBELS-PRE PSF	DIBELS-PRE NWF	DIBELS-POST ISF	DIBELS-POST PSF	DIBELS-POST NWF
Mean	2.13	2.47	2.93	2.9	3.17	3.67
Standard Deviation (Std)	0.97	1.11	1.14	1.06	1.05	1.15
Min	0	0	1	0	0	1
Max	4	4	5	5	5	5
25% (Q1)	2	2	2	2.25	3	3
50% (Median)	2	2	3	3	3	4
75% (Q3)	3	3	4	3.75	4	4

Figure III Shows the summary of descriptive analysis DIBELS results of the pre and post-intervention

Therefore, various tests of variability and reliability have been done to widen the credibility of the results. Adopting several forms of assessment and having stable progress on different parameters, increases credence to the credibility of the study, and the practical usefulness of the intervention.

Thus, the evidence supporting the effective results from the data presentation and analysis proves that the Phonics Explorer module increases phonemic awareness and knowledge of letter-sound relationships in preschoolers. Through Figures I through V, it is very easy to appreciate the various ranges and the magnitude of enhancements, which would give a bird's eye view of the success of the intervention. Besides proving the effectiveness of the presented module, these results open the possibility of its expansion and application in early childhood literacy initiatives.

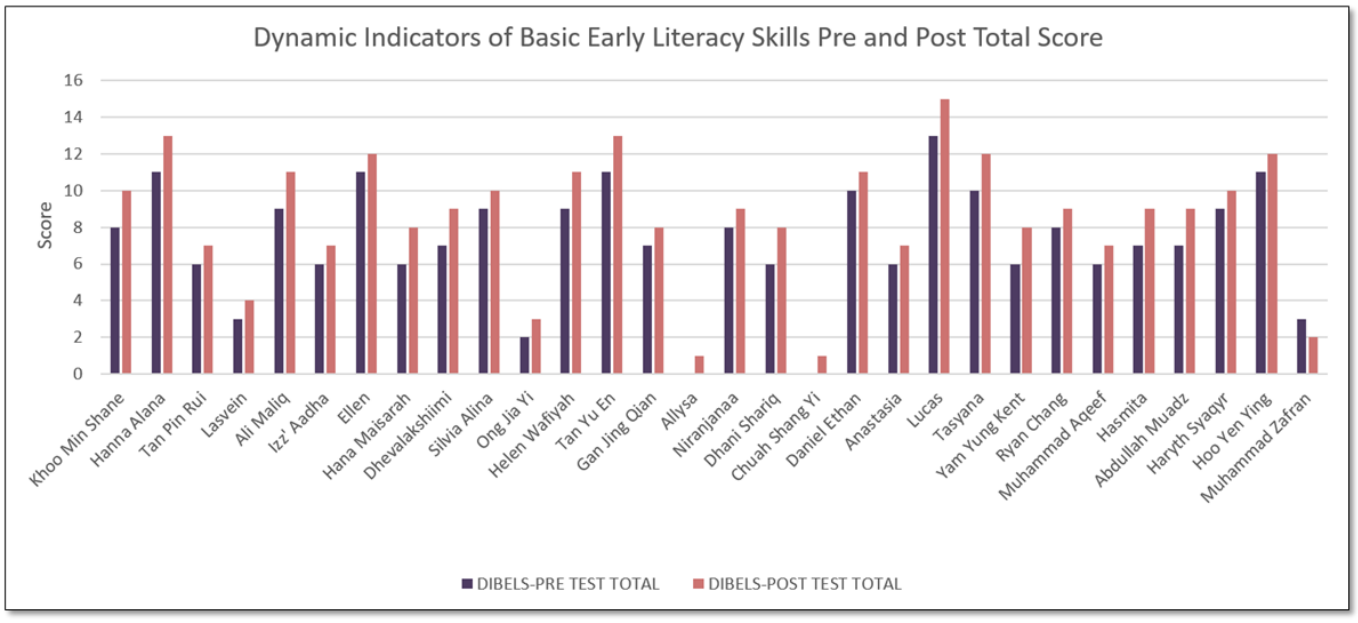

Figure IV Shows the total number of DIBELS results of the pre- and intervention of each student.

Phonological Awareness Test (PAT)

Enhancing Qualitative Insights in Phonemic Awareness Research

Preschool teachers and parents participated in interviews which generated thematic analysis results that yielded important qualitative findings regarding the Phonics Explorer module's effectiveness. The study discovered two main aspects: preschool teachers do not use traditional phonics approaches and they value interactive and visual learning equipment. Teachers observed that conventional phonics teaching methods lose child interest because they are both unengaging and non-participatory. Through its smartboard games and visual aids the Phonics Explorer module delivers substantial student engagement because it brings education to life in an exciting manner. The educational tools assist students in comprehending phonemic principles as they adapt to different learning methods specifically important in early educational environments.

This research demonstrates that differentiating instruction along with interactive education methods creates benefits for students' motivation levels and their developing self-assurance. Traditional phonics education systems that adopt uniform approaches fail to meet the wide variety of educational requirements that students in their early stages need. The Phonics Explorer module delivers individualized education that lets students move through content independently thus increasing their retention and comprehension of phonemic awareness. Interaction features merged with the module along with real-time feedback create active student engagement thus strengthening their understanding as well as self-assurance in their linguistic abilities. The obtained data demonstrates why technology integration remains fundamental for early childhood literacy education because it creates advanced learning platforms that excite students.

DISCUSSION

Effectiveness of the Phonics Explorer Module

The Phonics Explorer module successfully enhanced learning performance regarding both phonemic awareness and letter-sound correspondence in early education. Research supports the effectiveness of interactive phonics teaching methods delivered through technology which confirms the findings of this study. Assessments with CTOPP, DIBELS and PAT showed increased abilities in sound blending with phoneme segmentation and nonsense word fluency as evidence supporting the valuable impact of the module on core reading fundamentals. Teachers noted that students became more interested in learning through gamified aspects of their curriculum thereby reinforcing the positive outcome of play in literacy education.

Challenges and Limitations

The encouraging findings need to be evaluated through consideration of key environment-based obstacles that limit general implementation potential. Schools located in rural districts often experience two main barriers they lack smartboards and face problems with unreliable internet access. For such interventions to succeed, teachers need to be proficient in phonics teaching methods and in utilizing advanced digital educational resources while also accessing appropriate training. The acquisition and maintenance of required technologies become challenging because of financial restrictions that affect predominantly budget-limited educational institutions. The success of the Phonics Explorer module's dependency on these variables remains essential to reaching educational institutions with diverse educational contexts.

Future Research and Long-term Sustainability

Researchers need to investigate how well students remember phonemic skills throughout extended periods following intervention to determine the duration of their acquired knowledge. The research needs to study the relationship between skills learned during the intervention and their impact on further academic achievement and literacy growth after the observed immediate results. Examining regular skill reinforcement techniques including booster sessions and integrated curriculum activities would determine ways to maintain long-term

benefits from the Phonics Explorer module. The evidence gathered in this investigation will serve as a vital foundation when developing methods to sustain the long-term impact of technology-assisted phonics education in diverse educational settings.

CONCLUSION

According to cognitive learning principles and gamification methods, the Phonics Explorer module delivers interactive smartboard games that successfully enhance both phonemic awareness and letter-sound correspondence abilities among preschool children. This research demonstrates the need to combine modern technology with educational practices and attributes challenges to infrastructure requirements and teacher knowledge acquisition and operational funding needs for broader implementation of this technology. Academic research must concentrate on prolonged skill maintenance because sustainable learning gains will lead to advanced educational methods that work with technology and develop student needs.

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