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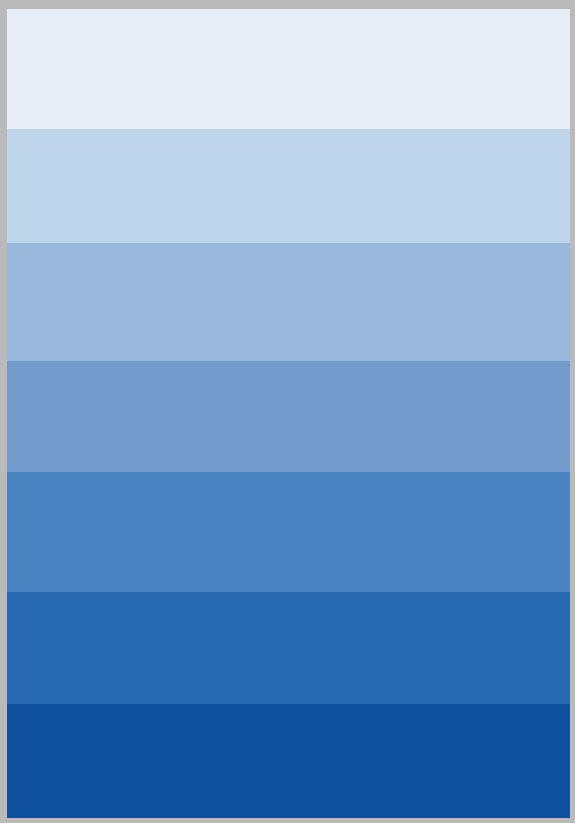

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An Empirical Analysis of Factors Affecting School Readiness Among Preschool Children in Sri Lanka Using Binary Logistic Regression

K. R. M. S. Ranasingha, T. Mukunthan, N. M. Hakmanage
[1]Department of Early Childhood Development and Primary Education, National Institute of Education, Sri Lanka
[2]Faculty of Education, The Open University of Sri Lanka
[3]Faculty of Computing and Technology, University of Kelaniya, Sri Lanka

ABSTRACT

This study investigates the key factors influencing school readiness among preschool children in Sri Lanka, with the goal of informing targeted interventions and education policies that support smooth and successful transitions into formal schooling. Child, family, and preschool-related factors were examined to evaluate their relative influence using statistical modelling. Using a stratified sampling method, 40 Early Childhood Development (ECD) centers with trained Early Childhood Development Assessment (ECDA) teachers were selected. A total of 360 children were assessed using the ECDA tool, and structured questionnaires were administered to parents and teachers to gather detailed information on child, family, and preschool characteristics. Binomial logistic regression analysis was applied to identify the most influential factors associated with school readiness. Results indicated that child and family characteristics were the primary determinants. Older age and female gender were positively associated with readiness. Among family-level factors, maternal employment and mother's education significantly enhanced readiness, whereas low-skilled parental occupations had negative effects. At the preschool level, only the instructional method used demonstrated a significant impact. These findings highlight the importance of addressing socioeconomic disparities and strengthening pedagogical quality in early childhood education. The study provides evidence-based insights to guide inclusive, developmentally appropriate practices and policy reforms aimed at improving school readiness outcomes in Sri Lanka.

Keywords: school readiness; preschool children; early childhood development in Sri Lanka; socioeconomic factors; maternal education; instructional methods; binomial logistic regression

INTRODUCTION

School readiness defined as a child's holistic preparedness to engage in formal schooling is a crucial predictor of later academic success and socio-emotional well-being (UNICEF, 2022; Pianta et al., 2009). From social constructivist and interactionist perspectives, readiness is not merely a fixed developmental milestone but a sociocultural construct shaped by interactions between the child and their environment (Hannify, 2017). Dockett & Perry (2009) contend that school readiness is a relational concept, and the 'Ready Child Equation' outlines what children need in order to be ready for school. The "Ready Child Equation" uses this to describe what children need in order to be ready for school: "Ready Families + Ready Communities + Ready Services + Ready Schools = Ready Children." UNICEF (2020) emphasized the significance of ready families, ready schools, and ready children as components of school readiness within a broader sociocultural context.

Global evidence consistently highlights the interplay of child characteristics, family socioeconomic conditions, and preschool experiences in shaping readiness outcomes (Likhar et al., 2022; Wangke et al., 2021). Although chronological age contributes to readiness, it is not the sole determinant (Bowman et al., 2001; Doyle, 2012). Other influential factors include gender (Matthews et al., 2021), health status (Janus & Duku, 2007), family structure (Ramey & Ramey, 1999), and parenting practices (Doyle, 2012). Family environments through parental involvement, values, and daily interactions provide the primary pathways for acquiring foundational cognitive, language, and self-regulation skills (Mashburn & Pianta, 2006; Thompson & Raikes, 2007). Maternal education and employment have been repeatedly linked to improved readiness outcomes by fostering stimulating home environments and structured routines (Meisels, 1999; Febriyanti & Dewi, 2020).

High-quality early childhood education and care (ECEC) programs further enhance readiness, particularly for disadvantaged children (Barnett, 2008; Zigler & Styfco, 2004). Process quality such as responsive teacher child interactions and child-centered pedagogy has stronger associations with outcomes than structural inputs like teacher qualifications (Kokkalia et al., 2019; Tilbe, & Xiaosong, 2024).

In Sri Lanka, where early childhood education remains largely privatized and heterogeneous, empirical evidence on the predictors of school readiness is limited. This study addresses this gap by examining child-, family, and preschool related factors influencing readiness and estimating the likelihood of a child being school-ready using binomial logistic regression.

METHODOLOGY

2.1Research Design, Sample and Data Collection

This cross-sectional study was conducted in the Colombo District of Sri Lanka's Western Province. Using a stratified sampling method, 40 Early Childhood Development (ECD) centers with teachers trained in the Early Childhood Development Assessment (ECDA) were selected. The sample comprised 360 children aged 56–63 months enrolled in a range of preschool types (government, semi-government, private, and NGO). Ethical approval was obtained from the Open University of Sri Lanka, and informed consent was secured from parents. Children's school readiness was assessed using the ECDA tool. Structured questionnaires were administered to parents and teachers to collect detailed information on child characteristics, family background, preschool attributes, and teacher profiles.

2.2 Variables and Data Analysis

The dependent variable was school readiness, coded as *Ready* (1) or *Not Ready* (0) based on the Early Childhood Development Assessment (ECDA) results.

The independent variables encompassed three domains:

- Child factors: age in months and gender.
- Family factors: maternal employment status, parental education levels, and maternal and paternal occupations (classified according to International Standard Classification of Occupations [ISCO] codes).
- Preschool factors: management type (government, semi-government, private, NGO), pedagogical method, language of instruction, teacher education, professional qualifications, and years of teaching experience.

Descriptive statistics were first generated to summarize sample characteristics and check for missing data or outliers. Subsequently, binomial logistic regression was performed using R software to examine the influence of these factors on school readiness. Log-odds coefficients were converted to odds ratios (ORs) to facilitate interpretation of effect sizes and the likelihood of readiness.

RESULTS

3.1 Child-Related Factors

The sample consisted of 187 boys (51.9%) and 173 girls (48.1%), reflecting a nearly equal gender distribution. Slightly more than half of the children (53.6%) were in the older age group (60–63 months), indicating that most participants were approaching the upper end of the preschool age range (Figure 1).

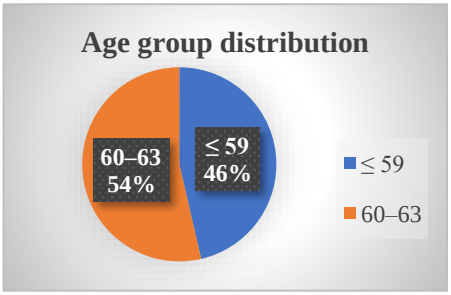

Figure 1: Age Group Distribution of the Sample

3.2 Family-Related Factors

Descriptive statistics of key family-related characteristics are shown in Table 1

Table 1: Descriptive statistics of family-related factors

Family Factor	Category	Mother n (%)	Father n (%)
Maternal Employment	Employed	217 (60.3)	—
	Unemployed	143 (39.7)	—
Education Level	Below O/L	3 (0.8)	20 (5.6)
	O/L	82 (22.8)	71 (19.9)
	A/L	185 (51.4)	168 (47.1)
	Degree	90 (25.0)	98 (27.5)
Occupation	Housewife	143 (39.7)	—
	Managers/Senior Officials	15 (4.2)	88 (24.6)
	Professionals	58 (16.1)	60 (16.8)
	Technicians/Associates	48 (13.3)	34 (9.5)
	Service & Sales	49 (13.6)	27 (7.6)
	Plant/Machine Operators	4 (1.1)	50 (14.0)
	Other*	43 (11.9)	98 (27.5)

Other includes military, agriculture, craft, and elementary occupations.

According to Table 1 above, most mothers were employed (60.6%), although 39.7% identified as housewives. Both parents were relatively well-educated, with over half of mothers (76.4%) and fathers (74.6%) having completed A/L or higher. Fathers were most commonly managers/senior officials (24.6%), professionals (16.8%), or plant/machine operators (14.0%). Mothers were primarily professionals (16.1%), technicians/associates (13.3%), or service/sales workers (13.6%). Only small proportions of parents were engaged in agriculture, crafts, or elementary occupations.

3.3 Preschool-Related Factors

Table 2 presents descriptive statistics of preschool characteristics.

Table 2: Descriptive statistics of preschool-related factors (N = 360)

Factor	Category	n (%)
Management Type	Private	249 (69.2)
	Semi-government	49(13.6)
	Government	31(8.6)
	NGO	17(4.7)
	Other	14 (3.9)
Method Used	General preschool	253(70.3)
	Montessori	77 (21.4)
	Other	30 (8.3)
Language Medium	Sinhala	336 (93.3)
	Tamil	19 (5.3)
	Other	5 (1.4)
Teacher Education	A/L	290 (80.6)
	Degree	65 (18.1)
	Master's+	5 (1.4)
Professional Qualification	Diploma/Higher Diploma	281(78.1)
	Degree in ECD/PE	55 (15.3)
	Certificate	24 (6.7)
Teaching Experience	16–20 years	177 (49.2)
	≥ 21 years	80 (22.2)
	11–15 years	70 (19.4)
	≤ 10 years	33 (9.2)

As shown in Table 2, most children attended private preschools (69.2%), with instruction predominantly in Sinhala (93.3%). Teachers were generally well-qualified and experienced: 78.1% held a diploma or higher diploma, and 71.4% had more than 15 years of teaching experience.

3.4 Logistic Regression Analysis

To identify key factors influencing school readiness, a binomial logistic regression model was estimated using R software. The dependent variable was school readiness (*Ready = 1; Not Ready = 0*). Independent variables included child, family, and preschool factors (see 2.2).

Table 3: Regression analysis of factors affecting child readiness for formal schooling

Variable	β Estimate	p-value
Intercept	–16.334	0.00036 ***
Child Age (months)	2.413	0.0057 **
Child Gender (Female)	0.816	0.0056 **
Maternal Employment	1.831	0.0056 **
Mother's Education	1.054	0.00099 ***
Mother's Occupation	–0.270	0.0137 *
Father's Occupation	–0.222	0.00012 ***
Preschool Method	0.585	0.0469 *
Father's Education	0.261	0.0624 n.s.
Other Preschool Factors	—	> 0.05 n.s.

The model showed strong predictive performance (Null Deviance = 463.64; Residual Deviance = 303.51; Akaike Information Criterion (AIC) = 333.51; Area Under the Curve AUC = 0.8683).

Key findings include:

- Child Age (β = 2.413, p = 0.0057): Older children were significantly more likely to be school-ready.
- Child Gender (β = 0.816, p = 0.0056): Girls had higher odds of readiness compared to boys.
- Maternal Employment (β = 1.831, p = 0.0056): Children of employed mothers were more likely to be ready.
- Mother's Education (β = 1.054, p = 0.00099): Higher maternal education strongly predicted readiness.
- Preschool Method (β = 0.585, p = 0.0469): Montessori or mixed pedagogies were associated with better readiness outcomes.
- Negative Predictors: Lower-skilled maternal (β = –0.270) and paternal occupations (β = –0.222) significantly decreased the likelihood of readiness.

Other preschool structural factors, including management type, teacher qualifications, language medium, and teaching experience were not significant after adjusting for child and family characteristics.

Overall, the analysis highlights child and family factors as the strongest determinants of school readiness. Older age, female gender, maternal employment, and higher maternal education were positive predictors, while low-skilled parental occupations reduced readiness odds. Among preschool characteristics, only the instructional method significantly improved readiness,

underscoring the importance of pedagogical quality over structural features.

DISCUSSION

4.1 Child-Related Factors of School Readiness

The logistic regression model identified two significant child-level predictors: age and gender.

Age: Chronological age was the strongest predictor of school readiness ($\beta = 2.413$, $p = 0.0057$), reflecting the role of developmental maturation. This finding aligns with Piaget (1970) and Vygotsky (1978), as well as empirical studies showing that each additional month supports gains in language, fine-motor coordination, and emergent academic skills. Winsler et al. (2012) reported that older preschoolers outperform younger peers in vocabulary, numeracy, and self-regulation measures, while Vlachos and Papadimitriou (2015) found superior reading fluency, comprehension, and overall literacy among older children. Beyond cognitive benefits, older children exhibit stronger emotional regulation, sustained attention, and task persistence competencies essential for smooth transitions into structured Grade 1 routines (Bassett et al., 2012). These findings highlight the need for developmentally appropriate school-entry policies and differentiated instruction that accommodate age-related readiness differences.

Gender: Gender was also a significant predictor, with girls more likely to be school-ready than boys ($\beta = 0.816$, $p = 0.0056$). Consistent with Son et al. (2013), girls outperform boys in early reading, social skills, and cognitive tasks. Matthews et al. (2021) similarly reported female advantages in self-regulation, mathematics, literacy, and general knowledge, while Brandlistuen et al. (2020) found that girls lead boys in naming, early numeracy, and behavioral regulation by preschool age. Bay (2020) noted higher affective readiness in girls, including cooperative play and emotional awareness. Fidjeland et al. (2023) emphasize that preschool scaffolding can help reduce gender disparities by providing boys with targeted support to strengthen early learning competencies. These results underscore the importance of gender-sensitive pedagogical approaches alongside developmentally appropriate entry policies.

4.2 Family-Related Predictors of School Readiness

Family characteristics, particularly maternal factors, were among the strongest predictors.

Maternal Employment: Maternal employment positively predicted school readiness ($\beta = 1.831$, $p = 0.0056$). Working mothers often provide greater financial stability, structured home routines, and cognitive stimulation, all of which enhance early learning opportunities (Isaacs, 2012; Waldfogel, 2006; Yoan et al., 2012). Additionally,

employed mothers may place higher value on early education and exhibit greater confidence in supporting their children's learning (Lombardi & Coley, 2014).

Parental Occupation: Lower-skilled parental occupations were associated with reduced readiness (mother: $\beta = -0.270$, $p = 0.0137$; father: $\beta = -0.222$, $p = 0.00012$), reflecting broader socioeconomic influences. Occupational prestige affects access to resources, time for parenting, and cognitive stimulation. According to Human Capital Theory (Becker, 1993; Heckman, 2006) and Bronfenbrenner's bioecological model (1979), families with higher-status occupations often benefit from greater income, reduced stress, and more enriching home environments (Bradley & Corwyn, 2002; Shah & Hussain, 2021).

Parental Education: Maternal education was a strong predictor of readiness ($\beta = 1.054$, $p = 0.00099$), whereas father's education showed a non-significant trend ($\beta = 0.261$, $p = 0.0624$). Educated mothers are more likely to provide stimulating learning experiences, including reading, storytelling, and structured play (Dearing et al., 2004; Vygotsky, 1978). Family Investment Theory also suggests that higher-educated parents devote more time and resources to early development (Conger & Donnellan, 2007). Attachment theory (Bowlby, 1969) further explains that responsive, educated parenting fosters confidence, curiosity, and exploration. Conversely, lower parental education often correlates with limited cognitive stimulation and higher stress, impeding readiness even with basic parental involvement (Rochimah et al., 2020).

Collectively, these findings highlight maternal employment and education as foundational to a child's early learning environment while underscoring the broader role of family socioeconomic resources, represented by parental occupation.

4.3 Preschool-Related Predictors of School Readiness

Among preschool-level variables, only the instructional method significantly predicted readiness ($\beta = 0.584$, $p = 0.0469$). Preschools employing Montessori, Japanese, traditional, or mixed approaches were associated with higher readiness outcomes. This aligns with meta-analytic evidence demonstrating that pedagogical quality characterized by active exploration, sustained engagement, and teacher scaffolding drives gains in language, pre-literacy, and self-regulation more effectively than mere preschool attendance (Camilli et al., 2010; Pianta et al., 2009). Constructivist frameworks (Piaget, 1964; Vygotsky, 1978) explain that rich, hands-on teacher-child interactions enhance cognitive flexibility and executive function, crucial for adapting to formal schooling (Diamond & Lee, 2011).

Other preschool-level structural factors including preschool management type, teacher education, professional qualifications, years of experience,

and language of instruction were not significant once child and family variables were controlled. This suggests that process quality and pedagogical practices are more influential than structural or institutional features, consistent with U.S. studies showing that teacher qualifications alone do not guarantee higher classroom quality or better child outcomes (Early et al., 2007; Lin & Magnuson, 2018). From a bioecological perspective (Bronfenbrenner, 1979), the microsystem of daily instructional practices and teacher-child relationships exerts a more direct influence on development than administrative structures.

Overall, the study corroborates prior research indicating that developmental maturity, gender-sensitive approaches, maternal resources, and high-quality, child-centered pedagogy collectively shape school readiness (Bay, 2020; Wangke et al., 2021). Cognitive, social, emotional, and physical development, together with family and preschool experiences, provide the foundation for successful transitions to formal schooling.

CONCLUSION

This study identifies age, gender, maternal education, maternal employment, parental occupation, and preschool method as key factors of school readiness among Sri Lankan preschoolers. Policy implications include:

- Developmentally appropriate school-entry policies to accommodate younger children.
- Gender-responsive pedagogies to support boys' socio-emotional and cognitive development.
- Maternal empowerment and parental education programs to enhance home learning environments.
- Strengthening preschool pedagogical quality by promoting active, child-centered instructional methods rather than focusing solely on teacher credentials.

These findings provide evidence-based guidance for policymakers, educators, and parents to improve early childhood development and ensure equitable transitions to formal schooling.

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Enhancing the Teaching-Learning Process through the Effective Implementation of School-Based Development Plans: A Study of Selected Schools in the Paddiruppu Education Zone, Batticaloa District, Sri Lanka

Shivanantham Sritharan
Zonal Education Office, Paddiruppu, Sri Lanka

ABSTRACT

This study was conducted in selected schools in the Paddiruppu Education Zone of the Batticaloa District, located in the Eastern Province, with attention to the contextual challenges of post-conflict regions. The study examined challenges in implementing the School-Based Development Plan (SBDP) and proposed strategies to strengthen the teaching–learning (T–L) process. A descriptive mixed-method design was adopted, involving 169 participants including principals, subject coordinators, teachers, and Sri Lanka Education Administrative Service officers. Data were collected through questionnaires, interviews, classroom observations, and document analysis, and analyzed using SPSS, Microsoft Excel, and thematic analysis. The study focused on six dimensions: teacher professional development, student motivation, resource utilization, monitoring and evaluation, community and parental involvement, and school leadership and management. Findings revealed that teacher professional development and student motivation were positively associated with student achievement, particularly in the GCE Ordinary Level examination. Resource utilization showed a moderate relationship with academic performance, while monitoring mechanisms supported sustained school improvement. School leadership emerged as the most influential factor in ensuring long-term effectiveness. Documentary analysis of six years of results from the GCE Advanced Level, GCE Ordinary Level, and the Grade 5 Scholarship Examination indicated positive correlations (r = +0.597, +0.391, +0.268), suggesting that effective SBDP implementation is associated with improved student performance. The study concludes that strengthening teacher capacity, enhancing leadership, institutionalizing monitoring systems, and promoting community engagement are essential for sustainable educational development in the Northern and Eastern Provinces of Sri Lanka.

Keywords: School-Based Development Plan, Teaching-Learning Process, Eastern Province, Educational Strategies, Student Performance

INTRODUCTION

1.1 Introduction

Sri Lanka's longstanding commitment to education is reflected in a series of national policy initiatives designed to enhance the quality and equity of schooling at all levels. A central component of this reform agenda is the second policy thrust area for school education, which aims to strengthen student learning competencies across both primary and secondary education. Achieving this objective requires the establishment of a strong culture of strategic planning and institutional accountability at the school level. Within this framework, the School-Based Development Plan (SBDP) has been introduced as a key mechanism to promote systematic improvement in the teaching-learning (T-L) process and overall school performance.

The SBDP is intended to function as a structured planning tool that aligns school-level activities with national educational goals while addressing local needs and contextual realities. Through participatory planning, resource allocation, monitoring, and evaluation, the SBDP seeks to enhance instructional quality, student achievement, and institutional effectiveness. However, despite the collaborative development of these plans by central and provincial authorities, their practical implementation often encounters significant challenges. Administrative constraints, limited professional capacity, insufficient monitoring mechanisms, and contextual socio-economic factors frequently undermine the intended outcomes of the SBDP.

Against this backdrop, the present study was undertaken to investigate the specific obstacles faced by schools in the Paddiruppu Education Zone of the Batticaloa District in implementing the SBDP. The primary objective is to identify context-specific challenges and propose actionable, evidence-based strategies to strengthen the teaching-learning process and improve student performance in the region.

1.2 Background of the Study

As a developing country with a strong public education system, Sri Lanka has a well-established tradition of educational planning and reform. Educational resources are allocated and managed through a coordinated structure operating at national, provincial, zonal, and school levels. This multi-tiered framework ensures that national policy directives are adapted to provincial and local contexts, thereby promoting both standardization and contextual responsiveness.

Within this system, the SBDP represents a pivotal instrument for decentralizing decision-making and empowering schools to take responsibility for their own development. It is designed to integrate curriculum planning, teacher professional development, resource management, student assessment, and community engagement into a coherent strategic

framework aimed at improving teaching and learning outcomes.

Nevertheless, while policy formulation at national and provincial levels has often been comprehensive and participatory, substantial gaps remain between policy intentions and classroom realities. Teachers, principals, school management committee members, and subject coordinators frequently encounter operational challenges that limit the effective execution of SBDP initiatives. These include constraints related to funding, training, leadership capacity, stakeholder engagement, and monitoring systems.

Accordingly, this study seeks to bridge the gap between policy design and practical implementation by conducting an in-depth investigation within the Paddiruppu Education Zone. By examining real-world challenges and institutional practices in this specific context, the research aims to generate evidence-based recommendations that can strengthen the teaching–learning process and contribute to sustainable educational improvement in the Eastern Province and similar post-conflict regions.

1.3 Problem Statement

The effective implementation of the School-Based Development Plan (SBDP) is intended to enhance the quality of the teaching–learning process and improve student achievement. However, in practice, its implementation is constrained by a range of interrelated institutional and professional challenges. A persistent lack of teacher motivation, coupled with resistance to adopting innovative pedagogical approaches, constitutes a significant barrier to meaningful instructional reform. This challenge is further intensified by limited access to sustained, collaborative, and needs-based professional development opportunities, which are essential for equipping teachers with the competencies required for contemporary teaching practices.

In addition, insufficient administrative guidance, weak monitoring mechanisms, and inadequate resource allocation undermine the operationalization of planned SBDP activities. These constraints contribute to a misalignment between policy intentions and classroom realities, resulting in minimal transformation of teaching practices and limited impact on student learning outcomes. Consequently, a substantial gap exists between the strategic objectives articulated in the SBDP and their practical realization within schools.

Addressing this disconnect is essential to ensuring that the SBDP functions not merely as a formal planning document, but as a dynamic and effective instrument for sustainable educational improvement.

1.4 Research Objectives

1.4.1 General Objective

To examine the challenges encountered in improving the

teaching–learning process through the School-Based Development Plan (SBDP) and to propose effective mechanisms to address and minimize these challenges.

1.4.2 Specific Objectives

1. To analyze the current practices of the School-Based Development Plan (SBDP) in relation to the teaching-learning process.
2. To examine the relationship between existing teaching-learning practices under the SBDP and student learning outcomes.
3. To identify the key challenges affecting the implementation of the teaching-learning process within the SBDP framework.
4. To propose evidence-based strategies to strengthen and enhance the teaching-learning process through effective implementation of the SBDP.

LITERATURE REVIEW

The existing body of literature on School-Based Development Plans (SBDPs) highlights their theoretical potential to improve school effectiveness, instructional quality, and student achievement. However, empirical research reveals several conceptual and practical gaps, particularly regarding the extent to which SBDPs produce measurable improvements in student learning outcomes.

Lack of Empirical Evidence on Student Learning Outcomes

Although SBDPs are widely promoted as mechanisms for decentralization and school improvement, there is limited robust evidence directly linking specific SBDP interventions to statistically significant gains in student examination performance. For example, a randomized controlled trial conducted in Sri Lanka by Aturupane et al. (2022) found that while SBDP-related reforms positively influenced teacher and principal behaviors, they did not result in significant improvements in student test scores. Similarly, Kumari (2022) argues that limited teacher participation in school development committees undermines the depth of implementation, thereby restricting the potential impact of SBDPs on classroom practices and student achievement. These findings suggest a critical gap between structural reforms and instructional transformation.

Teacher Motivation and Resistance to Change

Teacher resistance to change remains a recurrent theme in the literature on educational reform. However, relatively few studies examine the psychological, organizational, and socio-cultural factors underlying such resistance. Research indicates that teacher motivation is strongly influenced by access to continuous professional development, supportive leadership, collaborative school cultures, and adequate resources (Iqbal & Ali, 2024). Furthermore, Musaigwa (2023) emphasizes that transparent communication, participatory

decision-making, and trust-building processes are essential in reducing resistance and fostering ownership of reform initiatives. The literature therefore suggests that successful implementation of SBDPs depends not only on structural planning but also on addressing motivational and relational dynamics within schools.

The Digital Divide and Equitable Access

Technology integration has become a critical component of modern teaching and learning processes. Nevertheless, research indicates that equitable access to digital resources remains a persistent challenge, particularly in under-resourced contexts. Ramesh (2022) highlights the difficulties faced by schools with limited infrastructure and technical capacity. International reports further underscore the issue of the "digital divide," noting that many educators lack adequate training in digital pedagogy and that economically disadvantaged households often have limited access to necessary technological tools. This disparity constrains the ability of SBDPs to effectively integrate technology into instructional practice.

Parental and Community Engagement

Parental and community involvement is widely recognized as a significant contributor to student success. However, empirical studies reveal a persistent gap in understanding culturally responsive and context-sensitive approaches to engaging marginalized communities. Kumari (2022) observes that traditional forms of parental involvement often fail to foster meaningful participation. Aderibigbe et al. (2023) advocate for a shift from passive involvement to collaborative partnerships that empower parents as active stakeholders in school development processes. This perspective underscores the need for inclusive engagement strategies within the SBDP framework.

Sustainability and Long-Term Impact

Another significant limitation in the literature is the predominance of short-term evaluations of SBDP initiatives. Many studies focus on immediate behavioral or administrative changes without assessing long-term sustainability and institutional transformation. Cebrián et al. (2021) and Aturupane et al. (2022) emphasize the importance of developing a culture of continuous improvement that persists beyond externally funded projects or temporary policy interventions. The absence of longitudinal research limits understanding of how SBDPs can be institutionalized as enduring mechanisms for educational improvement.

METHODOLOGY

This study adopted a mixed-methods research approach, integrating both quantitative and qualitative methods within a descriptive research design. The purpose of employing a mixed-

methods framework was to obtain a comprehensive understanding of the challenges affecting the teaching–learning process under the School-Based Development Plan (SBDP) and to develop contextually relevant strategies for improvement. The study was conducted in the Paddiruppu Education Zone of the Batticaloa District.

The target population comprised 70 government schools within the zone. From this population, a sample of 169 participants was selected, including 50 school principals, 63 subject coordinators, 50 School Management Committee (SMT) teachers, and 6 officers from the Sri Lanka Education Administrative Service (SLEAS). The selection of participants ensured representation from both administrative and instructional levels, thereby enabling a multi-perspective analysis of SBDP implementation.

Data were collected using four primary methods to ensure triangulation and enhance the validity and reliability of findings:

- **Classroom Observations:** Direct observations were conducted to examine teaching practices, student engagement, and the use of instructional resources within classroom settings.
- **Questionnaires:** Structured, self-administered questionnaires were distributed to principals, subject coordinators, and teachers to collect quantitative data regarding perceptions, practices, and implementation challenges.
- **Semi-Structured Interviews:** In-depth interviews were conducted with selected principals and the Planning Deputy Director to obtain qualitative insights into institutional, administrative, and contextual challenges affecting SBDP implementation.
- **Document Analysis:** Relevant documents, including school development plans, policy guidelines, performance reports, and official circulars, were systematically reviewed to assess alignment between planned initiatives and actual practices.
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The integration of these data sources enabled the identification of both internal factors (such as teacher capacity, leadership practices, and monitoring mechanisms) and external factors (such as resource constraints and stakeholder engagement) influencing the effectiveness of the SBDP. Ultimately, the methodological approach was designed to generate evidence-based recommendations aimed at strengthening the teaching–learning process within the SBDP framework.

Table 1: Sampling techniques

Sample Type	Description	Sampled Subjects
Purposive Sampling	Participants were selected based on their expertise in the field and their in-depth understanding of the research topic.	Education administration service officers, principals, and Management Committee teachers.
Stratified Random Sampling	The population was divided into subgroups (strata) based on shared characteristics such as grade level, years of experience, and subjects taught. A random sample was then drawn from each stratum.	Prepared one-year and five-year school development plans, examination performance reports, and principals.
Convenience Sampling	Participants were selected based on ease of access and availability to this research.	Subject coordinators, teachers, principals, leadership committee members, and Sri Lanka Education Administrative Service members.

3.1 Population of the Study

The study population was drawn from two regions; Manumai South Eruvil Pattu and Porateevu Pattu. The distribution of participants is presented below.

Table 2: Population of the study

Serial No	Population Category	Manumai South Eruvil Pattu	Porateevu Pattu	Total
1	Principals	37	33	70
2	Subject Coordinators	79	75	154
3	Teachers of SMT	37	33	70
4	SLEAS Officers	3	3	6
Total		156	144	300

3.2 Sample of the Study

Based on the population distribution and sampling techniques, the selected sample is as follows.

Table 3: Sample of the Study

Serial No	Population Category	Total Population	Sample Size
1	Principals	70	50
2	Subject Coordinators	154	63
3	Teachers of SMT	70	50
4	SLEAS Officers	6	6
Total		300	169

Note: The sample size for this study was determined using the Krejcie & Morgan (1970) table.

3.3 Analysis Techniques

Data analysis for this study was conducted using SPSS Statistics Version 29.0.2.0(20) and M. The study employed a structured approach to align specific analytical techniques with each research objective, as outlined below.

1. To analyze current practices in the School-Based Development Plan (SBDP): Qualitative Content Analysis was used to systematically categorize and interpret textual data obtained from interviews and documents. This method enabled the identification of key themes related to existing teaching practices, resource utilization, and student engagement.
2. To identify the relationship between practices and student learning outcomes: This objective was addressed using a combination of Correlation Analysis for quantitative data and Thematic Analysis for qualitative data. Correlation analysis examined the statistical relationships between variables such as teaching practice frequency and student performance scores. Concurrently, thematic analysis identified recurring ideas and perceptions from interviews, providing insights into teachers' views on the impact of these practices on student outcomes.
3. To identify challenges in implementing the SBDP: Thematic Analysis was applied to categorize common challenges reported by participants, such as insufficient resources or limited time. Following this, a Root Cause Analysis was conducted to determine the underlying systemic factors contributing to these recurring issues.
4. To propose strategies to enhance the teaching and learning process:
   The final objective was addressed through a SWOT Analysis to evaluate the strengths, weaknesses, opportunities, and threats of the SBDP implementation. Subsequently, findings from this and all previous analyses were integrated through a

Synthesis of Findings, facilitating the development of comprehensive, evidence-based recommendations to improve teaching and learning practices.

3.4 Limitations of the Study

Despite careful planning and systematic implementation, this study has several limitations that should be acknowledged.

3.4.1. Reliance on Traditional Assessment Methods

The study primarily utilized traditional assessment approaches, such as examination results and performance reports, to evaluate outcomes. These methods may not fully capture the effectiveness of innovative or student-centered learning approaches. As a result, the measurement of the true impact of the proposed changes in teaching and learning practices may be limited.

3.4.2. Administrative and Financial Constraints

The implementation and evaluation of the School-Based Development Plan (SBDP) were affected by administrative and financial challenges. Insufficient funding, limited administrative support, and the absence of clear policy guidelines restricted the full execution of planned activities. These constraints may have influenced both the scope and effectiveness of the interventions examined in the study.

3.4.3. Technological and Resource Shortages

A shortage of essential technological equipment and learning resources posed a significant limitation. Limited access to modern teaching aids, digital tools, and instructional materials hindered the adoption and proper evaluation of contemporary teaching practices. This resource gap may have affected the overall implementation quality of the SBDP.

3.4.4 Predominantly Quantitative Data within a Qualitative Framework

Although the study framework highlights the importance of understanding complex factors such as teacher motivation, institutional support, and organizational culture, the analysis relied heavily on quantitative data (e.g., frequencies and percentages). This reliance may not fully capture the depth and nuance of participants' experiences. More extensive qualitative methods, such as in-depth interviews or focus group discussions, could have provided richer insights.

DATA ANALYSIS

4.1 Analysis of the Current Practices in the SBDP as They Relate to the Teaching and Learning Process

Table 4: Analysis of teaching practices and student outcomes

Sr. No.	Current Practices	Yes Responses	In Percentage
1	Defining Learning Objectives	102	60
2	Selecting Teaching Methods	134	79
3	Motivating Parents and Social Environments	150	89
4	Continuous Assessment of Progress	101	60
5	Teacher Supervision	97	57
6	Student Feedback	73	43
7	Peer Assessment	126	75
8	Use of Modern Learning/Teaching Aids	141	83
9	Teacher Training	147	87
10	Learning Resources	152	90
11	Sufficient Funding	160	95
12	Teacher Shortage and Additional Teachers	137	81
13	Curriculum and Acquired Knowledge	131	78
14	Assessment and Monitoring	102	60
15	Suitable Classroom Environment for Learning	150	89

Table 5: Result analysis of Paddiruppu education zone in last 11 years from 2013 -2023

G.C.E(A/L) Examination Results in Percentage	G.C.E(A/L) Examination Results in Percentage	G.C.E(O/L) Examination Results in Percentage	Garde5 Scholarship Examination Results in Percentage
2013	66	66	63
2014	68	69	67
2015	67	68	68
2016	63	70	67
2017	67	64	69
2018	64	67	69

2019	60	68	70
2020	63	69	79
2021	70	73	65
2022	70	69	72
2023	68	70	70

An examination of the current practices within the School-Based Development Plan (SBDP) shows that it plays an important role in improving the teaching and learning process. The SBDP is designed to address the specific needs of each school and provides a structured plan to enhance student learning outcomes. However, for the SBDP to be effective, schools must regularly review their existing practices and make necessary improvements. Without proper evaluation and modification, the SBDP may remain only a formal requirement rather than a meaningful tool for school improvement.

Evaluating current practices under the SBDP requires attention to several key areas. First, schools must clearly define their vision and educational goals and ensure that teaching practices align with these goals. Second, understanding how students learn is essential for improving classroom instruction. Teaching methods should encourage active participation, critical thinking, and student engagement. Third, the quality of teacher instruction significantly influences student achievement. Effective teaching should be learner-centered and make use of diverse strategies to meet the needs of different students. Assessment methods must also be carefully examined to ensure that they not only measure student performance but also provide constructive feedback that supports learning. In addition, identifying the strengths and weaknesses of current practices helps schools build on what works well and address areas that need improvement.

Important practices currently implemented in schools include defining clear learning objectives, selecting appropriate teaching methods, incorporating student feedback, using modern teaching and learning aids, aligning the curriculum with required knowledge and competencies, and maintaining a suitable classroom environment. These elements are central to strengthening the teaching and learning process within the SBDP framework.

Overall, the findings emphasize that the success of the SBDP depends on its alignment with each school's context and educational goals. Continuous monitoring, reflection, and adjustment are necessary to ensure that the plan remains relevant and effective. When treated as an ongoing process rather than a one-time document, the SBDP can significantly contribute to improving the quality of teaching and learning in schools.

4.2 Relationship Between Current Teaching-Learning Practices and Student Learning Outcomes

Relationship Between SBDP and Student Learning Outcomes

The School-Based Development Plan (SBDP) is closely connected to the teaching and learning process, as it provides a structured framework for improving instructional practices and student achievement. This study examined whether current teaching-learning (PT-L) procedures are associated with student learning outcomes, measured through performance in the G.C.E. Advanced Level (A/L), G.C.E. Ordinary Level (O/L), and Grade 5 Scholarship examinations.

Relationship Between PT-L Procedures and A/L Pass Rate

Table 06: Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
PT-L Proceedures	6	43	89	72.00	17.205
A/L Pass Rate	6	60	70	65.67	4.033
Valid N (listwise)	6				

The descriptive statistics show that the mean score for PT-L procedures was 72.00, with a standard deviation of 17.205, indicating some variation in the implementation of teaching practices. The mean A/L pass rate was 65.67, with a smaller standard deviation of 4.033, suggesting relatively stable student performance across the observed period.

Table 04: Correlations between PT-L Procedures and A/L Pass Rate

		PT-L Procedures	A/L Pass Rate
PT-L Proceedures	Pearson Correlation	1	.597
	Sig. (1-tailed)		.106
	N	6	6
A/L Pass Rate	Pearson Correlation	.597	1
	Sig. (1-tailed)	.106	
	N	6	6

The Pearson correlation analysis revealed a correlation coefficient of **r = 0.597** between PT-L procedures and the A/L pass rate. This indicates a moderate positive relationship, meaning that improvements in teaching–learning procedures tend to be associated with higher A/L pass rates. In other words, when teaching practices are stronger or more effectively implemented, student performance at the A/L level tends to improve.

However, the significance value (p = 0.106) is greater than the commonly accepted threshold of 0.05. This indicates that the relationship is not statistically significant at the 5% level. Therefore, while there appears to be a meaningful positive association, the evidence is not strong enough to confirm that the relationship is statistically reliable. The moderate correlation suggests potential influence, but further research with a larger sample size would be necessary to confirm this finding.

Relationship Between PT-L Procedures and O/L Pass Rate

Table 05: Descriptive Statistics and Correlations of PT-L Procedures and O/L Pass Rate

	N	Minimum	Maximum	Mean	Std. Deviation
PT-L Proceedures	6	43	89	72.00	17.205
O/L Pass Rate	6	64	73	68.33	2.944
Valid N (listwise)	6				

		PT-L Procedures	O/L Pass Rate
PT-L Proceedures	Pearson Correlation	1	.391
	Sig. (1-tailed)		.222
	N	6	6
O/L Pass Rate	Pearson Correlation	.391	1
	Sig. (1-tailed)	.222	
	N	6	6

The descriptive statistics indicate that the mean O/L pass rate was 68.33, with a standard deviation of 2.944, showing relatively consistent performance. The correlation between PT-L procedures and O/L pass rate was **r = 0.391**, indicating a moderate positive relationship.

This suggests that better implementation of teaching and learning practices is associated with improved O/L examination performance. However, the significance value (p = 0.222) is higher than 0.05, meaning the relationship is not statistically significant. There is a 22.2% probability that the observed correlation occurred by chance. Although the relationship shows a positive trend, it cannot be conclusively interpreted as statistically significant.

Relationship Between PT-L Procedures and Grade 5 Scholarship Pass Rate

Table 06: Descriptive Statistics and Correlations of PT-L Procedures and Grade 5 Scholarship Pass Rate

	N	Minimum	Maximum	Mean	Std. Deviation
PT-L Proceedures	6	43	89	72.00	17.205
Grade 5 Scholership Pass Rate	6	65	79	70.67	4.676
Valid N (listwise)	6				

		PT-L Procedures	Grade 5 Scholarship Pass Rate
PT-L Proceedures	Pearson Correlation	1	.268
	Sig. (1-tailed)		.303
	N	6	6
Grade 5 Scholership Pass Rate	Pearson Correlation	.268	1
	Sig. (1-tailed)	.303	
	N	6	6

The descriptive statistics show a mean Grade 5 Scholarship pass rate of 70.67, with a standard deviation of 4.676. The correlation coefficient between PT-L procedures and the Grade 5 Scholarship pass rate was **r = 0.268**, indicating a weak positive relationship.

This weak positive correlation suggests that improvements in teaching–learning practices are slightly associated with higher Grade 5 Scholarship examination results. However, the significance value (p = 0.303) exceeds the 0.05 threshold, indicating that the relationship is not statistically significant. Therefore, although there is a slight positive trend, the evidence does not strongly support a dependable statistical relationship.

Overall, the findings demonstrate positive correlations between current teaching–learning practices under the SBDP and student performance in A/L, O/L, and Grade 5 Scholarship examinations. The strongest relationship was observed with A/L results (r = 0.597), followed by O/L (r = 0.391), and Grade 5 Scholarship (r = 0.268).
Although none of the relationships reached statistical significance at the 5% level, all correlations were positive. This consistent positive direction suggests that effective implementation of teaching and learning procedures may contribute to improved student outcomes. The lack of statistical significance may be influenced by the small sample size (N = 6), which reduces statistical power.
These findings imply that strengthening teaching–learning procedures within the SBDP framework has the potential to improve student performance. Schools can use this evidence to refine instructional strategies, enhance monitoring mechanisms, and implement targeted interventions aimed at improving examination results.

At the same time, the implementation of teaching and learning processes within the SBDP faces practical challenges. Addressing these challenges strategically is essential to fully realize the potential impact of the SBDP on student achievement.

4.3 Challenges - Analysis of the Issues and Data Validation

The challenges identified under Objective 3 were systematically validated through both qualitative and quantitative data collected in the study. The use of multiple data sources, including questionnaires, interviews, classroom observations, and document analysis, strengthened the credibility of the findings through triangulation.

First, the lack of sufficient teacher training emerged as a significant challenge. Questionnaire responses indicated that a high percentage of participants perceived limited access to professional development opportunities. This quantitative finding was further supported by interviews with school leaders, who explained specific gaps in subject knowledge, modern pedagogical strategies, and assessment literacy. Additionally, document analysis of school development plans revealed limited structured provisions for continuous professional development, confirming that teacher training was not systematically prioritized within planning frameworks.

Second, low student engagement was identified as a classroom-level challenge. Classroom observations showed limited active participation among students. Interviews with teachers provided deeper insight into this issue, highlighting factors such as overcrowded classrooms and an imbalanced teacher-to-student ratio, which restricted individualized attention. Questionnaire responses also reflected relatively low scores on items related to student motivation and participation, further validating this concern.

Third, the continued reliance on traditional assessment methods was recognized as a core issue. Questionnaire data indicated that the majority of teachers and administrators primarily depended on conventional written examinations to measure student achievement. Document analysis of policy guidelines and school assessment frameworks confirmed this dependence on summative evaluation methods. Interviews further revealed that such traditional approaches often failed to capture critical thinking skills, creativity, and other higher-order learning outcomes, thereby limiting the measurement of innovative teaching practices.

Fourth, challenges related to parent involvement were clearly validated through both quantitative and qualitative evidence. Questionnaire results showed relatively low levels of parental participation in school activities and decision-making processes. Interviews with school leaders provided contextual explanations, including limited parental awareness of educational reforms and reluctance to provide financial or material support. These findings demonstrate that insufficient community engagement affects the successful implementation of the SBDP.

Fifth, the lack of administrative support was identified as a systemic challenge. Interviews with school administrators and education officers

highlighted issues such as delayed budget allocations, limited monitoring mechanisms, and unclear policy directives. Document analysis further supported this finding by revealing inconsistencies and gaps in policy implementation guidelines, particularly concerning innovative teaching approaches.

Finally, technological and resource limitations were confirmed as a major barrier to effective teaching and learning. Classroom observations indicated a clear shortage of technological equipment and modern teaching aids. Questionnaire responses provided quantitative evidence that many teachers lacked both the necessary digital skills and adequate technological resources. Furthermore, analysis of school development plans showed minimal allocation of funds for technological advancement, confirming that resource constraints hinder the adoption of modern educational practices.

Overall, the validation process demonstrates that the identified challenges are not isolated perceptions but are supported by consistent evidence across multiple data sources. The triangulation of questionnaires, interviews, observations, and document analysis strengthens the reliability of these findings and highlights the urgent need for strategic interventions to address these systemic and instructional limitations within the SBDP framework.

4.4 Strategies - Analysis of Strategies and Data Validation

The strategies proposed in this study were developed directly in response to the validated challenges identified through quantitative and qualitative data analysis. Each strategy is evidence-based and aligned with the findings derived from questionnaires, interviews, classroom observations, and document analysis.

The first strategy, planning and goal setting, addresses the absence of clearly structured and actionable school plans. Document analysis of existing school development plans revealed gaps in long-term planning, measurable targets, and structured implementation frameworks. Therefore, strengthening planning mechanisms ensures that the SBDP becomes a strategic and goal-oriented document rather than a routine administrative requirement.

The second strategy, creating a supportive learning environment, responds directly to the issue of low student engagement. Classroom observations and teacher interviews consistently highlighted limited student participation and passive learning behaviors. By improving

classroom conditions, promoting inclusive practices, and fostering positive teacher–student relationships, schools can enhance student motivation and active involvement in learning.

The third strategy focuses on teacher training and professional development. Questionnaire data and interview responses clearly indicated gaps in pedagogical skills, modern instructional strategies, and assessment literacy. Continuous professional development programs are therefore essential to strengthen teacher competency and improve classroom effectiveness. This strategy directly addresses the skill gaps identified in the study.

The fourth strategy emphasizes enhancing student engagement through diverse teaching methods. Observations and teacher interviews revealed a reliance on traditional instructional approaches with limited methodological variation. Introducing interactive, student-centered, and technology-supported teaching strategies can increase engagement and promote higher-order thinking skills.

The fifth strategy, improving assessment and feedback systems, responds to the identified reliance on traditional examination-based assessment methods. Questionnaire data and document analysis of assessment policies confirmed limited use of formative assessment practices. Strengthening feedback mechanisms and incorporating alternative assessment methods will allow for a more comprehensive evaluation of student learning outcomes.

The sixth strategy focuses on strengthening parent and community engagement. Both questionnaire findings and interviews with school leaders demonstrated low levels of parental cooperation and involvement. Increasing awareness programs, improving communication channels, and creating collaborative platforms can enhance stakeholder participation and support the effective implementation of the SBDP.

Finally, monitoring and evaluation mechanisms are proposed to address the lack of a systematic feedback and accountability framework. The synthesis of all data sources revealed insufficient monitoring of implementation progress. Establishing structured evaluation procedures will ensure continuous improvement, transparency, and evidence-based decision-making within schools.

Overall, the proposed strategies are strongly supported by empirical evidence collected in this study. The alignment between identified challenges and recommended

interventions demonstrates a coherent and systematic approach to improving the effectiveness of the SBDP.

These strategies collectively aim to strengthen teaching practices, enhance student learning outcomes, and ensure sustainable institutional development.

FINDINGS

Analysis of Teaching-Learning Practices under the SBDP

The findings reveal that the School-Based Development Plan (SBDP) emphasizes the importance of aligning the curriculum with student needs and national educational standards. Schools are encouraged to evaluate existing curricular structures and propose necessary modifications to improve relevance and effectiveness. Additionally, the review of current assessment methods is identified as a priority to ensure that student learning progress is accurately measured and meaningfully interpreted.

The study also highlights the need for continuous teacher professional development. Training opportunities are essential to update teachers on innovative teaching strategies, modern assessment techniques, and curriculum revisions. Furthermore, the SBDP stresses the importance of providing adequate learning resources, including textbooks, computers, and internet access, to support effective teaching and learning. Parental involvement is another critical component emphasized within the SBDP framework, as active parent participation in school activities contributes significantly to student academic success.

Relationship Between Teaching-Learning Practices and Student Learning Outcomes

The statistical analysis indicates positive relationships between teaching–learning practices under the SBDP and student examination performance. For the Advanced Level (A/L) pass rate, the Pearson correlation coefficient ($r = 0.597$) demonstrates a moderate to strong positive relationship. This suggests that improved teaching–learning practices are associated with higher A/L pass rates. However, the p-value of 0.106 exceeds the 0.05 significance level, indicating that the relationship is not statistically significant despite the positive trend.

In the case of the Ordinary Level (O/L) pass rate, the Pearson correlation coefficient ($r = 0.391$) indicates a moderate positive relationship. This implies that improvements in teaching–learning

practices may contribute to slight increases in O/L performance. Nevertheless, the p-value of 0.222 is also greater than 0.05, meaning the relationship is not statistically significant.

For the Grade 5 Scholarship examination, the Pearson correlation coefficient ($r = 0.268$) reveals a weak positive relationship between teaching–learning practices and pass rates. The p-value of 0.303 further confirms that this relationship is not statistically significant.

Overall, although none of the relationships reached statistical significance, all correlations were positive. The strongest association was observed with A/L performance. These findings suggest a potential positive influence of structured teaching–learning practices under the SBDP on student outcomes. However, further research with a larger sample size is recommended to confirm the statistical strength of these relationships.

Challenges in Implementing the Teaching-Learning Process under the SBDP

The study identified several significant challenges affecting the effective implementation of the SBDP. A major concern is the insufficient training provided to teachers, particularly in the use of modern teaching strategies and technological tools. Additionally, low student engagement was observed, with some students demonstrating limited enthusiasm for new learning approaches and not receiving adequate individualized attention.

The reliance on traditional assessment methods was also identified as a constraint. Current evaluation systems primarily focus on conventional examinations, which may not effectively measure innovative or skill-based learning outcomes. Furthermore, limited parental and community awareness of new educational approaches reduces external support for school initiatives.

Administrative and financial constraints represent another major challenge. Insufficient funding, limited administrative backing, and the absence of clear policy guidelines hinder effective implementation. The shortage of technological equipment and software further restricts the adoption of modern teaching practices, limiting the full realization of SBDP objectives.

Strategies to Improve the Teaching-Learning Process through the SBDP

Based on the identified

challenges, several strategic recommendations are proposed to strengthen the teaching–learning process under the SBDP. First, schools should establish clear, achievable, and measurable learning goals. Curriculum design, teaching methods, and assessment practices should be fully aligned with these goals to ensure coherence.

Second, diverse instructional strategies such as hands-on activities, collaborative group work, and technology-integrated learning should be encouraged to enhance student engagement and accommodate different learning styles. The effective use of computers, internet resources, and educational software should be promoted, accompanied by appropriate teacher training in educational technology.

Continuous assessment and constructive feedback mechanisms should be strengthened to monitor student progress and inform instructional adjustments. Ongoing professional development programs are necessary to keep teachers updated on emerging teaching tools and pedagogical innovations.

Additionally, schools must ensure the availability of adequate learning resources, including libraries, laboratories, and digital facilities. Strengthening parent and community involvement through structured engagement programs will create a supportive educational environment. Finally, it is essential to establish a safe, inclusive, and supportive learning environment that promotes equity and student well-being.

By implementing these strategies, the SBDP can more effectively achieve its intended goals and contribute to improving the overall quality of education.

POLICY RECOMMENDATIONS AND SUGGESTIONS

The following policy recommendations are derived from the identified challenges and empirical findings of the study. These recommendations aim to enhance the effectiveness of the teaching–learning process through the School-Based Development Plan (SBDP) and ensure sustainable educational improvement.

Teacher Skill Development and Training

Improving teacher competency is fundamental to elevating instructional quality. Continuous professional development programs should be systematically designed and implemented, focusing on lesson planning, innovative teaching strategies, constructivist principles,

student-centered approaches, and modern assessment techniques. Teachers must also receive specialized training in educational technology to effectively integrate digital tools into classroom instruction.

Furthermore, teacher training institutions should modernize their curricula by embedding educational technology, digital pedagogy, and contemporary instructional methodologies into diploma, certificate, and degree programs. Preparing future teachers with technological and pedagogical competence will ensure long-term sustainability in educational reform.

School Administration and Leadership

Effective implementation of the SBDP requires strong administrative leadership. School principals and management team members should receive targeted training on instructional leadership, strategic planning, and the integration of teaching–learning processes within the SBDP framework.

School leaders should cultivate a collaborative culture where teachers, students, and parents actively participate in decision-making processes. Leadership must shift from administrative supervision to instructional guidance, ensuring that classroom practices align with strategic educational goals.

Modernizing Teaching–Learning Processes

To improve student outcomes, schools must move beyond traditional teaching methods. Establishing e-learning hubs in schools, particularly in areas experiencing teacher shortages, can provide flexible learning opportunities and reduce instructional gaps.

Adopting a student-centered approach will encourage active participation, build student confidence, and allow teachers to act as facilitators and mentors rather than solely content transmitters. The use of modern learning aids, such as mobile science laboratories, mobile ICT laboratories, and digital learning platforms, should be expanded to enrich classroom experiences.

Through the SBDP, schools should intentionally develop 21st century skills, including critical thinking, communication, collaboration, and creativity. Traditional, teacher-dominated methods should gradually be replaced with innovative and inquiry-based approaches. Establishing educational field study centers in disciplines such as Science, ICT, and Agriculture can further strengthen experiential learning opportunities.

Planning, Monitoring, and Evaluation

The effectiveness of the SBDP depends heavily on structured planning and systematic monitoring. Schools should establish a dedicated internal unit responsible for coordinating the implementation of teaching-learning activities under the SBDP.

A clear monitoring and evaluation framework must be developed, incorporating both internal and external evaluation mechanisms. Continuous assessment of progress will allow schools to identify emerging challenges and implement timely corrective actions. Research related to teaching and learning should be encouraged during SBDP preparation to strengthen evidence-based decision-making.

At the zonal level, annual research sessions should be conducted to motivate teachers to address instructional challenges and share innovative practices. Such initiatives will promote reflective practice and professional collaboration.

Parent and Community Involvement

Educational improvement cannot be achieved without strong parental and community engagement. Implementing structured programs such as Community-Linked Education Development Programs (CLEDP) and Situational Analysis Education Empowerment Programs (SAEEP) can enhance collaboration between schools and communities.

Increasing parental awareness of educational reforms and the benefits of educational technology will foster mutual understanding between teachers and families. Active parent participation in school activities and decision-making processes will create a supportive environment for effective SBDP implementation.

Overall, the successful implementation of these recommendations will significantly enhance the quality of education in Sri Lankan schools and prepare students to face future academic and societal challenges.

CONCLUSION

This study identified a notable gap between the intended objectives of School-Based Development Plans (SBDPs) and their practical implementation in classroom settings. Although the SBDP framework is strategically designed to improve teaching and learning, its effectiveness is constrained by insufficient funding, limited resources, weak policy execution, and inadequate monitoring mechanisms.

A major finding of the research was the existence of a professional skills gap among teachers, principals, and educational administrators. Limited competence in educational technology, modern pedagogical approaches, and collaborative planning has restricted the successful transformation of classroom practices. The persistence of traditional teaching methods further reflects the need for systematic professional development and institutional reform.

To address these challenges, the study recommends transforming the SBDP from a static administrative document into a dynamic, context-responsive framework embedded in daily classroom activities. Emphasis must be placed on continuous professional development, technological integration, collaborative leadership, and systematic evaluation.

For SBDPs to meaningfully improve student learning outcomes, they must become operational tools guiding instructional practice rather than compliance-based documents. Empowering educators with appropriate skills, ensuring adequate resource allocation, strengthening leadership capacity, and fostering stakeholder collaboration are essential for sustainable educational reform.

FUTURE RESEARCH DIRECTIONS

Future research should consider expanding the sample size to improve statistical power and determine the significance of the relationships identified in this study. Longitudinal studies may provide deeper insights into the long-term impact of SBDP implementation on student achievement.

Further qualitative investigations, including in-depth case studies of high-performing schools, could identify best practices for effective SBDP implementation. Additionally, research focusing on the integration of educational technology and its measurable impact on learning outcomes would be valuable.

Comparative studies across different education zones in Sri Lanka may also help identify contextual variations and policy implications at national and regional levels.

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Integration of 21st Century Skills into Foreign Language Classroom in Sri Lanka

E. M. Thanuja Jayathilaka
Department of Classical, Foreign Languages and Bilingual Education,
National Institute of Education, Sri Lanka

ABSTRACT

The objectives of the study were to identify 21st century skills, to examine whether teachers incorporate these skills into contemporary foreign language classrooms in Sri Lanka, and to explore ways to integrate 21st century skills into foreign language learning. The researcher employed both quantitative and qualitative methods to achieve the research objectives. The population of the study consisted of all Grade 13 students studying foreign languages and all teachers teaching foreign languages at the Advanced Level in Sri Lankan government schools. Simple random sampling was used to select the student sample. Ten students were selected from each foreign language Japanese, French, Hindi, German, Chinese, Korean, Russian and Arabic resulting in a total sample of 80 students. Data were collected using questionnaires and interviews as research instruments. The questionnaire data provided a descriptive overview of students' preferences and experiences related to 21st century skills. Closed-ended questions were used to gather information on the integration of 21st century skills into foreign language learning. In addition, interviews were conducted with eight selected foreign language teachers. The results of the data analysis revealed a slightly satisfactory level of integration of 21st century skills in foreign language classrooms. The findings also indicated that teachers generally recognized the need for greater awareness and understanding of 21st century skills. Although the results showed positive integration of creativity, critical thinking, and life skills, further efforts are required to ensure more effective and consistent integration of these skills in foreign language lessons. The findings and discussion further revealed an unsatisfactory level of integration of collaboration, communication skills and information, media, and technological literacy skills in foreign language classrooms. Based on the results, it can be concluded that the Government of Sri Lanka, school principals and teachers should enhance their awareness of 21st century skills and take necessary steps to integrate these skills into foreign language learning and the broader education process. It is essential for educational leaders and teachers to continuously support the implementation of 21st century skills in foreign language education and to help students acquire and develop these competencies.

Keywords: Integration, 21st century skills, Foreign Language learning, classroom

INTRODUCTION

In today's rapidly changing world, it is essential for individuals to possess skills that are relevant to contemporary societal and professional demands. These skills, commonly referred to as *21st century skills*, are abilities that enable individuals to function effectively and successfully in the modern world. The term *21st century skills* encompasses a broad range of competencies, including critical thinking, problem-solving, communication, collaboration, creativity, digital literacy, and global awareness. The twelve commonly recognized 21st century skills include critical thinking, creativity, collaboration, communication, information literacy, media literacy, technology literacy, flexibility, leadership, initiative, productivity, and social skills.

In an increasingly fast-paced and technology-driven global context, the importance of 21st century skills cannot be overstated. As globalization continues to influence economic and social structures, individuals must develop these competencies to succeed in both personal and professional spheres. Unlike traditional educational approaches that emphasized rote memorization, 21st century skills focus on practical application, real-world problem solving and adaptability. As society progresses further into the 21st century, it has become evident that these skills are essential for success across all aspects of life. In the contemporary job market, employers seek individuals who possess a diverse set of skills that extend beyond traditional academic knowledge. Competencies such as critical thinking, creativity, effective communication, collaboration, digital literacy, and global awareness are highly valued. Consequently, possessing only academic qualifications is no longer sufficient; employers increasingly require individuals who can adapt to dynamic work environments, think critically, and collaborate effectively with people from diverse backgrounds.

Although there is widespread agreement regarding the importance of 21st century skills in education, there is less consensus on which specific skills should be prioritized. Various frameworks and models present different lists and classifications, resulting in considerable variation in the descriptions of the knowledge, attitudes and skills required (Ledoux et al., 2013). Despite these variations, a literature review conducted by Voogt and Pareja Roblin (2010) identified a set of commonly emphasized skills based on five major models of 21st century

skills: The Partnership for 21st Century Skills (P21), Assessment and Teaching of 21st Century Skills (ATCS), National Educational Technology Standards (NETS), and the Technological Literacy Framework for the 2012 National Assessment of Educational Progress (NAEP). In addition, their review examined recommendations proposed by international organizations, including the European Union (2006), the Organisation for Economic Co-operation and Development (OECD) (2004, as cited in Ananiadou & Claro, 2009), and UNESCO (2008).

The models examined by Voogt and Pareja Roblin (2010) have been further expanded in various contexts, each with differing objectives and frameworks. These frameworks prioritise different skills, which influence the perceived importance of each competency. Moreover, the categorization of 21st century skills varies across models. A notable limitation is that educational levels or instructional contexts are often not explicitly specified. Instead, the primary emphasis is placed on defining and understanding the skills themselves rather than on pedagogical approaches for teaching them.

Despite these differences, several commonalities can be identified across the models. All frameworks include higher order thinking skills, such as creativity, critical thinking and problem solving. Many also emphasize self-awareness and self-regulation. In addition, shared competencies include communication, digital literacy, and social skills. The models further acknowledge the importance of collaboration, responsible citizenship, and self-management. Although there is some variation in the treatment of personal skills such as time management and self-directed learning, the underlying focus remains on individual responsibility and the effective completion of tasks.

Voogt and Pareja Roblin (2010) finally note that the skills mentioned across all models include collaboration, communication, the use of ICT and social and cultural awareness, including citizenship. Furthermore, most models also emphasize creativity, critical thinking, problem solving skills and productivity. In addition, some models highlight self-regulation, learning to learn (metacognition), planning, flexibility and adaptability. Based on the literature review conducted by Voogt and Pareja Roblin (2010), eight key 21st century skills can be identified as particularly important: creativity, critical thinking, problem solving, communication, collaboration, digital literacy, social and cultural

skills and self-regulation (Authors, 2014).

Creativity: This skill involves generating novel ideas, examining them critically and further developing them. It requires a curious and entrepreneurial mindset, the ability to think beyond conventional boundaries and the capacity to recognize new connections.

Critical Thinking: This skill enables individuals to form independent judgments based on reliable evidence. It involves effective reasoning, interpretation and synthesis of information, as well as the ability to identify knowledge gaps, pose meaningful questions and reflect critically on one's own learning process.

Problem Solving: This skill involves identifying problems and developing appropriate plans to address them. It requires the ability to define, analyse and resolve problems, as well as to generate, evaluate and select suitable problem solving strategies.

Communication: This skill involves conveying and receiving information clearly and effectively. It requires goal-oriented communication, active listening, and the ability to identify the core message. It also includes managing various communication contexts, such as interviews, presentations, and debates, and using different media such as text, images, and videos to communicate effectively.

Collaboration: This skill involves working with others to achieve a common goal while complementing and supporting one another. It requires recognizing individual roles and responsibilities, seeking and offering assistance when needed and maintaining a positive and open attitude toward diverse perspectives.

Digital Literacy: This skill refers to the effective, efficient and responsible use of information and communication technology (ICT). It includes basic ICT competencies, computational thinking, media literacy, and information literacy.

Social and Cultural Skills: These skills involve learning effectively and interacting appropriately with individuals from diverse ethnic, cultural and social backgrounds. They require respectful communication in various social contexts, awareness of social norms and codes of conduct, constructive expression of emotions and empathy and concern for others.

Self-Regulation: This skill involves engaging in goal oriented behaviour. It requires setting realistic goals and priorities, carrying out goal-directed

activities (such as maintaining concentration, demonstrating self-motivation and working independently) and monitoring progress through planning and effective time management.

There is an ongoing debate regarding whether 21st century skills are genuinely new. It can be argued that the skills themselves are not new; rather, the significance attributed to them is relatively recent. This increased emphasis has created a need to approach these skills in a more structured and purposeful manner (Authors, 2014).

The true value of skills becomes evident when they are applied in practice. Traditional approaches are no longer sufficient in today's rapidly changing world. Addressing complex issues and social challenges requires innovative and creative solutions that bring together individuals from diverse fields of expertise. This, in turn, demands new ways of thinking and problem solving. Students must be able to think creatively and "outside the box" in order to identify new connections and select the most appropriate solutions for specific situations.

In the contemporary global context, education must respond to the evolving demands of the 21st century job market. Employers increasingly seek individuals who can think independently, collaborate effectively and solve problems efficiently. The rise of social media and digital technologies has transformed the ways in which information is shared and communication occurs. Consequently, educational systems must incorporate new competencies to prepare students for participation in the modern workforce. To ensure student success, schools and universities need to revise their curricula to include essential 21st century skills, which are highly valued in professional environments.

Similarly, foreign language education must adapt to the changing needs of learners. Globalization and technological advancement have significantly transformed language teaching and learning processes. As Eaton (2010) notes, the focus of language education in the twenty-first century is no longer limited to grammar, memorization, and rote learning, but rather emphasizes the use of language and cultural knowledge as tools for communication and global connection. Therefore, foreign language classrooms should prioritise the development of a broad range of competencies that support students' overall success.

The concept of 21st century skills encompasses higher-order thinking processes such as creativity, problem

solving, decision making, self-awareness, critical thinking and the ability to access and analyze information. In addition, these skills include learning and employability competencies, such as ICT literacy, adaptability, collaboration, communication, motivation and time management. Social competencies including citizenship, responsibility and cultural awareness are also recognized as integral components of 21st century skills (Voogt & Roblin, 2010). These competencies are essential for enabling students to thrive in an increasingly globalized world. While traditional language components such as grammar and vocabulary remain important, they should be integrated with these broader competencies.

Johnson (2006) emphasizes that foreign language teacher education should focus on teachers as users and creators of legitimate knowledge who make informed decisions about how best to teach within socially, culturally and historically situated contexts. Accordingly, foreign language teacher education must respond to societal changes and evolving educational expectations. With the growing emphasis on integrating 21st century skills into curricula, these skills have been conceptualized as cross-curricular competencies that underpin core subjects and contribute to the development of broader key competencies (Voogt & Roblin, 2010).

The effective integration of 21st century skills requires changes in teaching methodologies, assessment practices and evaluation procedures, as well as continuous professional development for teachers. Educators must be adequately trained to incorporate these skills into instructional strategies and assessment methods and to understand their relevance to subject content. Although this shift represents a significant transformation in foreign language education, it is essential for preparing students to succeed in the modern world.

1.1 Statement of the problem

The contemporary era is increasingly driven by knowledge and skills, with nations competing based on the competencies of their workforce. In this context, employees require more than foundational knowledge; they must possess advanced skills to succeed in complex and dynamic environments. Higher order thinking skills, such as critical thinking and problem solving, are particularly valued in today's workplaces. Therefore, education systems are expected to equip learners with the competencies necessary to thrive in the 21st century.

However, a significant gap exists between what students learn in school and the skills required for real-life situations. The existing foreign language curriculum is no longer fully adequate to prepare students for life and work in a rapidly evolving, technology driven world. Research indicates that learners are not sufficiently developing 21st century skills, largely because these competencies are not systematically fostered within instructional practices (Alemi & Daftarifard, 2010).

In the context of foreign language education in Sri Lanka, it can be observed that students are often not provided with sufficient opportunities to acquire the skills needed for real-world situations. Foreign language programs tend to emphasize traditional language components, which may not adequately support the development of higher-order thinking skills and other essential 21st century competencies.

Accordingly, this study seeks to examine the literature on 21st century skills, investigate their presence within foreign language classrooms in Sri Lanka, and explore ways in which these skills can be effectively integrated into foreign language learning. By addressing this issue, the research aims to bridge the gap between current instructional practices and the competencies required for active participation in the global economy and increasingly complex societies. Ultimately, this study attempts to contribute to the academic discourse by proposing strategies for incorporating 21st century skills into foreign language education, thereby enhancing the overall quality and relevance of language learning practices.

1.2 Objectives of the study

The main objective of this study is to examine the integration of 21st century skills into foreign language education in Sri Lanka.

The specific objectives are to:

1. identify and analyze the key 21st century skills highlighted in the literature;
2. examine the extent to which 21st century skills are incorporated into foreign language classrooms in Sri Lanka;
3. explore effective strategies for integrating 21st century skills into foreign language teaching and learning.

1.3 Research questions

This study seeks to answer the following research questions.

1. What are the key 21st century skills identified in the literature?
2. To what extent are 21st century skills incorporated into foreign language classrooms in Sri Lanka?
3. What strategies can be used to effectively integrate 21st century skills into foreign language teaching and learning?

1.4 Significance of the study

In today's globalized world, multilingual competence and intercultural understanding are highly valued skills, making foreign language education essential for students' academic and professional success. However, traditional language teaching approaches must evolve to incorporate innovative methods that integrate language learning with culture, technology, and essential 21st century skills. This study is significant because it contributes to a clearer understanding of 21st century skills such as critical thinking, problem solving, collaboration and digital literacy and demonstrates how these competencies can be effectively integrated into foreign language classrooms. By examining teachers' perceptions and experiences, the study promotes greater awareness of the importance of these skills and encourages reflective teaching practices that go beyond the development of linguistic competence alone. The findings will assist teachers in designing instructional strategies and assessment methods that foster both language proficiency and higher-order thinking skills, thereby better preparing students for academic achievement and participation in the modern workforce. Moreover, the results may inform curriculum developers and policymakers in designing foreign language programs that systematically incorporate 21st century skills. Ultimately, this study aims to support schools in equipping students with the competencies necessary to thrive in an increasingly interconnected and rapidly changing global environment.

LITERATURE REVIEW

Twenty firstcentury skills refer to a set of abilities and competencies considered essential for individuals to thrive in a modern, rapidly changing and increasingly complex world. These skills extend beyond traditional academic knowledge and encompass a broader range of competencies that enable individuals to adapt, innovate and succeed in personal, social, and professional contexts. Ledward and Hirata (2011) define 21st century skills as a blend of content knowledge, specific skills,

expertise and literacies required for success in work and life.

Pearson (2013) categorizes 21st century skills into three main groups: learning and innovation skills; information, media and technology skills; and life and career skills. Similarly, the Partnership for 21st Century Skills (P21) developed a comprehensive framework outlining the competencies students need to succeed in today's world. According to this framework, students should develop as critical thinkers, problem solvers, innovators, effective communicators, self-directed learners and individuals who are information and media literate, globally aware, civically engaged and financially and economically literate. The Partnership emphasizes that the foundation of 21st century learning lies in core academic subject knowledge, upon which additional competencies Learning Skills, Life Skills and Literacy Skills must be built.

Learning Skills: (often referred to as the "Four Cs"): critical thinking, communication, collaboration and creativity.

Life Skills: flexibility, initiative, social skills, productivity and leadership.

Literacy Skills: information literacy, media literacy and technology literacy.

Trilling and Fadel (2009) similarly identify twelve essential skills that are critical to students' academic and professional advancement. These include critical thinking, creativity, communication, collaboration, information literacy, technology literacy, media literacy, flexibility, leadership, productivity, initiative and social skills. Scholars widely recognize these twelve competencies as core components of 21st century skills. These skills are intended to help individuals, particularly students, adapt to dynamic and rapidly evolving labor markets. Each competency plays a distinct role in preparing learners to function effectively in a globalized and technologically advanced era (Farrah, 2020).

Critical Thinking

Critical thinking is widely regarded as one of the most essential 21st century skills. It is defined as reasoned and fair judgment that involves the application of logic and careful analysis (Farrah, 2020). Rather than relying on habitual or unexamined reasoning, critical thinking requires individuals to question assumptions, evaluate arguments and examine the logic underlying conclusions. According to Farrah (2020), critical thinking

enables students to recognize alternative interpretations of issues, events and cases, thereby strengthening their ability to form well informed opinions. She further describes critical thinking as a cognitive process that involves using the mind effectively and objectively. As such, it provides a systematic approach to addressing doubts and uncertainties, ultimately supporting more effective decision making. The integration of critical thinking into educational practice requires more than simple classroom participation; it demands engagement in inquiry based and problem solving activities that encourage students to actively discover and evaluate information.

Creativity

In contemporary society, there is an increasing demand for creative solutions across various sectors, including business, government and education. Creativity refers to the ability to generate new ideas and develop innovative methods to analyze, elaborate and expand upon them. This skill requires an entrepreneurial mindset and the capacity to think "outside the box." It also involves recognizing new relationships and connections, as well as engaging in brainstorming processes. Creativity often depends on a willingness to take risks, make mistakes, and view errors as valuable learning experiences (Voogt & Roblin, 2010). Traditionally, creativity in foreign language teaching has been associated with the use of creative texts such as poetry, songs, and literature (Jones & Richards, 2016). However, creativity extends beyond these applications. Chastain (1975) explains that a central objective of creativity in language learning is to motivate and engage learners. Richards (2013) further notes that creative language activities are typically student-centered and interaction-based. open-ended tasks, in particular, promote learner autonomy and encourage creative thinking and behaviour.

Communication

Communication is regarded as the effective and efficient exchange of messages. More specifically, it refers to a goal oriented process of conveying and receiving information through various modes, including speaking and listening, while identifying the core message. Effective communication also involves managing different communicative situations, such as interviews, presentations and debates and understanding relevant social conventions. Furthermore, communication includes the use of diverse media such as text, images and videos and the application of appropriate strategies to address specific contexts (Voogt & Roblin, 2010).

Collaboration

Collaboration refers to the ability to work effectively with others as part of a team. It involves understanding and working toward a shared goal while supporting fellow team members. Individuals with strong collaborative skills can recognize their own roles and responsibilities as well as those of others, seek and offer assistance when necessary and maintain a positive and open attitude. Collaboration requires respect for others' ideas, the creation of a supportive working environment, and an appreciation of diversity. Through negotiation and mutual agreement, collaborative team members can collectively achieve shared goals and objectives (Voogt & Roblin, 2010).

Information, Technology and Media Literacy

According to the American Library Association, information, media and technology literacies are skills that enable individuals to identify needed information and evaluate and use it effectively. Digital literacy specifically refers to the effective use of Information and Communication Technology (ICT). It includes basic ICT competencies, computational thinking and media and information literacy. Basic ICT skills involve knowledge of computer functions and software, the ability to operate various hardware devices, and the use of standard software on computers and mobile devices. It also includes the ability to navigate the internet safely and an understanding of online security and privacy.

Digital literacy is closely linked to computational thinking, which involves using digital processes to identify, analyze, and solve problems through ICT tools. Media literacy, on the other hand, encompasses the skills and attitudes required for the effective use of media platforms. It includes creating content, participating in social networks, and reflecting critically on one's own opinions and perspectives (Fisser & Thijs, 2015).

Flexibility

Flexibility refers to an individual's ability to adapt effectively to changing circumstances. This competency is essential for long-term professional and academic success. The ability to recognize when change is necessary, determine how to adapt and respond appropriately to new situations is a valuable lifelong skill. Flexible thinking is particularly important for adjusting to new learning environments, transferring knowledge to unfamiliar contexts, and solving novel problems (Spiro & Ramchandran, 2007).

Leadership

Leadership is a skill that can be developed through education and experience. It involves the ability to inspire and guide others, particularly

in challenging situations. Effective leadership includes generating innovative ideas and communicating them in a compelling and motivating manner (Ward, 2019). It also requires the ability to function effectively under pressure and to influence others positively.

Initiative

Initiative refers to the ability to take proactive action beyond assigned responsibilities. In contemporary educational contexts, students are expected to demonstrate productivity by completing tasks efficiently within given timeframes. Individuals who show initiative display a strong motivation to learn, explore and pursue new goals. This quality is highly valued, as it reflects enthusiasm, commitment, and a willingness to take responsibility for personal growth and achievement.

Productivity

Productivity involves the ability to set clear goals, prioritize tasks, manage time effectively and maintain high ethical standards in collaborative work environments. It reflects an individual's capacity to produce quality outcomes efficiently while adhering to professional and ethical expectations.

Social Skills

In the digital era, social interaction has evolved significantly. Students must develop essential interpersonal skills, such as initiating conversations, demonstrating appropriate social behavior, expressing gratitude and practicing responsible online etiquette. These competencies are crucial for successful participation in both personal and professional contexts.

2.1 21st Century Skills and Foreign Language Education

Voogt and Roblin (2010) emphasize the importance of integrating 21st century skills into modern educational systems. In their discussion paper published by the Netherlands Ministry of Education, they examine common issues associated with these skills across different countries and propose evaluation criteria for their implementation. The need to incorporate 21st century skills into education is largely driven by profound global transformations resulting from rapid technological advancements. These changes significantly affect not only how individuals live and work but also how they acquire knowledge and interact with others. The authors argue that this shift is primarily rooted in the transition from an industrial based society to one centered on information and communication technology (ICT). In the industrial era, education focused mainly on transmitting factual and procedural knowledge. In contrast,

the information age requires a more comprehensive educational approach that integrates critical thinking, problem solving, digital literacy and other essential 21st century competencies. Similarly, other frameworks highlight the impact of globalization and internationalization on the economy and labor market as major driving forces behind the growing emphasis on 21st century skills (Anderson, 2008). This societal transformation requires individuals to become more flexible and adaptable in an increasingly dynamic and complex world (Aceto, Doni, & Marzotto, 2010).

In the Sri Lankan school system, eight foreign languages French, Japanese, Hindi, Korean, German, Chinese, Russian and Arabic are taught at the Ordinary Level (O/L) and Advanced Level (A/L), beginning in Grade 10. Eaton (2010) argues that contemporary foreign language classrooms should move beyond a traditional focus on grammar instruction, memorization and rote learning. Instead, language classrooms should serve as spaces where learners use language and cultural knowledge to connect meaningfully with others around the world.

To achieve this goal, foreign language educators must design learning activities that engage students in authentic tasks and real world problem solving experiences. Warschauer (2001) suggests that such engagement can be facilitated through complex project based work that involves negotiation, collaboration, goal setting, meaningful communication and problem solving. Therefore, students need to develop new forms of foreign language literacies, including emerging modes of communication, reading and writing through online technologies. Warschauer (2001) further advocates for learner centered collaborative projects in which students interact with peers locally and globally using various technological tools.

Chang and Tung (2009) argue that foreign language students should not be limited to short-term assignments focused solely on memorization or translation exercises. Instead, they recommend project based learning as an effective strategy for developing essential skills such as critical thinking, problem solving, and decision making. This approach encourages students to work independently over extended periods to produce meaningful outcomes, such as presentations or projects, while teachers assume the role of facilitators who provide guidance and constructive feedback. Project based learning, therefore, offers a practical framework for integrating 21st century skills into foreign language education.

Furthermore, Black (2009) asserts that foreign language instruction should incorporate new technological tools and multimodal forms of communication to enhance both language proficiency and digital literacy. She suggests integrating digital platforms such as instant messaging, social media, digital storytelling, and media redesign activities into language learning. These practices enable students to engage creatively with popular culture and authentic texts while developing the ability to communicate effectively in digital environments through the integration of text, images and audio.

Overall, the integration of 21st century skills into foreign language education is essential to prepare learners for active participation in a technologically advanced and globally interconnected world.

METHODOLOGY

This study employed a mixed-methods research design to investigate the integration of 21st century skills in foreign language education in Sri Lanka. The study aimed to identify key 21st century skills, examine whether teachers incorporate these skills into foreign language classrooms, and explore effective ways of integrating them into teaching practices. A mixed methods approach was selected to obtain both quantitative data from students and qualitative insights from teachers, allowing for a more comprehensive understanding of the research problem (Creswell, 2014).

The participants consisted of 80 Advanced Level (Grade 13) students studying eight different foreign languages across selected schools in seven provinces of Sri Lanka, along with eight foreign language teachers. Quantitative data were collected through a structured questionnaire administered to students. The questionnaire included demographic questions and closed-ended items based on a three-point Likert scale to examine students' perceptions of classroom practices and the incorporation of 21st-century skills such as critical thinking, collaboration, communication, creativity and digital literacy.

Qualitative data were collected through semi structured interviews with eight foreign language teachers. The interviews included open-ended questions focusing on how teachers integrate 21st century skills into their daily teaching and the challenges they face in doing so. Due to practical constraints, interviews were conducted via telephone and in the participants' native language to ensure clarity and comfort. The responses were transcribed and

analyzed using thematic analysis to identify key patterns and themes.

Quantitative data were analyzed using descriptive statistics, including frequencies and percentages, while qualitative findings were coded and categorized into themes. The combination of both methods enhanced the reliability and validity of the study by allowing comparison and triangulation of findings.

Although the study was limited to selected schools in seven provinces, the centralized education system in Sri Lanka supports the relevance of the findings. Overall, this methodology enabled a focused examination of how 21st century skills are incorporated into foreign language teaching and learning contexts.

FINDINGS AND DISCUSSION

4.1 Findings Based on Student Questionnaire

This section presents the findings obtained from the questionnaire administered to 80 Grade 13 students studying eight foreign languages. The analysis focuses on how frequently students are given opportunities to develop 21st century skills in their foreign language classrooms. The results are organized according to the research questions and key skill categories. Percentages were calculated by assigning values of 1 (No), 2 (Slightly), and 3 (Always), and converting total scores into percentages using Microsoft Excel.

4.1.1 21st Century Skills Are Reflected in Foreign Language Classrooms

The questionnaire examined six major categories of 21st century skills: creativity, critical thinking, collaboration, communication, information/media/technology literacy and life skills. The results indicate that these skills are present in foreign language classrooms to varying degrees.

Table 1: Development of creativity

Statement	Always (3)	Slightly (2)	No (1)	Max. Score	Total Score	Percentage
a.I get the opportunity to create simple poems and	(34) 42%	(20) 26%	(26) 32%	240	168	70%

stories in target language.						
b..I get the opportunity to create concept maps according to a given topic.	(12) 15%	(16) 20%	(52) 65%	240	120	50%
c. I get the opportunity to present my own ideas according to a given topic or a situation.	(18) 22%	(51) 64%	(11) 14%	240	167	69.58%
d. I get the opportunity to create dialogs according to a given theme or a situation	(27) 34%	(53) 66%		240	187	77.91%
e. I get the opportunity to generate my own solutions about how to confront a problem or question related to language teaching – learning process	(66) 82%	(10) 12%	(4) 6%	240	222	92.5%

Creativity shows a relatively strong presence. Students reported high opportunities in generating their own solutions (92.5%) and creating dialogues (77.91%). Opportunities to write poems or stories (70%) and present personal ideas (69.58%) were moderately high. However, concept mapping activities received a lower percentage (50%), indicating that some creative strategies are less emphasized.

Table 2: Development of critical thinking

Statement	Always (3)	Slightly (2)	No (1)	Max. Score	Total Score	Percentage
a. I get the opportunity to compare information from different sources before completing a task or assignment.	(18) 22%	(54) 68%	(7) 10%	240	169	70.41%
b. I get the opportunity to draw my own conclusions based on analysis of numbers, facts, or relevant information.	(19) 24%	(45) 56%	(16) 20%	240	163	67.91%
c. I am asked to summarize or create my own interpretation of what I have read or been taught.	(15) 18%	(27) 34%	(38) 48%	240	137	57.08%
d. I get the opportunity to develop a	(13) 16%	(67) 84%	-	240	173	72.08%

persuasive argument or express my view related to a given topic.						

Critical thinking skills are moderately incorporated. Students reported opportunities to compare information from different sources (70.41%), draw conclusions (67.91%), and develop persuasive arguments (72.08%). However, summarizing or interpreting lessons independently recorded a lower percentage (57.08%), suggesting that reflective thinking activities need greater emphasis.

Table 3: Development of collaboration

Statement	**Always (3)**	**Slightly (2)**	**No (1)**	**Max. Score**	**Total Score**	**Percentage**
a.I get the opportunity to work in pairs or small groups to complete a task together.	(20) 25%	(20) 25%	(40) 50%	240	140	58.33%
b. I get the opportunity to work with other students to set goals and create a plan for our team.	(14) 18%	(36) 45%	(30) 37%	240	144	60%
c. I get the opportunity to present our group work to the class, teacher or others.	(10) 12%	(16) 20%	(54) 68%	240	116	48.33%
d. I get the opportunity to give feedback to peers or	-	(10) 12%	(70) 88%	240	90	37.5%

assess other students' work.						

Collaboration skills appear less effectively integrated. Opportunities to work in pairs or groups (58.33%) and set group goals (60%) were moderate. However, presenting group work (48.33%) and giving peer feedback (37.5%) were significantly low. This indicates limited structured collaborative learning practices in foreign language classrooms.

Table 4: Development of communication skills

Statement	**Always (3)**	**Slightly (2)**	**No (1)**	**Max. Score**	**Total Score**	**Percentage**
a.I get the opportunity to structure data for use in written products or oral presentations (e.g., creating charts, tables or graphs).	(19) 24%	(51) 64%	(10) 12%	240	169	70.41%
b. I am asked to prepare and deliver an oral presentation to the teacher or others.	(14) 18%	(24) 30%	(42) 52%	240	132	55%
c. I get the opportunity to create dialogs and present with my friends.	(67) 84%	(13) 16%	-	240	227	94.58%
d. I get the opportunity to convey my ideas	-	(11) 14%	(69) 86%	240	91	37.91%

using media other than a written paper (e.g. posters, video, blogs, etc.)						
e. I am asked to answer questions in front of an audience	(59) 74%	(21) 26%	-	240	219	91.25%

Communication skills show mixed results. A high percentage of students reported creating dialogues (94.58%) and answering questions in front of an audience (91.25%). However, only 55% reported preparing oral presentations, and very few students had opportunities to use alternative media such as videos or blogs (37.91%). This suggests that traditional speaking activities are common, but multimodal communication is limited.

Table 5: Development of information, media and technology literacy skills

Statement	**Always (3)**	**Slightly (2)**	**No (1)**	**Max. Score**	**Total Score**	**Percentage**
a. I get the opportunity to use technology or the Internet for self-learning for my language development.	(21) 26%	(22) 28%	(37) 46%	240	144	60%
b. I get the opportunity to select appropriate technology tools or resources for completing a task.	(18) 22%	(43) 54%	(19) 24%	240	159	66.25%

c. I get the opportunity to use online technology.	(13) 16%	(22) 28%	(45) 56%	240	128	53.33%
d. I get the opportunity to use the technology like Data base, Graphic programs when analyzing information.	(7) 08%	(19) 24%	(54) 68%	240	113	47.08%
e. I get the opportunity to do multi-media presentations related to various language activities .	-	(10) 12%	(70) 88%	240	90	37.5%
f. I am instructed to use technology such as email, social media to share information to support team work.	(8) 10%	(14) 18%	(58) 72%	240	110	45.83%

Information, media, and technology literacy skills show comparatively lower levels of integration. While 60% reported using technology for self-learning and 66.25% selecting appropriate technology tools, opportunities for multimedia presentations (37.5%), database usage (47.08%), and online collaboration (45.83%) were limited. These findings suggest insufficient technological integration in foreign language instruction.

Table 6: Development of life skills

Statement	Always (3)	Slightly (2)	No (1)	Max. Score	Total Score	Percentage
a.I am instructed to listen to and respect others' views	(80) 100%	-	-	240	240	100%
b. I try to develop the ability of enduring victory and defeat in the same way in learning activities.	(80) 100%	-	-	240	240	100%
c. I am motivated to be patient working with peers in group activities and not to make conflicts.	(80) 100%	-	-	240	240	100%
d. I get the opportunity to be a leader for the group in group activities at various occasions.	(15) 18%	(22) 28%	(43) 54%	240	132	55%

e. I try to design plans, direct and control others, entrust duties as a leader to complete a given task.	(13) 16%	(38) 48%	(29) 36%	240	144	60%
f. I am motivated to initiate and complete given tasks on time.	(80) 100%	-	-	240	240	100%
g. I am motivated to maintain time management in completing an exercise, activity or assignment.	(80) 100%	-	-	240	240	100%
h. I respect my teacher.	(80) 100%	-	-	240	240	100%
i. I try to be kind and show affection to others.	(80) 100%	-	-	240	240	100%

Life skills demonstrate the strongest presence. All students (100%) reported being encouraged to respect others, manage time, complete tasks responsibly, and maintain positive attitudes. However, leadership opportunities were less frequent, with only 55% - 60% reporting chances to act as group leaders or manage tasks. Although moral and behavioral aspects are strongly emphasized, practical leadership experience is comparatively limited.

4.1.2 Teachers' Incorporation of 21st Century Skills in Foreign Language Classrooms

Based on student responses, it can be concluded that teachers incorporate certain 21st century skills,

particularly creativity (dialogue creation and problem solving), communication (oral interaction) and life skills (respect, responsibility, time management). However, collaboration and digital literacy skills are not consistently or sufficiently integrated. The findings suggest partial implementation rather than systematic integration of all 21st century competencies.

4.2 Findings Based on Teacher Interviews

To further explore Research Question 3 (How can 21st century skills be integrated into foreign language learning?), interviews were conducted with eight foreign language teachers.

Teachers reported using videos, YouTube, laptops and language laboratories to promote digital literacy. They also incorporate group work to encourage collaboration, leadership and initiative. Creative writing tasks, dialogues and presentations are used to foster creativity and communication skills. Games, songs and puzzles are introduced to make lessons interactive and to enhance critical thinking and problem solving.

However, teachers identified several challenges, including limited access to technology, insufficient internet facilities, a lack of professional training on integrating 21st century skills, time constraints due to examination focused syllabi and inadequate resources. The digital divide among students was also mentioned as a barrier.

The triangulation of questionnaire and interview findings indicates that although teachers are aware of the importance of 21st century skills and attempt to incorporate them, structural and institutional constraints limit full implementation.

CONCLUSION

Twenty first century skills such as collaboration, communication, creativity, critical thinking, problem solving and digital literacy are essential competencies for learners in the information age. This study examined the extent to which these skills are integrated into foreign language teaching and learning in Sri Lanka. The findings reveal a moderate level of integration overall. Positive results were observed particularly in the areas of creativity, certain aspects of critical thinking and the development of life skills such as responsibility, respect and time management.

However, the study also identified several areas requiring improvement. Collaboration, multimodal communication and information, media and technology literacy skills were not consistently or effectively incorporated into classroom practice. Although teachers demonstrate awareness of the importance of 21st century skills

and attempt to apply them, structural limitations hinder full implementation. These challenges include insufficient technological resources, limited access to computers and internet facilities, funding constraints and inadequate professional training for teachers.

Therefore, while foreign language classrooms show potential for fostering 21st century competencies, a more systematic and structured approach is necessary. Strengthening teacher training, improving infrastructure and aligning classroom practices with curriculum objectives are essential steps toward ensuring that students are adequately prepared to meet the demands of a rapidly changing global environment.

SUGGESTIONS

Based on the findings of this study, several recommendations can be proposed to enhance the integration of 21st century skills into foreign language education.

Twenty first century skills should be systematically integrated into the foreign language curriculum, taking into account both global trends and local educational needs. Curriculum designers should ensure that learning outcomes explicitly reflect competencies such as collaboration, critical thinking, creativity and digital literacy.

Professional development programs should be organized to raise teachers' awareness and provide practical training on how to effectively implement 21st century skills in classroom instruction. Continuous in-service training would enable teachers to adopt innovative teaching strategies and technological tools with confidence. Students should be made aware of the importance of 21st century skills and encouraged to take responsibility for their own skill development. Promoting self-directed learning and reflective practices can help students apply these competencies beyond the classroom.

Furthermore, adequate funding and technological resources must be provided to schools to support effective implementation. Access to computers, internet facilities, multimedia tools and language laboratories is crucial for developing information and media literacy skills.

In addition, further research should be conducted to explore best practices and share successful models of integrating 21st century skills into foreign language education. Educational leaders and policymakers should provide ongoing support by promoting a curriculum framework that emphasizes innovation, flexibility and real world readiness.

Finally, there should be a shift in traditional beliefs about foreign language learning from a focus on rote memorization and grammar-based instruction to a more communicative, skill-oriented, and learner centered approach. Such a transformation will better equip

students to succeed academically, professionally and socially in the 21st century

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Enhancing Students' Conceptual Understanding of Chemical Bonds through a Multiple Representational Model

T. M. P. L. Bandara, I. R. Perera
[1]Saralankara College, Hikkaduwa, Sri Lanka
[2]Faculty of Science, University of Peradeniya, Sri Lanka

ABSTRACT

Chemical bonding is one of the most conceptually demanding topics in secondary chemistry education due to its abstract sub-microscopic nature and the need to coordinate macroscopic, sub-microscopic, and symbolic representations. This study investigated the effectiveness of a Multiple Representational Model (MRM) in enhancing Grade 10 students' conceptual understanding of chemical bonding in Sri Lanka. A mixed-method quasi-experimental design was employed with 193 students from a 1AB school in the Southern Province. Students were assigned to experimental and control groups using stratified random sampling based on pre-test performance. The experimental group received instruction based on MRM, while the control group was taught using conventional methods. Quantitative data were analyzed using normalized gain scores, paired sample t-tests, and effect size (Cohen's d), while qualitative data were analyzed thematically. Results indicated a statistically significant improvement in the experimental group ($p < .05$, Cohen's $d = 0.39$), whereas no significant improvement was observed in the control group. Qualitative findings supported these results, showing improved conceptual clarity, engagement, and reduced misconceptions among students exposed to MRM. The findings suggest that MRM is an effective pedagogical approach for teaching chemical bonding at the secondary level.

Keywords: Multiple Representational Model, Chemical Bonding, Conceptual Understanding, Secondary Chemistry Education

INTRODUCTION

1.1 Background

Chemistry is a universal subject that is highly applicable to daily life. However, only a limited number of individuals understand the chemistry underlying these everyday activities. Chemical literacy can be defined as the skills and knowledge required to understand chemistry in a social, democratic, cultural, and utilitarian context (Nuffield Curriculum Projects Centre, 2001).

Gabel (1998) revealed that one of the most common criticisms of chemistry teaching is the lack of connection between chemistry content and the real world and the lived experiences of learners.

Mental Models in Learning Chemistry

A mental model refers to an individual's internal explanation of how something works in the real world. Chemical representations are closely related to chemical concepts and contribute significantly to the development of mental models. These representations consist of three levels. Alex H. Johnstone (1991) argued that the three chemical representations are interconnected.
One of the major problems in chemistry education is students' inability to transfer understanding between the macroscopic level and the submicroscopic level (Nurma Yunita & Hans Dieter, 2017). When the teaching process incorporates the use of models, it supports the development of students' mental models (Chittleborough et al., 2002). Several researchers have indicated that mental models influence students' ability to reason using external representations. Students generally rely on their mental models when engaging in problem-solving tasks.

Misconceptions in Learning Chemistry

Gilbert et al. (1982) revealed that students often hold conceptions that are inconsistent with scientifically accepted views. These conceptions are deeply rooted in students' cognitive structures because they appear reasonable from the learners' perspective. Teaching should begin with children's experiences, as each new classroom experience is organized using existing concepts.

According to Jean Piaget (1971), without explicitly addressing and replacing misconceptions, it is not possible to establish scientifically sustainable concepts. H. Pfundt (1975) emphasized that chemical education should serve as a bridge between students' preconceptions and contemporary scientific concepts.

Understanding chemistry involves assigning meaning to entities that are unseen and intangible (Kozma & Russell, 1997). However, many students tend to memorize chemical concepts without genuinely understanding them (Haidar, 1997; Niaz & Rodriguez, 2000). Non-scientific conceptions negatively affect further learning and hinder students from constructing new ideas consistent with scientifically accepted explanations (Gilbert & Watts, 1983; Griffiths & Preston, 1999). As in other sciences, misconceptions are also common in chemistry (Tan & Treagust, 1999; Nicoll, 2001). For effective teaching and learning to occur, teachers must identify and address students' misconceptions, some of which may differ significantly from scientific explanations.

Chemical bonding is a topic that heavily involves the use of models, ranging from simple conceptual models to sophisticated abstract models that include considerable mathematical complexity. It is widely recognized as a challenging topic in which students develop various alternative conceptions (Noor Dayana et al., 2013).

Within the topic of chemical bonding, students cannot directly observe how atoms or elementary particles are held together or how they interact to form compounds. Misconceptions in this area often arise because students operate primarily in a macroscopic world and struggle to shift between macroscopic and microscopic levels (Noor Dayana et al., 2013). Students' ability to construct effective mental models can be enhanced through the use of appropriate models in the teaching-learning process. According to H. D. Barke (2009), many misconceptions in chemistry do not originate from learners' everyday experiences but rather from science instruction itself.

Misconceptions in Chemical Bonding

Chemical bonding is a broad topic rich in abstract concepts. Teaching chemical bonding at the secondary school level is particularly important because it can either enhance or hinder students' future understanding of chemistry (Anders, 2014).

In the absence of solid conceptual knowledge and effective mental models of chemical bonding, achieving meaningful results in any chemical field or application becomes extremely difficult (Nimmermar, 2014). Common misconceptions related to this topic include the belief that since copper is red, the copper atom must also be red, and the idea that at equilibrium the forward reaction is completed

before the reverse reaction begins (Talanquor, 2006).

A later study on Australian lower secondary school students' mental models of atoms and molecules by Harrison and Treagust (1996) discussed the risk of teachers unintentionally creating misconceptions when using analogies, metaphors, and models without sufficient clarification and discussion.

Chemistry Triplet

It is important to distinguish the three levels of representation of matter described by Johnstone (1982, 1993). The idea that chemical knowledge can be represented in three main ways, macroscopic, submicroscopic and symbolic, commonly known as the Chemistry Triplet, has become paradigmatic in chemistry and science education (Vicente, 2011).

The teaching and learning of chemistry require smooth transitions between these three levels in order to develop conceptual understanding (Clough & Olson, 2007; Taber, 2009). The suggestion that chemical knowledge is generated, expressed, taught, and communicated at these three interconnected levels has been one of the most powerful and productive ideas in chemical education over the past 25 years (Gabel, 1999; Gilbert & Treagust, 2009; Johnstone, 1982).

Johnstone (1982) pointed out that expert chemists are able to view their subject matter simultaneously at the macroscopic, submicroscopic, and symbolic levels.

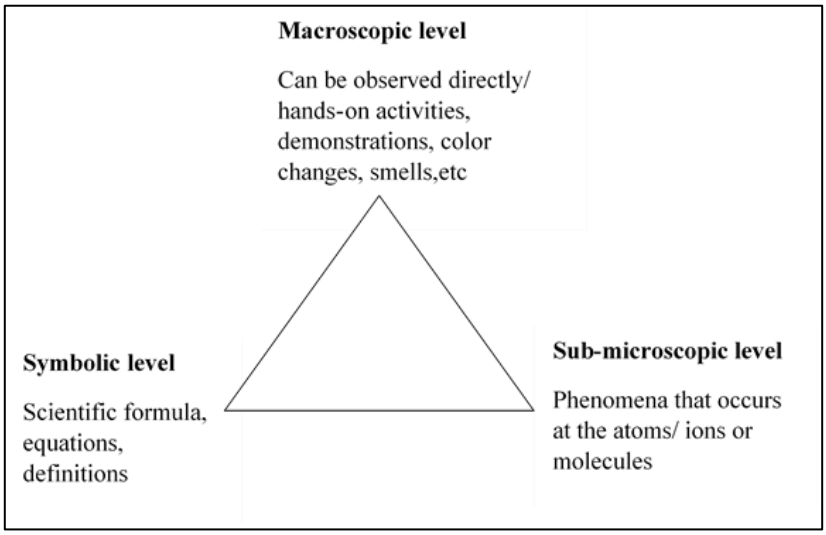

Figure 1: Diagrammatic representation of the Chemistry Triplet

Students frequently experience difficulty when translating between macroscopic phenomena, submicroscopic interactions, and symbolic representations. When representations are interpreted as exact depictions of reality rather than as conceptual tools with specific purposes and limitations, they may unintentionally reinforce misconceptions (Taber, 2009).

The submicroscopic level in chemistry refers to the world of atoms, ions, molecules and related entities. This domain is inherently unobservable and cannot be perceived directly through the senses. Instead, it is accessed through scientific inference, imagination and sophisticated characterization techniques.

As noted by Bucat and Mocerino (2009), submicroscopic phenomena are accessible only through imagination, which highlights the necessity for learners to develop clear conceptual understandings of the relationship between representations and the underlying reality they are intended to describe. The submicroscopic level functions as a bridge between the macroscopic and symbolic levels of chemical representation. However, students may sometimes focus primarily on the surface features of symbolic representations, such as formulas or diagrams, rather than on the actual submicroscopic processes these symbols are meant to represent (Kleinman, Griffin, & Kerner, 1987).

1.2 Research Questions

1. What concepts related to chemical bonding should be taught to Grade 10 students?
2. What misconceptions are associated with chemical bonding?
3. What is meant by the Multiple Representational Model (MRM)?
4. How can this model be applied in the teaching of chemical bonding?

1.3 Objectives of the Study

1. To identify the difficult areas in chemical bonding among Grade 10 students.
2. To determine the effectiveness of the Multiple Representational Model (MRM) in the teaching of chemical bonding.
3. To enhance students' performance in learning chemical bonding.

1.3 Research Hypotheses

Based on the second objective, the following hypotheses were formulated to be tested and either sustained or rejected through data analysis.

H_{01}: There is no significant difference between the mean pre-test and post-test scores of students who studied chemical bonding using the Multiple Representational Model (MRM) and those who studied using the conventional teaching model, when both groups have similar initial capability.

H_{02}: There is no significant difference in the test scores of students taught using the traditional teaching method before and after instruction.

1.4 Significance of the Study

Education plays a vital role in the development of any nation. Therefore, the teaching-learning process at every grade level should be carried out effectively and meaningfully. The G.C.E. Advanced Level (A/L) Examination is the final certification examination of secondary education in Sri Lanka. It also serves as a selection examination for admission to national universities, higher education institutions, vocational training institutes and National Colleges of Education. Furthermore, it is recognized as a qualification for entry into tertiary-level employment.

According to the evaluation report of the Department of Examinations on the G.C.E. (A/L) Examination 2015, several student weaknesses were identified, including difficulties in drawing Lewis structures related to chemical bonding.

When students begin studying chemistry at the Advanced Level, it is essential that they possess a strong foundation in the basic concepts acquired at the G.C.E. Ordinary Level Examination. Many chemistry concepts taught at both secondary school and university levels are grounded in a sound understanding of fundamental principles related to chemical bonding. The literature further indicates that misconceptions associated with this topic are strongly linked to traditional teaching approaches commonly employed in the teaching-learning process.

Students are first introduced to basic concepts of chemical bonding in Grade 10 and continue to study more advanced aspects in Grades 12 and 13. However, students often encounter difficulties in understanding chemistry concepts due to the abstract, unobservable, and particulate nature of the subject. These difficulties are further intensified by the rapid transitions required between the macroscopic, submicroscopic, and symbolic levels of representation, as highlighted by Alex H. Johnstone (1999).

Therefore, this study is significant as it seeks to address these conceptual challenges and improve students' understanding of chemical bonding through a more effective instructional approach.

METHODOLOGY

3.1 Research Design

This study employed a mixed-method approach, integrating a quasi-experimental design with qualitative inquiry. The quantitative component examined the effectiveness of the Multiple Representational Model (MRM) in teaching chemical bonding, while the qualitative component explored students' perceptions, engagement, and conceptual development through structured interviews, classroom observations, and questionnaires. The use of methodological triangulation enhanced the validity and reliability of the findings.

3.2 Population and Sample

The research population consisted of five parallel Grade 10 classes from a 1AB school in the Southern Province of Sri Lanka (School X). A pre-test was administered to all 193 students to assess their initial level of understanding of chemical bonding concepts. Based on the scores obtained in the pre-test, students were classified into three strata according to their prior knowledge levels, namely high, moderate, and low.

Table 1: Students' performance data at the pre-test

Class	Higher Marks (71-100) (Number of students)	Moderate Marks (41-70) (Number of students)	Lower Marks (0-40) (Number of students)	Total number of students
10 A	09	23	06	38
10 B	10	26	03	39
10 C	03	26	09	38
10 D	10	27	03	40

10 E	04	30	04	38
Total	36	132	25	193
Percentage	18.7%	69.4%	12.9%	

Using a stratified random sampling technique, a total of 72 students were selected from the identified strata and equally assigned to the experimental and control groups, with 36 students in each group. To ensure comparable initial capability between the two groups, equal numbers of students from the high, moderate, and low knowledge strata were included in both the experimental and control groups.

Table 2: Student sample for each Experimental and control class/group

Student's Initial Capability						**Total**	
High		Moderate		Low			
Exp.	Ctrl.	Exp.	Ctrl.	Exp.	Ctrl.	Experimental	Control
12	12	12	12	12	12	36	36

Notes: Exp = Experimental group, Ctrl = Control group

Responses to the essay questions were categorized according to the three levels of chemical representation, and the percentage of responses in each category was calculated. The categories were defined as follows: Completely understood, where responses demonstrated full or substantial use of relevant knowledge and were aligned with scientifically accepted concepts; Partially understood, where responses were acceptable but did not fully meet the expected scientific explanation and reflected alternative or incomplete understanding; and Blank response/Wrong understanding, where responses contained incorrect information or showed no evidence of conceptual understanding. Part (ii) of the pre-test was analyzed separately for each stratum (high, moderate, and low) to identify differences in conceptual understanding across representational levels. In addition to the quantitative data collected through pre- and post-tests, qualitative data were gathered through structured interviews, classroom observations, and student

questionnaires. These instruments were designed to obtain insights into students' engagement, perceptions of the instructional methods, and conceptual development during and after the intervention.

Teaching Approach

Lesson plans were prepared to cover the fundamental themes of chemical bonding included in the Grade 10 chemistry syllabus, such as the formation of chemical bonds; reasons for bond formation; cations and anions; electrostatic interactions and ionic bond formation; covalent bonding; Lewis structures for simple covalent compounds; models of ionic and covalent compounds; electronegativity differences and bond polarization; intermolecular interactions in water; and the physical properties of ionic and covalent compounds.

The teaching-learning processes in the experimental and control classes were conducted separately. The experimental group was taught using lesson plans developed in accordance with the Multiple Representational Model (MRM), whereas the control group was instructed using the conventional teaching approach, which primarily emphasized lectures and assignments.

In the control class, the traditional teacher-centered method was applied. Instruction was based on textbook activities and the chalk-and-talk method, delivered by the same teacher to maintain consistency. This approach generally assumes that all students possess similar background knowledge and are capable of learning at the same pace.

Multiple Representational Model (MRM) in the classroom

In contrast, the Multiple Representational Model (MRM) implemented in the experimental classroom integrated macroscopic, submicroscopic, and symbolic levels of representation. The lessons were designed to enhance students' ability to accurately represent chemical bonding phenomena by drawing diagrams, making observations, providing oral explanations, and using symbolic representations. Videos, simulations, and computer-based interactive activities were employed to help students visualize and understand the unobservable submicroscopic level. Students were organized into five-member groups, with one group consisting of six members, and each group was provided with a structured worksheet containing lesson objectives, required materials, and procedural steps. The procedures were explicitly designed to address and connect the three representational levels, thereby

promoting deeper conceptual understanding.

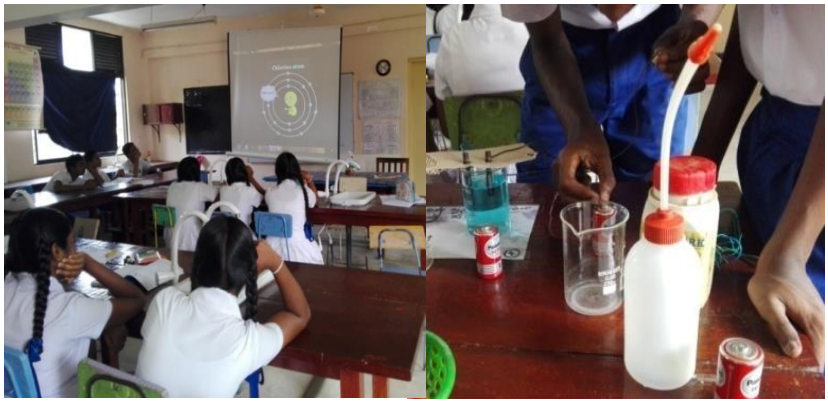

Figure 2: Activities related to the lessons based on MRM

3.3 Data Analysis

Quantitative data were analyzed using descriptive statistics, paired sample *t*-tests, and Cohen's *d* to determine the effectiveness of the instructional intervention. Descriptive statistics, including mean, standard deviation, and standard error of the mean, were used to summarize students' pre-test and post-test scores. The paired sample *t*-test was conducted to examine whether there was a statistically significant difference between pre-test and post-test performances within each group. Effect size was calculated using Cohen's *d* to determine the magnitude of the intervention effect.

Qualitative data obtained through interviews, classroom observations, and questionnaires were analyzed using thematic analysis. Emerging themes were identified to explore patterns related to students' engagement, clarity of conceptual understanding, and attitudes toward the teaching-learning process.

Normalized Gain

The concept of normalized gain was introduced by Richard Hake (1998) as a measure of instructional effectiveness in promoting conceptual understanding. It is commonly described as the proportion of content learned relative to the maximum possible improvement. First, the individual gain score (g) was calculated for each student. Subsequently, the average gain score ($\langle g \rangle$) was computed for each stratum. The normalized gain was calculated using the following formula.

$$\langle g \rangle = \frac{(\%\ Post\ assessment - \%\ Pre\ assessment)}{(100\% - \%\ Pre\ assessment)}$$

The criteria of ‹g› score is,

- If ‹g› >0.7- the course with "high" ‹g› score
- If 0.3< ‹g› ≤ 0.7-the course with "moderate" ‹g› score
- If ‹g› ≤ 0.3- the course with "low" ‹g› score (Hake, 2002)

This measure provided an estimate of the extent to which students improved relative to their initial performance level.

RESULTS AND DISCUSSION

Students' Performance at the Pre-test

Based on the pre-test scores, the majority of Grade 10 students across the parallel classes (132 out of 193) fell into the moderate knowledge stratum (Figure 3). This classification provided a baseline understanding of students' initial capabilities in chemical bonding.

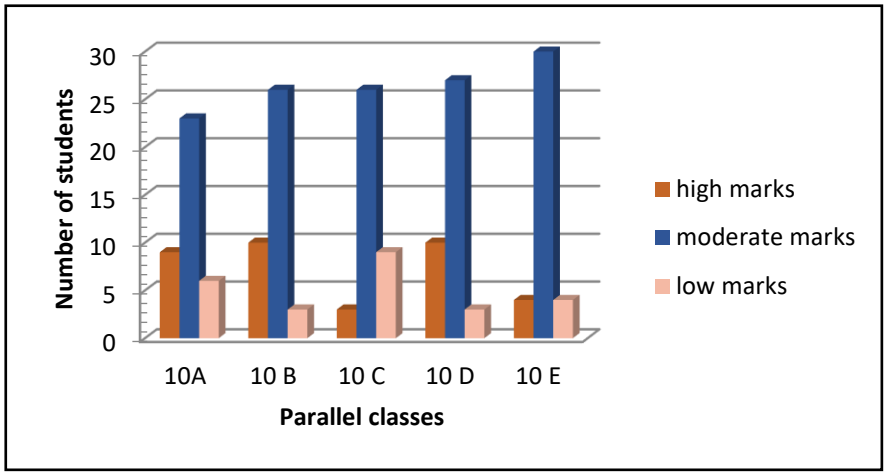

Figure 3: Students' performance of the pre-test

Normalized Gain (N-gain)

The average normalized gain scores for the high, moderate, and low strata in the experimental group were higher than those in the control group, despite both groups having similar initial capabilities (Table 3). This suggests that the improved performance in the experimental group may be attributed to the use of the Multiple Representational Model (MRM) in teaching. To determine whether this observed difference was statistically significant, a paired sample *t*-test was conducted.

Table 3: Average gain scores of the students in experimental and control groups

Category	Experimental group	Control group
High	0.499	0.214
Moderate	0.269	0.064
Low	0.074	0.052

The pre-test and post-test scores were summarized using mean and standard deviation to provide an overview of students' performance. Since the test scores are continuous data, the paired sample *t*-test was applied to compare the means of the related samples, that is, the pre-test and post-test scores of the same students. This statistical test evaluates whether the mean difference between the paired observations is significantly different from zero, thereby indicating whether the teaching intervention had a measurable effect on student learning (Table 4).

Table 4: Summary of descriptive statistics for experimental and control groups

Measurement	Experimental group		Control group	
	Pre-test	Post-test	Pre-test	Post-test
Mean	51.28	61.64	51.47	52.67
Standard deviation	19.98	23.73	19.93	21.86
Standard Error of the Mean	3.31	3.96	3.32	3.64

The normality of the data distribution was assessed using the Kolmogorov-Smirnov test, which is a prerequisite for the valid application of the paired *t*-test. The test results indicated that the pre-test and post-test scores were normally distributed, confirming that the assumptions for conducting the paired *t*-test were satisfied.

Table 5: t-test results for pretest of experimental and control groups

		Mean Differences							
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference		t	df	Sig. (2-tailed)
					Lower	Upper			
Pair 1	Pretest_marks_exp - Pretest_marks_control	-.194	5.651	.942	-2.106	1.718	-.206	35	.838

According to Table 5, the mean difference in pre-test scores between the experimental and control groups at a confidence level of $\alpha = 0.05$ was 0.19. This difference was not statistically significant ($p = 0.838 > 0.05$), indicating that there was no meaningful difference between the two groups at the start of the experiment. This confirms that the students in the experimental and control groups had comparable initial capabilities prior to the application of the different teaching methods. To assess the extent of improvement in the experimental group's performance, a comparison analysis of pre-test and post-test scores was subsequently conducted.

Table 6: Paired sample t-test results of pre and post-test marks of the experimental group

		Paired Differences							
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference		t	df	Sig. (2-tailed)
					Lower	Upper			
Pair 1	Pretest_marks_exp - Posttest_marks_exp	-10.361	6.048	1.008	-12.408	-8.315	-10.279	35	.000

The paired t-test results (Table 6) for the experimental group showed that the mean difference between pre-test and post-test scores was statistically significant ($p < 0.001$). Consequently, the null hypothesis

H_{01} was rejected, supporting the alternative hypothesis that the Multiple Representational Model (MRM) significantly enhances student learning.

Subsequently, the pre-test and post-test scores of the control group were analyzed to determine the extent of improvement achieved through the conventional teaching method (Table 7).

Table 7: Paired t-test results of pre-test and post-test marks of control group.

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Pretest_marks _control - Posttest_marks _control	-1.194	4.591	.765	-2.748	.359	-1.561	35	.127

As shown in Table 7, the control group's mean difference between pre-test and post-test scores was small, and the result was not statistically significant ($p = 0.127 > 0.05$). Therefore, the null hypothesis H_{02} is accepted, indicating that the traditional teaching method did not produce a significant improvement in student performance.

Overall, the *t*-test analysis demonstrates clear differences in the performance of students taught using the Multiple Representational Model (MRM) compared to those taught using the traditional method, even when initial capability levels were the same. While a significant *p*-value indicates that the intervention is effective, the effect size quantifies the magnitude of this impact. Using Cohen's *d* (1992), the calculated effect size for the post-test was 0.39, suggesting that the MRM-based teaching method had a moderate effect on the experimental group's performance.

Students' Misconceptions in Chemical Bonds

The nature of students' responses across selected chemical bonding topics was analyzed and expressed as percentages for both experimental and control groups (Figure 3). The percentage of complete understanding for each concept was calculated for the pre-test and post-test to evaluate changes in conceptual understanding and the reduction of misconceptions following the teaching intervention.

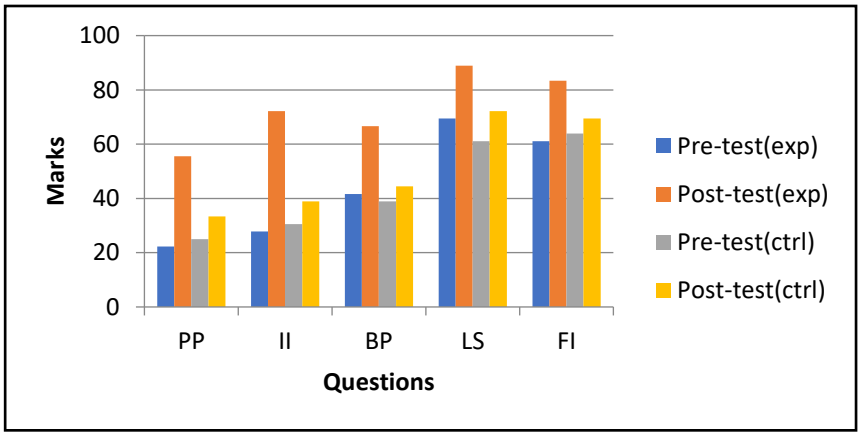

Figure 4: Nature of understanding for selected concepts

Note: PP- Physical properties, II- Intermolecular interactions, BP- Bond polarity, LS- Lewis structures, FI Formation of ions

Figure 4 illustrates students' levels of understanding across five selected concepts before and after the teaching intervention. Students in the experimental group demonstrated a marked improvement in complete understanding for all concepts, particularly for those requiring the integration of macroscopic and sub-microscopic levels. In contrast, the control group showed only minimal improvement. It is also notable that higher initial scores on symbolic-level questions suggest that students often rely on memorization rather than deep conceptual understanding. These results indicate that the Multiple Representational Model (MRM) effectively enhances conceptual understanding by helping students connect and interpret information across different representational levels.

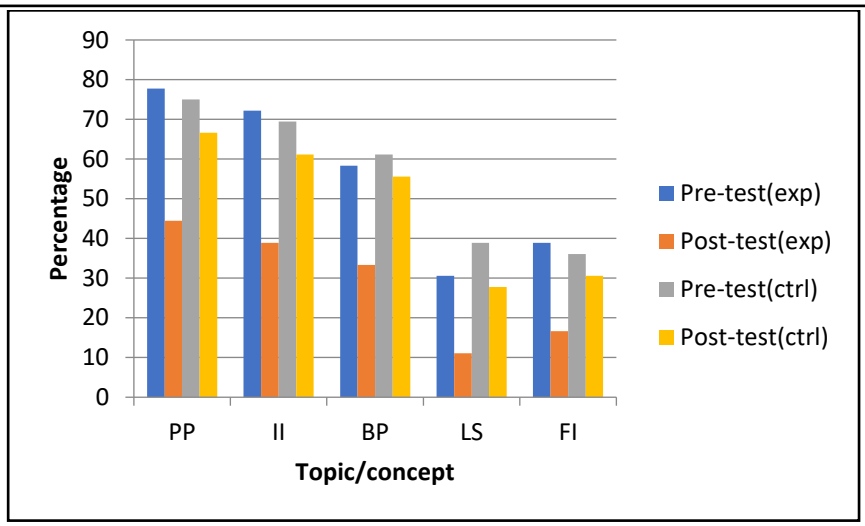

Figure 5: Percentage of students' misconceptions before and after the teaching intervention for experimental and control groups

Figure 5 illustrates the reduction of students' misconceptions across five key concepts in chemical bonding following the teaching intervention. In the experimental group, taught using the Multiple Representational Model (MRM), there was a significant decrease in misconceptions for all topics, particularly for physical properties and intermolecular interactions; for instance, misconceptions related to physical properties dropped from 77% to 44% after the intervention. In contrast, the control group, which received traditional instruction, exhibited only a slight decrease in misconceptions. This comparison underscores the effectiveness of the MRM-based approach in reducing misconceptions and enhancing conceptual understanding in chemical bonding.

The qualitative findings corroborated the statistical results. Themes emerging from student interviews and questionnaires indicated improved conceptual clarity, increased motivation, and greater engagement in the learning process. Classroom observations revealed higher levels of student interaction, questioning, and the use of scientific language during MRM-based lessons. The alignment between the quantitative improvement in post-test scores and students' reported experiences suggests that the MRM approach fosters a deeper and more meaningful understanding of abstract chemistry concepts.

CONCLUSION AND RECOMMENDATIONS

The findings of this study confirm that the Multiple Representational Model (MRM) is significantly more effective than traditional teaching methods in enhancing students' understanding of chemical bonds. Statistical analysis, including a moderate effect size (Cohen's d = 0.39), demonstrated that students in the experimental group achieved notable improvements in conceptual understanding and experienced a marked reduction in misconceptions compared to the control group. These results support the view that successful learning is rooted in effective teaching (Olaleye, 2005) and underscore the importance of engaging, student-centered pedagogies.

Students exposed to MRM exhibited greater enthusiasm and deeper involvement in learning tasks, aligning with Hanson and Wolfskill's (2000) observation that innovative instructional strategies can improve motivation and performance in science education. By integrating macroscopic, sub-microscopic, and symbolic representations, MRM enables students to construct knowledge and develop representational competence, which is critical for meaningful understanding and problem-solving (Tasker & Dalton, 2006; Taber, 2002).

However, the study also revealed that many students still rely heavily on memorized symbolic representations and struggle to conceptualize sub-microscopic phenomena, indicating a persistent gap in representational ability (Treagust et al., 2003; Johnstone, 1993). To address this challenge, the study recommends adopting multiple representations in the teaching-learning process, utilizing modern technologies such as simulations and animations to visualize abstract chemical concepts, encouraging the use of varied models including 3D physical models, role-plays and particulate drawings, training teachers to implement these strategies effectively, and revising curriculum materials to ensure that all three representational levels are meaningfully addressed, reducing the risk of school-developed misconceptions caused by over-reliance on symbolic forms (Taber & Coll, 2002; Bucat & Mocerino, 2009).

Overall, the combination of quantitative and qualitative findings indicates that the Multiple Representational Model is an effective instructional strategy not only for improving academic performance but also for enhancing conceptual understanding, student

engagement, and classroom interaction in the context of chemical bonding.

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The Impact of Kahoot on Student Motivation, Engagement and Academic Performance in Mathematics at the Secondary Level in Sri Lankan Schools

W. K. T. Subhashani
Nakulugamuwa Gamini M.V, Hambanthota, Sri Lanka

ABSTRACT

This study aims to determine the effects of utilizing Kahoot a popular educational technology platform, on the motivation, engagement, and performance of students in mathematics education. A sample of 70 students in the eighth-grade secondary school was randomly allocated into both experimental and control groups. Student learning performance is assessed by mathematics assessments, including Kahoot! Quiz and test. The surveys utilized Likert-scale items to measure student motivation and engagement. The findings revealed that students engaged in Kahoot-based learning demonstrated significantly enhanced performance in mathematics and exhibited heightened levels of motivation and engagement in their learning. The study provides insights into the potential of Kahoot! as a tool for enhancing mathematics learning experiences and suggests implications for educators and policymakers aiming to integrate technology in the classroom.

Keywords: ***Game-based learning, Kahoot, Mathematics Education, Motivation, Engagement, and performance***

INTRODUCTION

1.1 Background

Advancements in information technology have transformed traditional teaching methods into technology-enhanced methods, providing innovative approaches that enhance students' learning experience. One of those technologies, Kahoot popular as a game-based learning platform to offers interactive quizzes and real-time feedback features to promote classroom engagement and active participation, and is widely used worldwide in subjects such as mathematics education.

1.2 Rationale

Student motivation, engagement, and academic performance continue to present significant challenges in mathematics education (Xia et al., 2022). Many students perceive mathematics as difficult and uninteresting, which negatively affects their learning outcomes. Scarpello (2007) reported that approximately 75% of Americans discontinue studying mathematics, thereby limiting their access to mathematics-related careers. In the Sri Lankan context, the education system has faced persistent challenges related to low achievement levels in mathematics and science at the secondary school level (Liyanage, 2014). These concerns highlight the need for innovative instructional approaches that can enhance students' learning experiences and academic outcomes in mathematics.

To address these challenges, this study investigates the impact of Kahoot as a pedagogical tool on students' motivation, engagement, and academic performance in mathematics. Kahoot was specifically selected for this study due to its accessibility, user-friendly interface, real-time feedback features, and gamified learning environment that promotes active participation and healthy competition among students. Unlike many other digital learning platforms that require advanced technical skills, paid subscriptions, or extensive teacher training, Kahoot can be easily implemented in regular classroom settings with minimal resources. Furthermore, its interactive quiz-based format aligns well with mathematics instruction, particularly for formative assessment and concept reinforcement. Therefore, Kahoot was chosen as a practical, scalable, and context-appropriate technology for enhancing mathematics learning in Sri Lankan secondary schools.

The purpose of this study is to provide clear guidance and empirical evidence on how technology-

enhanced learning environments, specifically game-based platforms such as Kahoot, can support and improve student achievement in mathematics.

1.3 Research Objectives

The primary objective of this study is to examine the impact of Kahoot on student motivation, engagement, and performance in mathematics education. Specifically, the research aims to:

i. To evaluate the effect of Kahoot-based instruction on enhancing student motivation in mathematics among eighth-grade students.
ii. To determine the impact of Kahoot-based instruction on student engagement during mathematics learning among eighth-grade students.
iii. To assess the effect of Kahoot-based instruction on academic achievement in mathematics among eighth-grade students.

1.3 Significance of the Study

This study contributes to the growing body of research on technology-enhanced learning by providing empirical evidence on the effectiveness of Kahoot as a gamified instructional tool in secondary-level mathematics education. While gamification has received increasing scholarly attention, several critical gaps remain in the literature, particularly concerning its sustained impact on multiple learning outcomes within mathematics classrooms.

First, although prior research has examined the role of gamified platforms in improving student engagement and classroom participation, relatively few studies have rigorously evaluated their impact on measurable academic achievement in mathematics using controlled experimental designs. Much of the existing literature emphasizes students' perceptions, enjoyment, or short-term motivational gains rather than long-term academic outcomes (Dicheva et al., 2015). Systematic reviews of gamification in education have noted that empirical evidence linking gamification to improved academic performance remains limited and methodologically inconsistent (Hamari et al., 2014). Consequently, there is insufficient evidence demonstrating whether increased engagement through gamified tools translates into improved mathematics achievement.

Second, existing research on gamified learning tools has predominantly been conducted in Western or technologically advanced educational contexts. There is limited evidence from developing

countries, including Sri Lanka, where contextual factors such as digital infrastructure, classroom culture, and teacher preparedness may significantly influence implementation and effectiveness. Furthermore, studies examining technology integration in mathematics highlight that contextual and pedagogical factors strongly affect learning outcomes (Bakker et al., 2015). This contextual gap restricts the generalizability of prior findings and underscores the need for research within diverse educational settings.

Third, many previous studies have investigated motivation, engagement, or achievement independently rather than examining their combined effects within a single experimental framework. However, motivation and engagement are closely related constructs that jointly influence academic performance (Fredricks et al., 2004). Without integrated analysis of these variables, the holistic impact of gamified instruction in mathematics remains insufficiently understood.

By addressing these gaps, the present study offers a rigorous experimental investigation of Kahoot-based instruction and its effects on student motivation, engagement, and academic performance among eighth-grade students in Sri Lanka. The findings provide context-specific evidence that contributes to both local and international scholarship on gamified learning. Additionally, the study offers practical implications for instructional design, curriculum planning, and policy-level decisions related to technology integration in mathematics education.

Overall, this research strengthens the empirical foundation for adopting gamified learning tools in mathematics classrooms and supports evidence-based approaches aimed at improving student learning outcomes.

LITERATURE REVIEW

Introduction of Kahoot

Kahoot is an educational platform founded by Johan Jamie Brooker, Brand, and Morten Versvik in 2013 which has obtained extensive popularity in more than 200 countries with 2 billion students and 20 million teachers (Official Kahoot, 2019). Kahoot has two official web addresses, https://kahoot.com/ for instructors and https://kahoot.it/ for students. Kahoot can be used at no cost. The Kahoot platform supports numerous games together with online quizzes, surveys, and discussions.

Educational technology integration has been cited to play an increasingly more outstanding role in mathematics education in recent years as teachers try to revolutionize the gaining knowledge of experience. An extremely good instance of such technology is Kahoot, a gamified platform that has been used to inspire students' participation and engagement in classrooms in arithmetic training. This review examines previous studies into the results of Kahoot on student motivation engagement and overall performance in mathematics.

Motivation in Mathematics Education

Motivation is an important factor that impacts the strength of learning (Nurhasanah & Sobandi, 2016). Especially in mathematics, attitudes and beliefs could greatly impact students' learning achievements (Wigfield & Eccles, 2000). Student motivation can be categorized as intrinsic and extrinsic (Harandi, 2015). According to Deci & Ryan (1985), intrinsic motivational state is associated with higher performance in mathematics. Kahoot implementing an engaging game-based tool that produces entertaining and interactive learning activities. It has recently been acknowledged as a motivational tool (Vlachopoulos et al., 2018).

Engagement and Active Learning

Student engagement is another key aspect in mathematics education where the students exhibit their high participation, effort, and achievement (Fredricks et al., 2004).Kahoot creates an interactive learning space that involves students with mathematical concepts by encouraging collaboration, competition, and instant feedback (Allsop et al., 2019; Uzunboylu & Karagozlu, 2015).

Academic performance in Mathematics

The main aim of mathematics learning is to increase students' scores and success in maths subjects. Several studies have indicated a positive connection between the role of game-based learning platforms, such as Kahoot, and student academic achievement (Setiawan & Soeharto, 2020). In addition, these Kahoot quizzes facilitate knowledge retention, critical thinking, and problem-solving skills (Gulikers et al., 2017).

Integration of Kahoot in Mathematics Education

Educators have adopted Kahoot as a helpful tool to enhance teaching-learning and comprehension in mathematics. They consist of user-friendly interfaces and real-time

feedback features. Hence, the versatility of Kahoot for education gives rise to different modes of learning and teaching (Uzunboylu and Karagozlu, 2015). Moreover, the recurrent theme in several studies was the success of using Kahoot! Integrating the quizzes into mathematics lessons serves purposes such as reinforcing concepts, evaluating student comprehension, and promoting active involvement (Lynch & Soukup, 2017; Allsop et al., 2019).

Gaps in the Literature

Existing studies explored the potential advantages of utilizing Kahoot in mathematics education. Few studies have concentrated on how Kahoot! influences student motivation, engagement, and performance in mathematics classrooms.

In the Sri Lanka context, a noticeable gap exists in the available literature concerning the effectiveness of educational technology, especially in mathematics education. While various studies have delved into different teaching methods and instructional strategies, there is limited research dedicated to examining how digital tools like Kahoot impact on student motivation, engagement, and performance in mathematics. Moreover, current literature primarily focuses on conventional teaching approaches and lacks thorough investigations into incorporating technology-enhanced learning platforms such as Kahoot into the mathematics education. This gap impedes comprehension of how these tools can be optimally leveraged to enrich the teaching and learning environment in Sri Lankan schools.

METHODOLOGY

3.1 Research Design

This study employs a quantitative research design to comprehensively explore the impact of Kahoot! on student motivation, and engagement. Experimental designs are suitable for evaluating interventions by directly comparing outcomes between groups subjected to different treatments (Trochim & Donnelly, 2008). The study compared the performance of students taught using the conventional teaching method (control group) with those instructed to utilize Kahoot (experimental group)

3.2 Sampling Procedure

The target population comprised students in Grade 8 from H/Nakulugamuva Gamini Maha Vidhyalaya, a government secondary school located in the

Hambantota district of Sri Lanka. A simple random sampling method was used to select the students for the control and experimental groups. The control group consisted of 35 students who were taught using the traditional conventional technique, while the experimental group also comprised 35 students instructed to utilize Kahoot for mathematics teaching.

3.3 Instrument design

Data were collected using a mathematics achievement test and structured questionnaires measuring students' motivation and engagement. The achievement test consisted of 20 items covering key algebraic concepts aligned with the Grade 8 national curriculum. Content validity was ensured through expert review by two experienced mathematics teachers and one subject specialist, who evaluated item clarity, relevance, and alignment with curriculum objectives. Students' intrinsic motivation was measured using an adapted version of the scale developed by Shyr et al. (2021), which included items assessing interest, competence, pressure, value, effort, and choice. Student engagement was measured using an adapted instrument developed by Rimm-Kaufman et al. (2015), assessing emotional, social, and cognitive engagement. Minor wording modifications were made to contextualize the instruments for the Sri Lankan secondary school setting.

To strengthen the credibility of the instruments, a pilot study was conducted with 20 Grade 8 students from a comparable school to assess clarity and administration procedures. Feedback from the pilot testing led to minor refinements in item wording. Internal consistency reliability was established using Cronbach's alpha, which indicated excellent reliability for the motivation scale ($\alpha = .962$) and engagement scale ($\alpha = .984$), exceeding the recommended threshold of .70 (Hair et al., 2006). Quantitative data were analyzed using descriptive statistics (means and standard deviations) and independent samples t-tests to compare differences between the control and experimental groups at the 0.05 significance level.

The Experimental Teaching and the Lesson Topic

Lesson on "Algebra" can be mentioned as the main content of the Mathematics curriculum at secondary levels of education in Sri Lanka. At the secondary level, from grade eight, simple algebraic equations range from basic concepts to solving equations with basic arithmetic operations. Figures 1, 2, and 3 illustrate several tabs of the

developed Kahoot app used for the experimental lesson. Students participated in the game as an assessment consisting of 20 quizzes.

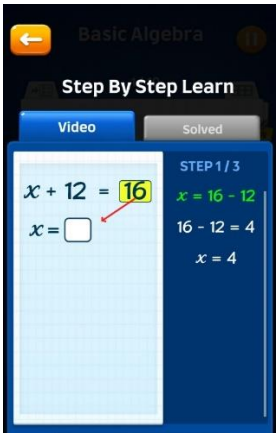

Figure 1: Guided interface

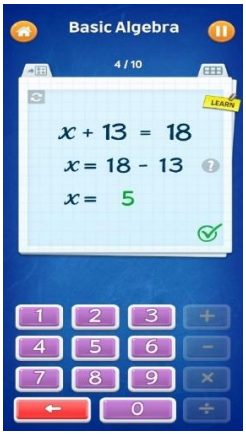

Figure 2: Game interface I

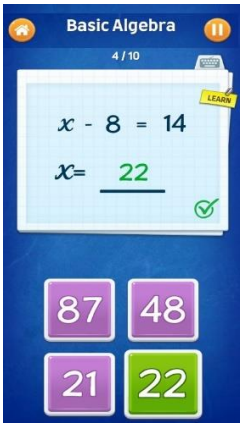

Figure 3: Game interface

The control group was taught algebraic concepts through a traditional classroom-based teaching method. The experimental group was taught mathematical concepts related to simple algebraic equations using Kahoot in the computer lab outside the traditional classroom.

The same time period was used for both groups for teaching, and in the end, both groups answered the same question paper with 20 questions. In addition, both groups completed questionnaires on motivation and engagement related to mathematics.

DATA ANALYSIS

4.1 Reliability of Instrument

instrument, internal consistency was measured using Cronbach's alpha. Although the lowest acceptable value for Cronbach's alpha is 0.70, a value of 0.60 can be considered acceptable in certain situations; however, the recommended value is above 0.80 (Hair et al., 2006).

Based on Table 1, Cronbach's alpha values above 0.80 were considered acceptable, indicating satisfactory reliability. These findings demonstrate that the questionnaire items used in the study are reliable measures for assessing the intended constructs of

motivation, engagement, and performance in mathematics.
To assess the reliability of the survey

Table 1: Reliability Statistics

Construct	Cronbach's Alpha	N of Items
Motivation	.962	12
Engagement	.984	13
Overall	.927	25

4.2 Descriptive Analysis

Table 2: Statistics of constructs

Construct	Mean	Std. Dev
Motivation	3.94	.866
Engagement	3.95	0.952

According to Table 2, Motivation (M=3.94) and Engagement (M=3.95 have high mean values, indicating participants tend to have positive experiences in these areas.

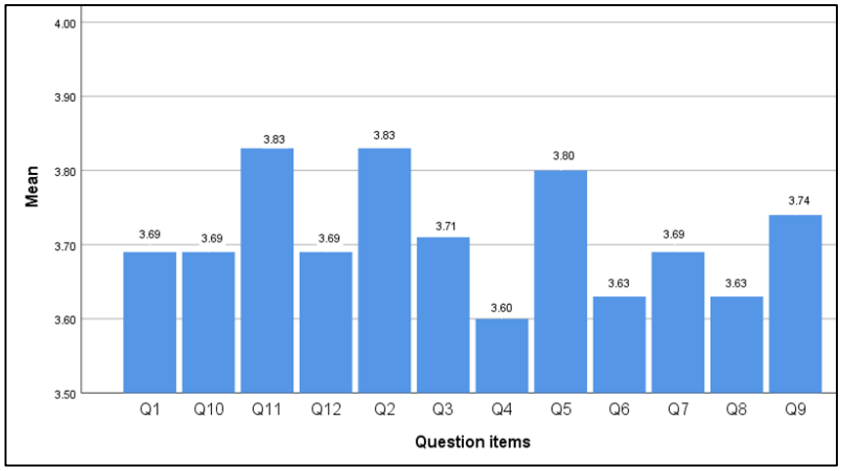

Figure 4: Bar chart of mean scores for motivation-related question items

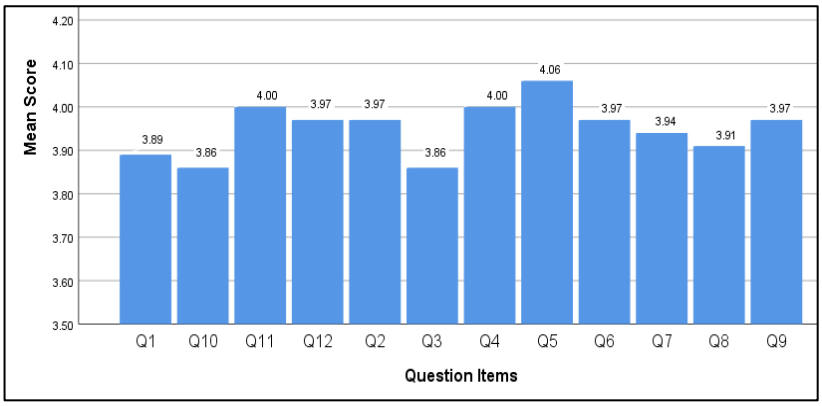

Figure 5: Bar Chart of Mean Scores for Engagement-Related Question Items

Figure 4 and Figure 5 display mean scores for question items related to engagement and motivation measured on a Likert scale. Figure 4 bar chart shows generally high engagement, with most items clustering close to a score of 4. Figure 5 presents positive motivation levels. Overall, both charts indicate positive responses, with engagement levels appearing slightly higher than motivation levels.

Comparisons between Control and Experiment groups

Table 3: Descriptive statistics and results of Independent Samples T-tests on students' learning performance, motivation and engagement

	Group	N	Mean	S. D	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Performance	Control	35	35.57	19.20	-10.148	68	.000	-43.00	-51.456	-34.544
	Experiment	35	78.57	16.11						

Motivation	Control	35	2.42	.614	-7.660	68	.000	-1.290	-1.627	-.954
	Experiment	35	3.71	.785						
Engagement	Control	35	2.31	.666	-8.797	68	.000	-1.624	-1.993	-1.256
	Experiment	35	3.94	.866						

The results in Table 3 show the effectiveness of Kahoot in enhancing students' performance in mathematics. Students in the experimental group have a mean score of 78.57 (SD = 16.11), while those in the traditional lecture group have a mean score of 35.57 (SD = 19.20). Additionally, the results of the Independent Samples T-test indicate a significant difference between the mean scores of the experimental and traditional lecture groups ($p < 0.01$). Table 4 illustrates that students' motivation in the Kahoot group is higher (M = 3.7, SD = 0.785) compared to the control group (M = 2.42, SD = 0.614). The Independent Samples T-test confirms a statistically significant difference in motivation scores between the two groups ($p < 0.01$).

The results reveal that Kahoot significantly enhances students' engagement in mathematics in the experimental group. Similar to performance and motivation, the mean score of engagement in the experimental group is 3.94 (SD = 0.866), which is significantly higher than that of students in the control group, with a mean of 2.31 (SD = 0.666), in the level of $p < 0.01$.

CONCLUSION

This study examined the effect of Kahoot-based instruction on students' motivation, engagement, and academic performance in secondary-level mathematics education in Sri Lanka. The findings revealed that students who participated in Kahoot-integrated lessons demonstrated significantly higher levels of motivation, engagement, and mathematics achievement compared to those taught using traditional lecture-based methods ($p < .01$). These results are consistent with previous studies that highlight the positive influence of gamified learning environments on student outcomes. Overall, the findings suggest that Kahoot can serve as an effective instructional strategy to enhance students' learning experiences and academic performance in mathematics.

The results have important implications for teaching practice and educational policy in Sri Lanka.

At the classroom level, integrating gamified formative assessment tools such as Kahoot! can promote active participation, sustain students' attention, and strengthen intrinsic motivation. Teachers may use such platforms strategically for concept reinforcement, revision activities, and continuous assessment rather than as occasional supplementary tools. From a policy perspective, the findings support the integration of accessible and low-cost digital technologies into the secondary school curriculum. Providing professional development opportunities for teachers on effective technology integration could further enhance instructional quality and support student-centered learning approaches in mathematics education.

Despite its contributions, this study has several limitations. The sample was drawn from a single secondary school, which may limit the generalizability of the findings to other regions or educational contexts. The intervention was implemented over a relatively short period and focused on a single mathematics topic, which restricts conclusions about long-term effects or applicability across different mathematical domains. Additionally, motivation and engagement were measured using self-reported questionnaires, which may be influenced by response bias.

Future research should involve larger and more diverse samples across multiple districts to strengthen external validity. Longitudinal studies examining the sustained impact of gamified learning tools over extended periods would provide deeper insights into their long-term effectiveness. Comparative studies investigating different digital platforms or blended instructional approaches could also help determine the most effective strategies for enhancing mathematics learning. Incorporating qualitative methods such as interviews or classroom observations would further enrich the understanding of how gamified tools influence student learning and classroom dynamics.

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