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Students' Experiences of Game–based Learning in Early Childhood Science in Trinidad: The Effects of a Food Bingo Board Game on Learning Outcomes

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Abstract

The introduction of STEM subjects in the early years (5-8 years old) can enhance children's lifelong disposition to learning science. Game–based Learning (GBL) has been identified as an effective strategy to support young students' understanding and engagement with science concepts. This study explored how a non–digital board game, Food Bingo, could influence young students' learning outcomes as well as their perceptions and experiences of GBL. A mixed method, intervention design exposed two Infant classes (n=38; 6–7 years) to an adapted Food Bingo game. Pre- and post–tests indicated a statistically significant improvement in students' knowledge of food groups. Students' focus group interviews and responses to a Likert questionnaire were triangulated by their teachers' observations. The majority of students rated the game as fun, exciting, and easy to play — though some students identified stressors associated with losing, turn–taking, and delayed gratification. Teachers, however, believed that these challenging emotional experiences were important for developing social skills and internal discipline.

Keywords: Game-based learning, early childhood science, Bingo board game

Introduction

Children can observe, explore, and discover the world around them from an early age (National Science Teachers Association (NSTA), 2014). Consequently, science in the early years should be mostly tactile and sensory, involving active, hands–on learning and personal experiences. Such experiences support developing scientific concepts and encourage interest in future science learning (Cremin et al., 2015; Johnston, 2009; Lind, 1998). Game-based learning (GBL) has the potential to engender active learning and development of scientific concepts in young students. However, while there is substantial international research on the impact of GBL on young children's learning across multiple subjects (Eriksson et al., 2021; Gashaj et al., 2021; Gasteiger & Moeller, 2021; Mostowfi et al., 2016; Zsoldos–Marchis & Hari, 2020), very few studies have been located for Trinidad and Tobago — Welsh et al. (2022) being an exception. This study sought to address this gap in empirical research on GBL at the early primary science level in Trinidad and Tobago by introducing an innovative board game, Food Bingo, to Trinidadian Infant 2 students. The study assessed the effectiveness of GBL as a teaching tool through assessment of students' learning outcomes and game–play experiences.

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Background

Science Education for the Caribbean

The introduction of STEM subjects (science and mathematics) in the early years can enhance children's lifelong disposition to science by taking advantage of their prior experiences, knowledge, and interest (Speldewinde et al., 2018). Since 2007, the Caribbean Community (CARICOM) an inter–governmental regional organization, has recommended "revolutionising methods of teaching science in kindergarten and early childhood, to make science fun and develop innovative hands–on approaches that stimulate curiosity without the use of textbooks" (Caribbean Council for Science Teaching [CCST], 2007, p. 8). This continues to be a contemporary issue advocated throughout the region to stimulate the advancement of Science, Technology, and Innovation (Abdul–Majied & Figaro–Henry, 2015; Sweeney & George, 2024; Warde & Sah, 2014).

Primary Science Education in Trinidad & Tobago

The national primary school science curriculum has adopted a thematic design which promotes a holistic, interactive pedagogy that is relevant to the lives of students (Jennings, 2017; John, 2015; Ministry of Education, Republic of Trinidad & Tobago [MOETT], 2013, p. 14). Teachers are encouraged to engage students in active learning, as teaching that instils enthusiasm and a sense of wonder is more likely to foster a lifelong love for learning science (Bonwell & Eison, 1991; MOETT, 2013, p. 17; National Association for the Education of Young Children [NAEYC], n.d.; NSTA, 2014). However, without access to educational tools and effective teaching strategies, regional and local research indicates that teachers will return to traditional methods which do not provide adequate opportunities to engage with science in a meaningful way (Jennings, 2017; John, 2015, National Institute of Higher Education, Research, Science & Technology [NIHERST], 2003, 2015).

Board Games: An Innovative Pedagogy

One innovative teaching strategy that was explored in this study to address the needs of teachers for interactive, low–cost, indigenised teaching tools was non–digital board games. The use of traditional board games in education requires low administrative overheads (Naik, 2014). Teachers who strive to meet curriculum goals with limited funds could adapt board games to foster active learning. Further, when board games are indigenised to incorporate local examples and contexts, they can enable relevant and contextually rich learning that is inclusive of all learners (George, 2001; Okeke, 1984; Trajkovik et al., 2018). The socio–cultural environment creates and nurtures knowledge, and the links between prior knowledge and the sociocultural environment are inseparable (Boisselle, 2016; George & Glasgow, 1999; Jegede & Aikenhead, 1999). This study incorporated an adapted, indigenised board game into teaching a science unit on nutrition.

Science Education in Early Childhood

Science lessons should motivate and inspire learners from an early age to develop the knowledge and skills required to make informed choices and prepare for lifelong learning (Clarke, 2015; Jaipaul–O'Garro, 2016; Kahwa, 2007). The young learners in this study were 6–7 years old in the early childhood education (ECE) category. In Trinidad and Tobago, ECE includes students 3–8 years old (kindergarten to Grade 3).

Innovative teaching methods cognisant of the real constraints faced in primary classrooms can make science lessons more engaging and effective for young learners. Innovative pedagogies should encourage active learning in which students master the basic processes of observation and classification, thereby enabling students to experience the nature of science and construct meaning about their natural world (Johnston, 2009; MOETT, 2013; Pakombwele & Tsakeni, 2022). Active learning further enhances students' attitudes towards cooperation, perseverance, and failure. Positive attitudes support emotional and intellectual development by creating a readiness for questioning and curiosity. These attitudes encourage exploration of the natural and social world (Eshach & Fried, 2005; Jirout & Zimmerman, 2015), connecting science to real–world situations which support authentic learning (Armstrong, 2020; Lind, 1998; MacKenzie, 2021).

Board games can encourage fun and interaction as scientific concepts are introduced, providing students with the confidence to solve problems, answer science–related questions, and complete challenges (Bendixen–Noe, 2010). This type of game could be particularly beneficial for young learners, as it introduces science in an enjoyable and accessible way, reducing the intimidation factor that often accompanies the subject.

Game–based Learning (GBL)

Board games used as an educational tool are examples of game–based learning. Games can take many forms — digital; non–digital; competitive; collaborative; and played by individuals, pairs, or teams (Russo et al., 2025). Games have been defined as social systems involving actors/players, rules and resources, and characterised by competition, engagement, and immediate rewards (Guan et al., 2022; Klabbers, 2003).

GBL is distinguished by its instructional focus that facilitates students' academic achievement, socio–emotional skills, and engagement in learning (Azhar et al., 2022; Russo et al., 2025). For this study, a game is defined as a multi–player, team-based, competitive activity, governed by rules and structures which determine success. Food Bingo is a non–digital game designed to promote students' understanding of the food groups and healthy eating, while building their social skills and enjoyment of science.

Problem

There is limited documented research on GBL in science for young children in the Caribbean, and specifically in Trinidad and Tobago. An international review of GBL has found that the majority of empirical studies refer to self–designed digital games at the secondary and tertiary levels (Guan et al., 2022). Published studies in the Caribbean reveal a similar trend (Jaggernauth & Lochan, 2021; Kalloo & Mohan, 2012; Mohammed & Mohan, 2011; Walcott, 2023; Walcott & Corbin–Babb, 2016). Within the region, a few studies have begun to investigate digital game–based learning at the primary school level (Clerveaux et al., 2008; Welsh et al., 2022).

Guan et al. (2022) and Russo et al. (2025) have noted however, that despite the popularity of digital GBL, the passive nature of e–games, and the long hours children of all ages spend on screens, negatively affects their health. They warn that the introduction of e–games as learning tools into schools, can inadvertently worsen students' habits. Further, e–games require online access and mobile and/or computer technology which are limited or often non–existent in many primary schools in Trinidad & Tobago.

Board games are a relatively low–cost, innovative teaching tool that has the potential to address these challenges. Board games can create fun and interaction as scientific concepts are introduced. They can encourage students to solve problems, answer science–related questions, and complete challenges as they learn (Bendixen–Noe, 2010). These games could be particularly beneficial for young learners — introducing science in an enjoyable and accessible way, building their social skills, and reducing the intimidation factor that often accompanies the subject.

However, empirical data on non–digital GBL as a teaching tool among early childhood learners in Trinidad is sparse. This study sought to address this gap by investigating the effects of a non–digital instructional board game (Food Bingo) at the Infant 2 level in Trinidad and Tobago.

The study builds on the exploratory studies of non–digital GBL by Pinder (2016), Jaggernauth et al. (2020), Kalloo et al. (2019), Ramjattan (2014) and the game design research of Kamalodeen et al. (2021).

Purpose

The purpose of this research was to explore how a non–digital instructional board game (Food Bingo) influenced young students' learning outcomes as well as their perceptions and experiences of GBL. GBL was integrated into to a unit on food groups and healthy eating for 6–7–year–old Trinidadian learners, and the game was modified to incorporate local foods.

The research questions were:

1. What are the effects of an instructional Bingo game on EC students' learning outcomes in a science unit on food groups and nutrition?
2. How do students rate their perceptions and experiences of using an instructional Bingo game to learn about food groups and nutrition?
3. How do students and teachers describe the experiences of learning science through an instructional Bingo game?
4. How do quantitative and qualitative outcomes combine to deepen our understanding of young students' experiences of learning science through GBL?

Literature Review

Theoretical Framework

This research adopted the behaviourist position that learning involves providing meaningful experiences; and that through reinforcement, the desired change in learners' observable behaviour occurs (Carlson et al., 2007). Behaviourist theory is enacted through the game elements of challenge, response, and feedback (Plass et al., 2015). In Food Bingo, students were challenged to find a pattern of food groups, and in so doing were rewarded by winning the game and consequently mastering the content, all while receiving feedback from the teachers.

Food Bingo was played collaboratively and therefore also aligned to theories of Vygotskian Social Constructivism (Vygotsky, 1978). Lev Vygotsky's Zone of Proximal Development (ZPD) explored the idea that learning best occurs when learners attempt tasks slightly beyond their capabilities, with the guidance of someone who is more knowledgeable. In this study, the "more knowledgeable other" was a peer or the teacher. Social Constructivism (Vygotsky, 1978) further suggests that learners are actively involved in constructing knowledge and connecting new information with existing knowledge as they participate with peers in their learning.

Theoretical Metaphors of Game Play

Food Bingo, therefore, encompasses two metaphors of learning: Metaphor 1, learning as the acquisition of concepts – a Behaviourist construct in which the learner is viewed as a vessel absorbing information and mastering concepts; and Metaphor 2, learning as an interactive process arising from the constructivist theories of Piaget and Vygotsky. In Metaphor 2, games are a social activity in which learning is an "apprenticeship in thinking" (Klabbers, 2003). As apprentices, players are supported by an adult or more capable peer, who can potentially move players through their ZPD to master the gaming objectives (Plass et al., 2015). Knowledge is constructed as players learn game rules through observation and collaboration.

Game Design for Game Effectiveness

Game Design

Game design is both a process and a skill. Ahmad (2019) identifies four elements of game design as mechanics, aesthetics, story, and technology. The mechanics of the game are the rules and procedures that help the players to achieve the games' goals. In Bingo the rules are carefully explained to players, prior to game play. Repeated play improves game mechanics and complements the other three elements.

The overall game environment is considered to be the aesthetics. To bolster and set up an aesthetically pleasing environment, the game board and game pieces were purposefully engineered with brightly coloured objects, icons, and game pieces.

The unfolding series of events is the story element during gameplay. There is a relationship between the mechanics and the story. Rapid and frequent internalization of the rules and procedures for the game assists the story. The Bingo game was played many times during the intervention period. In game design, the resources, tools, and skills are called the technology. This design element is important and is needed to enliven the game.

Elements of Game Effectiveness

Effective games are designed to balance four elements: motivation, engagement, the capacity for adaptability, and a context for "graceful failure" (Plass et al., 2015). Cognitive engagement facilitates the achievement of learning goals, and engenders affective, behavioural, and socio–cultural engagement. Motivation helps the players to return to the game multiple times and master the subject matter (Barseghian, 2013). Motivation, which is related to adaptivity and the capacity for graceful failure, accommodates differences among learners. Motivational elements capture learning styles and facilitate success at mastering the game's objectives. Although failure is a necessary step in the learning process, successful games lower the consequences of failure, encouraging risk–taking, exploration, and self–regulation during play (Plass et al., 2015).

Play and Game–based Learning

Research supports the power of play for development and learning in early childhood (Vogt et al., 2018; Zsoldos–Marchis & Hari, 2020). Hirsh–Pasek and Hadani (2020) explain that through play–based approaches, "learning can be active, engaging, meaningful, socially interactive, iterative, and joyful" (p. 3). They posit that playful learning advances the development of their 6 Cs - collaboration, communication, critical thinking, creativity, content, and confidence. Educational games can also advance understanding of concepts, processes, and relationships between content (Klabbers, 2003; Russo et al., 2025; Zsoldos–Marchis & Hari, 2020); as well as the development of non–cognitive skills such as collaboration, persistence, and discipline — which have been associated with higher IQs (MacKay, 2013). Additionally, some games help students to think, adapt, master content, compete and have fun, while building social skills and self–esteem (Catapano, 2009; Zsoldos–Marchis & Hari, 2020). Competition motivates students to persist when solving complex or challenging problems, and in team games it can facilitate the development of negotiation skills (Walcott & Corbin–Babb, 2016).

Social–emotional Learning (SEL)

Games as a form of play can also provide opportunities to foster emotional competence, which includes emotional recognition and regulation — essential attributes for school success (Dell'Angela et al., 2020). Games, including educational games, also support higher emotional competence associated with lower self–reported difficulty and effort. Games operate at three levels to promote social and emotional learning – the skill level through experiential practice; the interactional level through peer learning; and the mediated level where adults help to facilitate learning (Dell'Angela et al., 2020). Additionally, games create positive emotions such as happiness and connections between real life and school learning in a fun and relaxed environment where students learn without fear of making mistakes (Lee, 2012).

Learning with Board Games

Treher (2011) describes non–digital/ traditional board games as "critical tools in our arsenal of educational products" (p. 9), noting that well–designed board games use a linear approach, frequently and accurately checking for understanding and information. They provide multiple examples, stress important points, and have repeat play value. She also argues that digital games should not be viewed as an improved replacement for non–digital games as these have their own value, are cost–effective, and encourage hands–on learning.

Further, traditional games can facilitate inquiry and problem–solving skills, foster the development of students' social and executive skills, and engender a sense of ownership of indigenous cultures and resources (Assapun & Thummaphan, 2023; Bayeck, 2020; Dell'Angela et al., 2020; Gashaj et al., 2021; Ramani et al., 2012; Trajkovik et al., 2018).

Students' Experiences with Bingo Board Games

Bingo, a popular low–cost board game, can encourage holistic, experiential learning. Studies evaluating Bingo for developing science concepts exist mainly at the secondary and

post–secondary levels (Crute, 2000; Derby & DeCesare, 2011; Tinsley, 2019).

Notable is Piziak's (2021) study of a Latino pictorial Bingo game called Loteria, because of its similarity to Food Bingo. Loteria was part of an intervention package to improve the dietary choices and exercise habits of 148 Hispanic preschoolers enrolled in a Head Start programme in Southern Texas. Students identified healthy foods such as local fruits and vegetables and viewed videos which encouraged them to exercise. Parents also used the Bingo game at home. Teacher and parent observations revealed a positive change in students' and families' eating patterns and exercise behaviour.

Most GBL studies describe positive effects of board games on students' learning. By utilising an interactive approach to learning science concepts (as with Loteria), non–digital games can influence young students' physical, social, emotional, and cognitive development (Squire, 2007). Board games, including Bingo, facilitate learning across multiple disciplines, including science (Liu & Chen, 2013; Wahyuni & Rozani Syafei, 2016). Further, opportunities for collaboration and enjoyment make them especially supportive of social and emotional development in the early years (Hromek & Roffey, 2009).

The literature reviewed guided the choice of a board game as a learner–centered intervention. Board games are governed by a theory of learning that allows both mastery and active construction of knowledge (Klabbers, 2003). Board games are therefore well–suited as a classroom strategy to promote active learning. The effectiveness of board games is further supported by global findings of positive learning outcomes: when board games are played collaboratively, learners interact socially — constructing knowledge together, and receiving guidance from both teachers and peers. For Caribbean educators, the low cost and high motivational nature of Bingo board games (particularly if they incorporate effective design elements) allows them to be adapted across grade levels and subject disciplines. Food Bingo required minimal teacher training, contained all elements of effective games, and was easily adaptable to a low–resource Caribbean context.

Methodology

Design

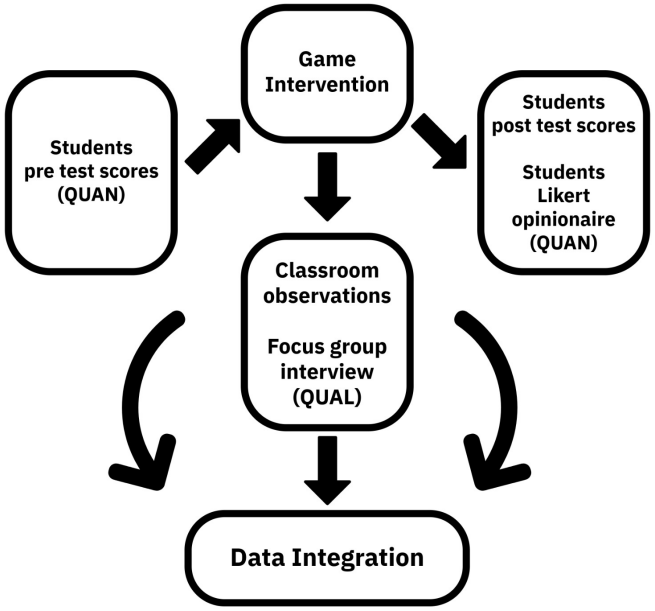
The study utilised a mixed–method, quasi–experimental (intervention) design (Creswell & Plano Clark, 2018). The goal was to obtain a comprehensive understanding of the effect of the intervention (a Food Bingo game) on students' learning outcomes, perceptions, and experiences of playing the game. A case study approach gathered multiple forms of qualitative and quantitative data (see Figure 1). The case (a bounded system) involved two infant classes in one school. Rich, holistic, descriptive, and multi–source data were needed to uncover the underlying process and complex interactions between the variables examined. The case study allowed for a deep, comprehensive, in–depth exploration of the complexities of the Food Bingo game in teaching and learning.

Data was collected pre, post, and during the intervention (see Figure 1). A food quiz (see Figure 4) measured students' knowledge before and after the intervention. A Likert Opinionnaire titled "Rate my Game" (see Figure 5) collected students' perceptions and feelings about playing Food Bingo. Qualitative data collected via focus group interviews (students and teachers) advanced a more complex and nuanced understanding of the impact of the game on learning outcomes (Creswell, 2016; Creswell & Plano Clark, 2018), while classroom observations facilitated researchers' understanding of the context in which learning occurred.

Figure 1 illustrates the quasi–experimental (intervention) design which integrated the qualitative and quantitative strands of the data (Creswell & Plano Clark, 2018). Data integration was supported by the construction of a joint display comparing the results of both databases (see Table 4).

Figure 1

Mixed Method Intervention Design



Two mixed Infant 2 classes (6–7 years), Class S and Class F, and their teachers participated in this study. Class F and Class S consisted of 24 and 22 students respectively, but the sample represented 38 students (19 from each class) who completed both the pre- and post–tests. Class S consisted of 13 boys and 6 girls, and Class F consisted of 11 boys and 8 girls.

The sampling method was purposive. This was one of 5 schools from a larger study using Food Bingo as a teaching tool, who had consented to participate in the research. The case study school was chosen because it had a complete data set and high attendance of students throughout the teaching of the unit.

Intervention

The intervention began with a teachers' training session at the school on April 5, 2017, hosted by the GBL researchers. The intervention timeline is provided in Figure 2. Teachers requested that they be allowed to implement the game at the time scheduled for teaching the topic in the third term, between April and May 2017 (see Figure 2).

At the training session teachers were introduced to the objectives of the project, its methodology, and its instruments. Teachers offered feedback on how well the game, the data collection instruments, and the team approach to playing Food Bingo were suitable for their students. The protocol for administering the pre- and post–tests was also discussed, and the goal of eliciting students' knowledge and candid opinions (rather than a pre–determined correct answer) was emphasised.

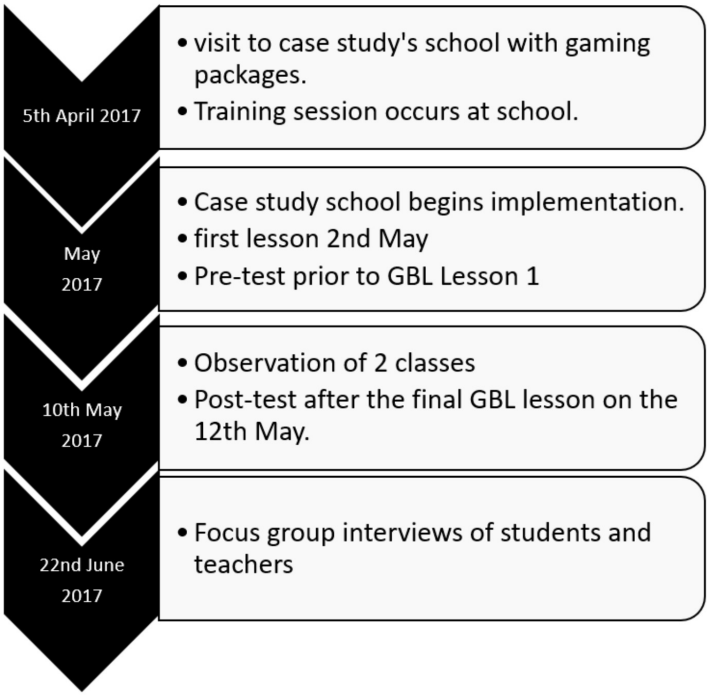
Researchers introduced teachers to a unit and lesson plans which served as a template for how the Food Bingo game could be integrated in teaching (see Appendix 1). Teachers were free to adapt the plans which were included in their game package. Face and content validity were established through the teachers' feedback on the plans' appropriateness for their classes. The game packages (which contained 5 bingo boards, cover tabs, game instructions, and an answer board) were distributed to each class. Teaching began soon after teachers received the packages. Each session was approximately 25 minutes.

A 5–lesson unit on the "Go, Grow and Glow" food groups was taught by each teacher (see Appendix 1). The unit developed the science process skills of observation and classification subsumed under the topic Food Groups and Healthy Eating in the Ministry of Education, Republic of Trinidad & Tobago's syllabus (MOETT, p. 35). At the end of the unit, students should have been able to:

1. Classify foods into go, grow and glow food groups.
2. State the function of the go, grow and glow foods.
3. Identify foods which belong to more than one food group.
4. Group local foods according to the food groups.
5. Justify making healthy food choices.

Figure 2

Intervention Timeline

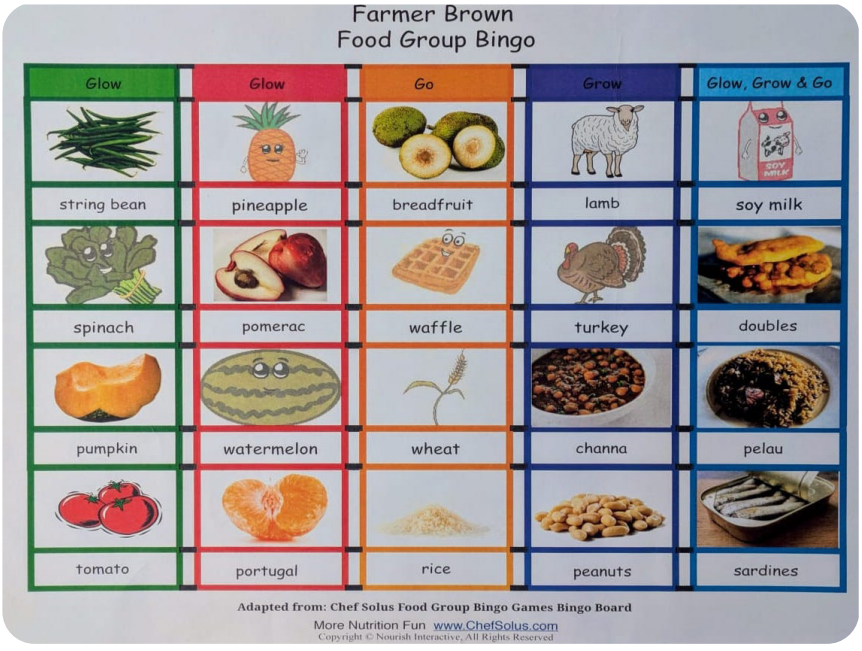


Five boards were distributed to each class. The items on the board were arranged in four columns: Grow Foods/meats and beans; Glow Foods/fruits & vegetables; Go Foods/starches & sugars; and foods that include the three food groups (see Figure 3). In each lesson, student teams played the game to identify specific food groups and their functions. In Bingo style, the teacher would call out a food which was on the board and students would cover the representative picture on their boards (see Figure 3). If students covered a row or column of foods that corresponded to the food group, they would shout "Bingo!". Teachers manipulated the game to ensure that different teams won the game at least once over the course of the unit.

A summary of the classroom observations for one lesson is presented in Appendix 2.

Figure 3

The Bingo Board Game



Note. Food Bingo Board adapted from Chef Solus open–source website (https://www.superkidsnutrition.com/nc_nutrition-education/)

The Food Bingo board used in this study was adapted from the Chef Solus Food Group Bingo board. In the adapted game, foods not grown in Trinidad were replaced with locally grown fruits and vegetables, meals, and street foods. The Chef Solus website is an open–source website dedicated to improving children's nutrition (Nourishinteractive.com).

Instruments

The study utilised three instruments for data collection. Table 1 illustrates the relationship between the first three research questions, the data collecting instrument, the sources of data, and the type of data collected. Research Question 4 is a mixed method question which addresses the integration of data at the analysis phase.

Table 1
Research Questions, Instruments, Data Sources, and Types of Data Collected

Research Question	Instrument	Quan/Qual	Data source	Type of data collected
1. What are the effects of an instructional Bingo game on EC students' learning outcomes in a science unit on food groups and nutrition?	**Pre- & Post tests**	**Quan**	**Students**	**Achievement scores**
2. How do students rate their perceptions and experiences of using an instructional Bingo game to learn about food groups and nutrition?	**Opinionnaire**	**Quan**	**Students**	**Rating scores**
3. How do students and teachers describe the experiences of learning science through an instructional Bingo game?	**Opinionnaire – open ended questions**	**Qual**	**Students**	**Opinions**
	Focus group	**Qual**	**Teachers**	Perspectives
	Focus Group			Experiences

Quantitative Instruments

Pre- and Post Tests

The pre- and post–tests were designed by one researcher and consisted of 13 items each (see Figure 4). In this study 9 questions covered the knowledge objectives of the unit and lesson plans. These objectives were:

i. Classify foods by the "Go, Glow and Grow" nomenclature (Questions 2a, 3a, 4a – 1 mark each);

ii. Identify the functions of the Go, Grow and Glow group of foods (Questions 2b, 3b, 4b – 2 marks each);

iii. Identify a healthy, balanced diet using a mixture of Go, Grow and Glow foods (Questions 5, 6b, 8 – 1 mark each)). These objectives represented new knowledge for students and were emphasised when playing Food Bingo (see Appendix 4). Items omitted dealt with students' physical experience of foods (observing, tasting, enjoying, etc.).

To prevent problems with internal validity due to item differences between tests, the pre- and post–tests were identical. The tests were piloted with one class of 23 Infant 2 students at another school who played the game once. Their test results and teacher feedback provided information on the appropriateness of the test content for young learners (e.g. the pilot teacher suggested ticks and Xs for item identification, as these were the instructions used in students' workbooks). She also suggested that the test have a more child–friendly format. As such, visual elements were incorporated on the test sheets. Samples of the test questions are illustrated in Figure 4. Prior to implementation, the tests were reviewed for academic and developmental appropriateness by the team's early childhood expert.

The Rate My Game Opinionnaire

The student opinionnaire assessed students' perspectives and emotional responses to playing the Food Bingo game. It was adapted from Knezek, Christensen, & Tyler–Wood's STEM Semantics Survey (Knezek & Christensen, 2010) and consisted of a 3–item differential adjective pair rated on a Likert scale. The survey was created to assess general perceptions of STEM disciplines and careers. The Alpha value (.84-.93) reported by Knezek and Christensen (2010) suggests a high degree of reliability or internal consistency of Knezek's scale. Smiley face emojis were used for visual, student–friendly appeal. Two open–ended questions were included and were analysed thematically. Content validity was determined through teacher feedback on the appropriateness of the opinionnaire for their students' academic levels (see Figure 5).

Figure 4

Sample Questions from the "I love my food" Quiz

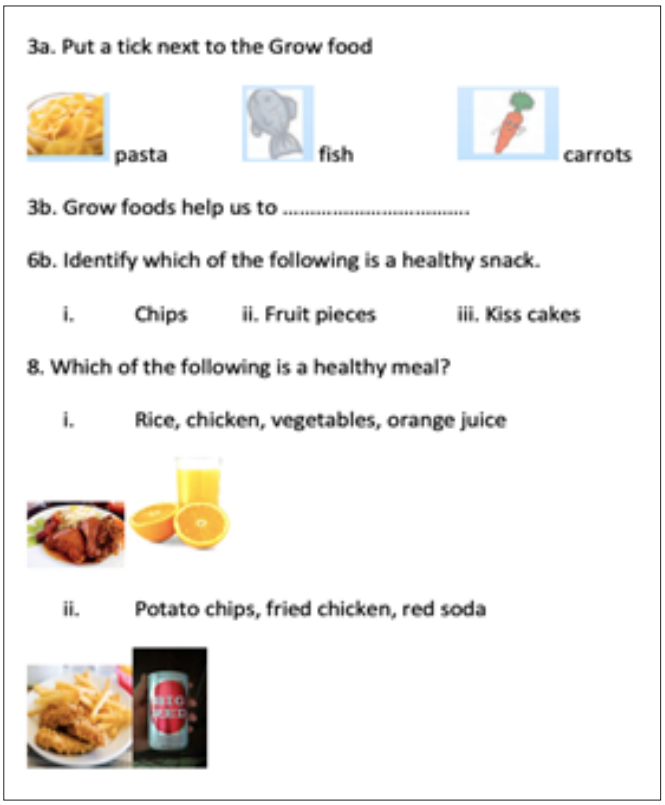
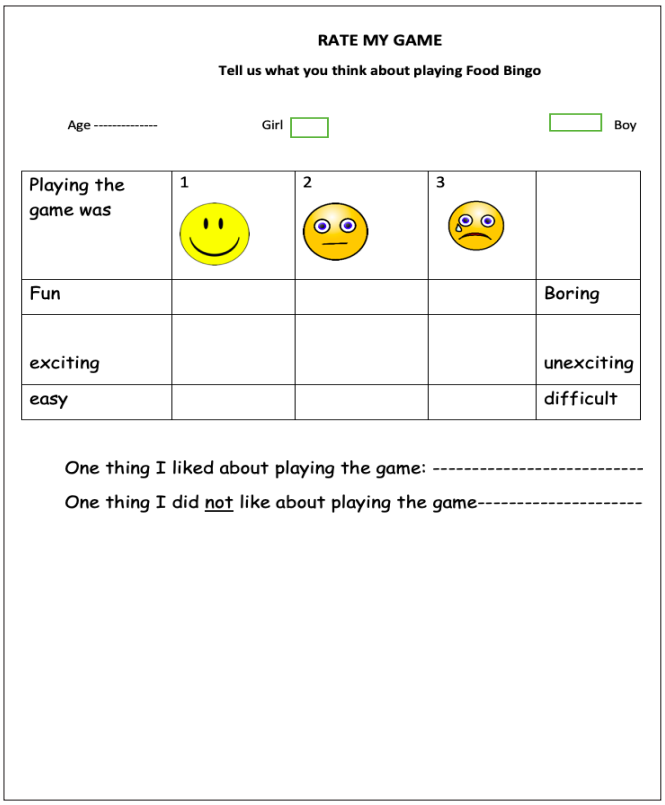


Figure 5

Students' "Rate my Game" Opinionnaire



Qualitative Instruments

Students' Focus Group Interviews

Six student volunteers were selected based on the teachers' recommendation of their ability to articulate their thoughts. They were interviewed by one researcher. Children candidly responded to researcher questions, thereby presenting their own experiences of GBL. The interviews took place in the students' classroom during their break. The interview was approximately 15 minutes.

The guiding questions were:

i. What were some of the things you did in class while playing Food Bingo?

ii. Did you like playing the bingo game?

iii. Were there any foods that you came across which you might not have heard about before?

iv. Did you help anyone, or did anyone help you to play the game?

v. How do "Go", "Glow" and "Grow" foods help you to become healthier?

Teacher Focus Group Interviews

Teachers of Classes F and S were interviewed together. Teachers shared their observations of students' response to game play and compared the incorporation of GBL with their traditional teaching methods.

The interviews took place during the break and were approximately 30 minutes long. Interviews were guided by the following questions:

i. Have you taught this topic before? How was it taught?

ii. Was the lesson format observed similar or different for the 5 lessons?

iii. How would you compare students' responses to Food Bingo with your traditional teaching method?

iv. What new knowledge was learnt by the students?

v. What kinds of behaviour were displayed by the students during the game?

vi. What were some of the challenges involved in playing the game?

vii. How do you think we could improve the game?

Trustworthiness of the interview data was facilitated by the verbatim transcription of the taped interviews. Analysis used in vivo coding, and students and teachers' voices supported the emergent themes, ensuring authenticity, credibility, and transparency

Data Collection

Teachers administered the pre- and post–tests and the students' opinionnaire at the end of the unit under regular classroom conditions. The researchers were not present during administration. We believe that teachers followed the agreed protocols and students answered independently without undue teacher influence. Evidence that students provided candid responses could be gleaned from their writing, which contained age–appropriate spelling and misspellings.

Data Analysis

Pre- & Post–Tests

Descriptive statistics and p scores were calculated in Microsoft Excel. Statistics included measures of central tendency (mean, mode, median), minimum and maximum scores, comparative line and bar graphs, and standard deviations. P scores were calculated using a paired t–test for means. T–tests measured the statistical significance of the pre- and post–test means (Creswell & Plano Clark, 2018).

Thematic Analysis

Thematic analysis was the method used to analyse the qualitative data. It is a systematic, rigorous, yet flexible analytic procedure which captures the subjective voices of participants in ways which are authentic and meaningful (Braun & Clarke, 2006). "Thematicizing data" involved inductively identifying and analysing patterns across a data set. Analysis was conducted through 6 described stages (Braun & Clarke,

2006; Burnard et al., 2008), and this was a relatively small data set it was done manually.

- Stage 1: Tidying and transcription. Multiple readings allowed for deep familiarity with the data set and finding of initial patterns. Intuitive memoing occurred.
- Stages 2 & 3: Coding and categorising. Data sets with similar meanings were colour-coded on the transcript. Coding occurred in cycles beginning with In vivo codes which prioritised participants' voices and kept the researcher close to the meanings attributed by participants (Miles, Huberman, & Saldana, 2014).
- Stages 4 & 5: Constant comparisons of codes reduced data into themes, sub-themes, and categories. Themes were reviewed across the total data set.
- Stage 6: Development of an analytical narrative.
- Appendix 3 presents the analysis of students' open–ended questions. In the first stage of thematic analysis, 22 student responses were read, re–read, and compared. Participants' voices were used to label the data set with in vivo codes, e.g. "winning", "losing", or "it was exciting". A comparison of patterns across the in vivo codes revealed analytical themes, such as "emotional satisfaction", "game success", and "losing". A review of the full data set further divided themes into categories of positive and negative experiences. A similar thematic process was used to analyse teacher and student focus group interviews. A meta–analysis of quantitative and qualitative data is represented in a joint display (see Table 4). The process of data integration is illustrated in that section.

Credibility and Trustworthiness

Qualitative analysis strives for authenticity, credibility, and trustworthiness rather than reliability and validity, which characterise the statistical analyses of quantitative studies. The authenticity of the data was strengthened by the length and quality of the time spent in the field. Researchers collected questionnaires, observed classrooms, and interacted closely with participants, allowing a deep understanding of the context and interpretation of their experiences. Transcripts presented verbatim reports of participants' perspectives, and in vivo coding ensured that the researchers stayed close to the data set. Several researchers collected the data, and their respective contributions to the process were described. Additionally, peer review served as a quality check for bias and competing interpretations of the analysis.

Ethical Procedures

Strategies to ensure adherence to ethical standards included written permissions to conduct the study which were obtained from The UWI, The MOETT, teachers, principals and parents of students. The researchers also ensured that participants fully understood the research activities and expectations. Informed consent procedures prioritized participant protection. Further, participation was voluntary, and unconditional withdrawal was provided without any consequences to participants. Confidentiality and anonymity were assured by removing identifying information and substituting pseudonyms for names. Data access was restricted to the researchers and permission to utilise the data for educational publication purposes was obtained. Data were stored in a password protected computer. Only the principal investigator had access to the locked filing cabinet containing the hard copies.

Findings

The findings are presented in relation to the research questions which guided analysis.

Quantitative Findings

Research Question 1: What are the effects of an instructional Bingo game on EC students' learning outcomes in a science unit on food groups and nutrition?

The pre- and post–tests ("I love my food quiz") assessed changes to students' knowledge. The results of these tests are presented in Table 2.

Table 2

Descriptive Statistics for Pre- and Post–Tests of Classes S & F (N=19)

Class test	2F Pre	2F Post	2S Pre	2S Post
Sum	35	91	100	143
Mean	1.8	4.8	5.3	7.3
Min score	1	1	0	5
Med	2	5	6	8
Max	3	9	7	11
P(T<=t) two–tail	***p < .001		***p < .001	
t Critical two–tail	2.0		2.03	

The results of the pre- and post–tests revealed an increase in the mean scores of both Class S and Class F (see Table 2). The minimum score increased in Class S but remained the same in Class F. Both Class S and Class F increased their maximum scores (see Table 2). Further, both classes separately (n = 19;***p< .001) and combined (n=38; ***p < .001) showed statistically significant improvements in their learning outcomes, post the intervention (see Table 2).

Figure 6

Graph of Students vs Pre- and Post–test Scores of Class F

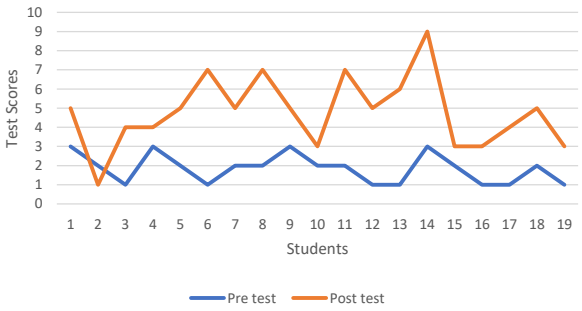
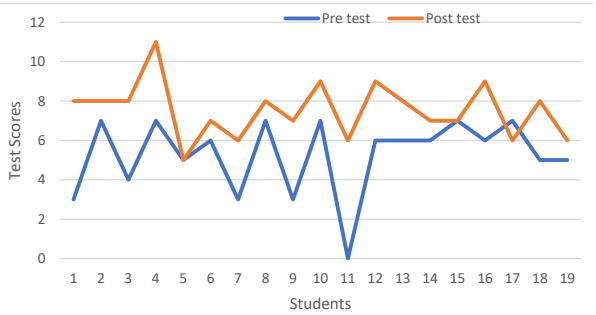


Figure 7

Graph of Students vs Pre- and Post–test Scores of Class S



Figures 6 and 7 compare the individual pre- and post–test scores of individual students. The majority of students (with the exceptions of Student 17 in Class S and student 2 in Class F) increased their mean score. Overall, Class F had a greater increase in their mean scores compared to Class S. Despite the significant improvement in scores individually, Figures 8 and 9 highlight observable differences in test scores when analysed by item. The implications of these outcomes are discussed on p.124.

Figure 8

Pre- and Post–Test Raw Scores by Item/ Question: Class F (n=19)

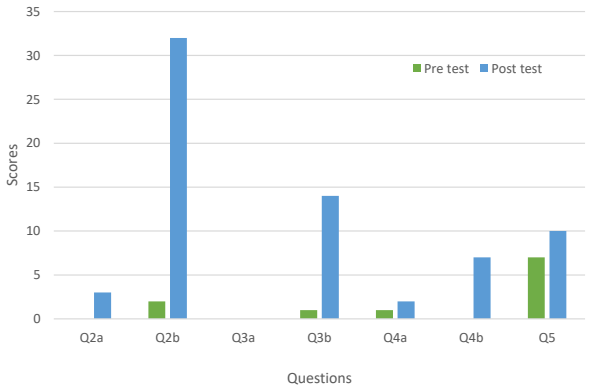
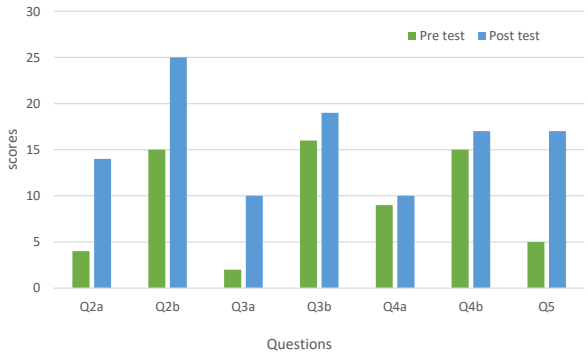


Figure 9

Pre- and Post–Test Raw Scores by Item/ Question: Class S (n=19)



Questions 2a, 3a, and 4a asked students to categorise a food category according to the food group, while the b section of the question asked students to identify the function of the food group. Both classes were less successful in recalling the food group (grow, glow or go food) compared to recalling the function of the food. Students could identify the function of the food group using the prompt, e.g. "grow food helps us to grow," but they had difficulty identifying the category of food.

Class F scored significantly lower than Class S in questions 2a, 3a, and 4a. Less than 5 students in Class F were able to respond correctly to these questions; and in question 3a, none of the students recalled the category of food (see Figure 8). Responses suggest that for many young students, recall of information without a memory hook (in this case the question's stem) was a challenging task. The visual and interactive nature of games provide memory hooks which can facilitate improved learning (Mayer, 2021).

Research Question 2: How do students' rate their experiences of using an instructional Bingo game to learn about food groups and nutrition?

Table 3 presents students' rating of their game experience across a 3–point Likert scale, on the dichotomous criteria of fun – boring, exciting – unexciting, easy – difficult.

Table 3

Students' Perceptions of Playing a Food Bingo Board Game for the Criterion Fun, Excitement, Difficulty (n=19 Class S; n= 19 Class F)

Rating Criteria	**Class F**			**Class S**		
	Happy	**Neutral**	**Unhappy**	**Happy**	**Neutral**	**Unhappy**
Fun – Boring	77	23	0	100	0	0
Exciting – Unexciting	72	14	44	99	1	0
Easy – Difficult	59	14	27	100	0	0

The majority of students in both classes rated their levels of enjoyment highly, but students in Class S had a higher rating for positive experiences compared to Class F.

Seventy–two percent of Class F and 100% of Class S experienced fun and excitement. One hundred percent of Class S felt that the game was easy to play, compared to 59% of Class F. Additionally, only 1 neutral score in Class S was related to the "Exciting – unexciting" category, compared to 14 neutral scores in Class F. Class F also attained a lower mean score in their post–test (see Table 5).

Qualitative Findings

Research Question 3: How do students and teachers describe the experiences of learning science through an instructional Bingo game?

Qualitative data for this question was collected through open–ended questions of the student opinionnaire and teacher and student focus group interviews. Students' responses to the open–ended questions, revealed both positive and negative perceptions of the game, which were captured in 6 subthemes or categories (see Appendix 3). Comparison of codes and categories across the opinionnaire and the focus group interviews are discussed under 6 emergent themes: Scientific Knowledge, Indigenous Knowledge, Healthy choices, Positive Emotions, Social Learning, and Visual Aesthetics**.** The Joint Display matrix (see Table 4) further integrated the qualitative and quantitative data under three broad learning outcomes: the cognitive, affective, and social domains. These findings illustrate the thematic process which crunches data from dozens of first cycle in vivo codes, to more abstract and interpretive categories/sub–themes, and themes.

The key categories/sub–themes emerging from the opinionnaire (see Appendix 3) and focus group interviews are discussed below.

Content Knowledge

When asked what they learnt from the game, students spontaneously named the food groups and their functions: "(Go foods) they give you energy to run, jump and play. (Glow foods) give us healthy eyes and skin. Some 'Glow' foods are like fruits and vegetables."

Under the opinionnaire theme *appreciation of food variety*, students named food groups and favourite foods as one of the things they liked about the game.

Indigenous Knowledge

Children readily shared their local experiences with their teachers and the researchers: "Miss I have this in my backyard" and "my aunty have a tree like this."Teacher S observed, "a lot of them did not know some of the fruits and the vegetables. I had to, like, tell them. I give them a little history [about local fruits]." In their interviews they noted, "I heard about almost all the foods, but some I never heard about … Five fingers, I never heard about [those before]."

Healthy Choices

Students could identify foods they believed were healthy choices and demonstrated a positive attitude to consuming fruits and vegetables: According to Teacher F, "they know what is unhealthy."

In their interviews some students informed us, "I found more fruits and vegetables that I should eat … my favourite vegetable is carrots and cucumber."

Children even tried to influence their parents' eating habits: "Mummy does say she always going on a balanced diet, but she isn't. She keeps eating unhealthy … I does tell her I would make a salad for her with carrots, lettuce … all the vegetables." Their conversation also revealed an ability to use the language of science, e.g. a balanced diet, in the proper context.

Positive Emotions

Students were enthusiastic about playing the game, particularly "winning".

"It makes me happy, it was exciting" (see Table 4).

Teacher S substantiated the students' affective claims when she said

"…they [students] were real excited about playing it. So, it kind of made them interested in it." (see Table 4).

Social Learning

The was no doubt that the competitive aspect of the game had a strong appeal "I love it because we won" wrote one student. Conversely, losing generated negative emotions. For a minority of students, the game did not satisfy their learning needs. In their interview one student described the game as "kind of boring" and the other as "difficult". Despite their dislike of losing, when asked if anybody helped them play the game, they noted that teamwork helped them "a lot". "My team helped me very much… I helped you a lot (speaking of his classmate)."

Teachers corroborated students' emotional responses to winning and losing, but they believed game play created developmentally important social skills such as self–control, collaboration and delayed gratification. One teacher commented, "… you could see the *teamwork* being displayed." She noted, "They [students] were *controlled* in a sense that they were *active* in the game. They were *concentrating*, *waiting* for you to call the fruit and you could see the *teamwork* being displayed."

Delayed gratification (waiting their turn) was not initially displayed by students, who were at times uncooperative. However, teachers facilitated turn–taking by adjusting play so that different students would get the opportunity to win. To quote teacher F, "I told them [the students] that the day that they had a turn … the other day, the next person would get a turn. Some of them, they were not cooperating, but it [turn–taking] helps with the cooperation."

Visual Aesthetics

Teachers also observed that students were attracted to the board's bright colours, and the images of the food, which they believed improved learning. One teacher stated that "when they actually saw the fruit! … the colour … they might make a connection to it, and they may remember it [and] they'll be able to recognize it because of the pictures."

Discussion

Integration is described as the centrepiece of mixed–methods research as it allows a rich and holistic understanding of complex systems in which "the whole is greater than the sum of the individual qualitative and quantitative parts." (Guetterman, Fetters, & Creswell, 2015, p. 555). Integration is captured in Research Question 4: How do quantitative and qualitative outcomes combine to deepen our understanding of young students' experiences of learning science through GBL? This discussion synthesises and interprets the findings from both the qualitative and quantitative data which has been interrogated through the research questions.

Three thematic domains – Cognitive, Affective, and Social Learning – emerged from analysis of the data. A joint display matrix facilitated the synthesis (see Table 4). Guetterman, Fetters, and Creswell (2015) recommended the use of joint displays as "a visual means to draw out new insights beyond the information gained from the separate quantitative and qualitative results" (p. 555).

Table 4

Joint Display: Integration of Qualitative and Quantitative Findings

GBL Learning Domains	Quantitative data	Qualitative data	Themes: GBL learning outcomes and experiences
Cognitive	2F: mean= 4.8 2S: mean= 7.3 Class F & S ***p < .001 Rejection of the null hypothesis. Statistically significant increase in post-test scores.	"It helped me with more learning and seeing what would happen when you eat those foods." Student: "it was putting the cards on the picture." Student: "it was showing glow food," Teacher: " 'Cause they actually saw the fruit! And so the colour and… they might make a connection to it… and they may remember it." Teacher: "They'll be able to recognize it because of the pictures."	**Increased scientific knowledge** **Engagement through active learning** **Visual learning – linking language and visuals**
Cognitive	100% of Class S rated the game easy to play; 59% of Class F rated the game easy to play.	Students: "It was rushing," "it was difficult." Students: "I heard about almost all the foods, but some I never heard about…", "Five fingers." Teacher: "A lot of them did not know some of the fruits and the vegetables … I give them a little history about it … I told them that we also have this in Trinidad."	**Differentiated experiences** **Indigenous knowledge** **Enhanced science experience Engendering curiosity**
Affective	72% of Class F and 100%of Class S rated the game positively for fun and excitement.	Student: "It was fun and nice and we had a good time." Teacher: "They [students] were real excited about playing it. So, it kind of made them interested in it." Student: "I love it because we won."	**Emotional appeal** **Motivation through game success**
Social		Student: "My team helped me very much." Teacher: "You could see the teamwork being displayed." Student: "I was playing with my friend." "I did not get Bingo." "The next team was winning."	**Collaborative opportunities** **Capacity for graceful failure**

Cognitive

Knowledge

GBL was associated with a measurable increase in scientific knowledge, a fact reinforced by children's own observations: "It helped me with more learning and seeing what would happen when we eat those foods". Quasi–experimental studies cannot definitively assert that learning outcomes are caused by the intervention. However, statistically significant increases between pre- and post–test mean scores (*** P< .001) suggest a strong probability that the difference between these scores was not simply due to chance. Since board games can encourage students to solve problems, answer science–related questions, and complete challenges as they learn, it is quite understandable that student scores significantly increased after the intervention (Bendixen–Noe, 2010).

The difference in the mean post–test scores between classes F and S (4.8 vs 7.3), may be related to several factors, including students' developmental levels. However, only a more structured experimental study would be able to identify a causal relationship.

Indigenous Knowledge

Jegede and Aikenhead (1999) have theorised that it is the socio–cultural environment which creates and nurtures knowledge. Children's fascination with local fruits appears to support their premise. Adapting the game board to highlight local foods built awareness of the natural and cultural environment, a precursor to attitudes which support local environmental conservation and sustainability (Boisselle, 2016; George, 2001; George & Glasgow, 1999).

Visual Learning

Game visuals also seemed to enhance the learning experience. The teacher reiterated, "if they actually saw the fruit…they might make a connection to it...and remember it." Mayer's (2021) spatial contiguity principle hypothesises that learning improves when visuals and related text are kept close together. The picture of the food, name of the food group, and the name of the food were in proximity on the board.

Rewards and Challenges

Teacher interviews revealed that although teaching normally incorporated active elements such as singing and discussions, the game added novelty, motivation, and enhanced learning. Most students expressed high levels of enjoyment, as measured through their game ratings and interviews. (see Table 3).

Further, as Klabbers (2003) argued, games incorporate a built–in reward system which provides feedback, reinforcing knowledge and motivating students to repeat learning and attain content mastery.

Game Design

Student ratings of their learning experiences with the game can be analysed by examining game design. Since the class with the academically "brighter" students consistently rated learning from the game more positively than the other class (see Table 3), it is quite possible that some elements of game design did not accommodate academically "weaker" students. Using Ahmad's (2019) four elements of game design: mechanics, aesthetics, story, and technology — the mechanics aspect can be applied. Rules and procedures may not have helped some players to achieve the game's goals. Since data were collected over a limited time period, there may have been insufficient repeat play for some students to master the game (Ahmad, 2019). Game design for this project may have needed more careful attention to ensure that cognitive engagement met the learning goals of all students (Plass et al., 2015).

Further, Vygotskian theory suggests that game design could have been more deliberately crafted to ensure that students obtained sufficient scaffolding to achieve learning mastery; and through a Behaviourist lens, unfavourable responses may result if the challenge is too difficult for students to be rewarded with winning.

Differentiation

The difficulties students had with naming the food groups were not evident in the focus group interview. When interviewed, students stated both the names and the functions of food groups

accurately. The understanding that assessment tests for young children should include both formal and informal methods (NAEYC, n.d.), seems applicable in assessing children's science learning from the board game. Young students may function better when tested orally and in more informal situations. In addition, the students interviewed (a small subset of the class) may have had a better grasp of the concept than their classmates. These outcomes suggest that a more nuanced data collection process may be necessary when working with young students.

Affective

Emotional Appeal

Game elements supported positive affective experiences. Quantitative and qualitative findings identified the game as creating "fun" and "excitement" and motivating students through its competitive aspect. "I love it because we won", was a common expression. The game, therefore, had both an emotional and a motivational appeal, which has been associated with improved cognitive outcomes by encouraging gamers to attain mastery through repeated game play (Barseghian, 2013).

Both qualitative and quantitative findings suggested that there were differentiated outcomes, as elements such as losing and the speed of play were stressful for some. Affective outcomes may be attributable to how games influence emotional engagement when used as a learning strategy (Barseghian, 2013; Plass et al., 2015). Successful games are noted to lower the consequences of failure, and so encourage risk–taking, exploration, and self–regulation (Plass et al., 2015).

Competitiveness

The major negative finding of Food Bingo, was that students disliked losing. It is noteworthy that teachers doctored the game so every team won at least once, yet the contrast between students' positive feedback on winning and the disappointment of losing suggests that these young students found the game easy to play, but difficult to deal with emotionally.

Despite their disappointment, students persisted in playing the game and retained friendships even when they lost. Teachers echoed Plass et al.'s (2015) argument that games provide a context for graceful failure. Despite the stressors associated with turn–taking and delayed gratification, teachers believed that learning how to lose gracefully was a precursor to social development and academic success.

Healthy Choices

Focus group interviews revealed that learning moved beyond the regurgitation of knowledge. Students were adopting healthy food practices by increasing their consumption of fruit and vegetables, identifying their favourite vegetables, and trying to influence their parents' eating habits. A similar outcome was derived from the Hispanic Bingo Loteria study (Piziak, 2021).

Social Experiences

A third domain emerging from the qualitative findings was the development of social skills. Since Food Bingo was a team game, collaboration and teamwork were essential learning experiences identified by students and teachers. When the teacher stated – "You could see the teamwork displayed", and children noted "my team helped me very much" they gave recognition to the significance of collaboration for enhancing the learning experience.

Social Constructivism seemed to have guided the social context of learning, as game-playing occurred in an environment that facilitated social collaboration and interaction (Vygotsky, 1978). Hromek and Roffey (2009) suggest that games which accommodate collaboration and enjoyment support social and emotional development in the early years (Hromek & Roffey, 2009; Squire, 2007)

Studies of pre–school and elementary school Bingo have mainly pursued the development of mathematical and language skills (Noviyanti et al., 2019; Tella & Fatoki, 2021). In this study Bingo provided students with an enhanced science experience. The authors found no science studies other than Piziak (2021) that researched Bingo in early childhood science classrooms. Piziak

(2021) focussed on changing attitudes, while this study measured a broad range of cognitive, affective, and social learning outcomes.

Food Bingo as an intervention was embedded within a larger unit on Food Groups, aligned to the objectives of the Trinidad and Tobago Science syllabus. The game was adapted to feature local foods and facilitate curiosity, indigenous knowledge, and the identification and classification of food groups and their functions, as well as healthy and unhealthy options. The game contextualised learning, created authenticity, and enriched students' experiences.

Implications

As an innovative student–centred pedagogy, Food Bingo positively influenced students' perceptions and experiences of learning science. Findings from this research can be used to highlight broader implications for early childhood education and game–based learning as well as teacher training in the Caribbean. Since there is limited empirical research on GBL at the early childhood primary level in Trinidad and Tobago, this study fills an important gap by helping us to better understand the benefits which could be derived from incorporating GBL in Science education for young learners. Though small scale, the findings can serve as a guide for understanding how to develop similar board games for Science teaching in similar contexts at the early childhood level.

The students benefitted cognitively, socially, and emotionally from the intervention. Although a few students did not like the game, their feedback was important for guiding future game development. Students' perceptions and experiences were related to the quality of their engagement in the gaming environment as well as the emotional appeal and relevance of the game. Guided by Vygotsky's ZPD (Vygotsky, 1978), more scaffolding may be needed for some students to achieve successful learning outcomes. Additionally, assessment practices that involved both formal (paper tests) and informal approaches (student interviews) were important for gaining a true reflection of student learning.

Implications for teacher training in the Caribbean include continuous professional development programmes that teach principles of assessment for the early years. This would assist teachers to better understand how to more accurately assess the needs of young learners who are at the beginning stages of developing an understanding of the world around them. Professional development in differentiated instruction and GBL would enhance teachers' skills and confidence in effectively developing and implementing games within their classrooms. Finally, teacher professional development that fosters active science pedagogies grounded in indigenous practices is a prerequisite for meaningful learning in the Caribbean.

Conclusion and Recommendations

Students' experiences of Food Bingo created interest, excitement, motivation, and improved learning. These findings align with GBL studies globally (Al–Tarawneh, 2016; Pinder, 2013; Piziak, 2021; Trundle, 2009; Wahyuni & Rozani Syafei, 2016). Mixed methods provided opportunities for data enrichment from multiple sources, including pre- and post–tests, rating scales, and observation. The game design provided greater insight into the nuances of specific game elements, student characteristics, and the classroom dynamics that influence students' learning experiences. The data highlighted variations in young students' understanding, literacy levels, and the social challenges associated with game play. Such observations suggest that with GBL, the role of the teacher is critical for differentiating learning. Games that allow teacher adaptation for specific classroom contexts have the potential for more success in meeting students' developmental needs.

Learning Science at early ages should imbue children with a sense of inquiry and wonder about their natural world. The NAEYC (n.d.) advises the fostering of young children's joyful learning to ensure that every child achieves their full potential. Food Bingo, adapted to students' cultural context, and designed as team play, created opportunities to engage actively with

scientific concepts, and develop essential scientific skills. This study adds to the limited Caribbean literature on young children and learning science through GBL. It reinforces the importance of authentic learning in science classrooms, and the role of indigenous knowledge in developing curiosity and ownership of learning.

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Appendix 1: GBL Unit and Lesson Plan

UWI SOE GBL — UNIT PLAN

School _____ Date _____

Teacher _____

<table>
<tr><td colspan="2">Unit Title: Healthy Eating</td></tr>
<tr><td colspan="2">Unit Objectives

1. Identify common foods using the sense of smell, taste, touch and sight.

2. Classify foods by their origin – from plants or animals.

3. Classify foods by the “Go, Glow and Grow” nomenclature.

4. Identify the functions of the Go, Grow and Glow group of foods

5. Identify a healthy, balanced diet using a mixture of Go, Grow and Glow foods.

6. Distinguish foods grown locally and internationally.</td></tr>
<tr><td>No. of

Lessons: _____</td><td>Lesson Titles

1. Different kinds of food (Objectives 1 & 2)

2. Go foods and their functions. _____

3. Grow foods and their functions. _____

4. Glow foods and their functions.

5. Balanced diets. _____</td></tr>
<tr><td colspan="2">Resources</td></tr>
<tr><td colspan="2">Unit Evaluation</td></tr>
<tr><td colspan="2">Notes</td></tr>
</table>

UWI SOE GBL- LESSON PLAN

Identify foods which help us glow (Glow foods)

School_____ Teacher _____

Date: _____ Age Group_____ No. in Class _____ No. Present_____ Duration:_____mins	**Lesson Topic/Title** _____ _____	Unit Topic _____ _____
Previous Knowledge		
Lesson Objectives Identify foods which make us glow (fruits, veggies) Identify the function of the Glow foods Describe the colour, texture and taste of Glow foods (observation) Distinguish the Glow foods in a mixture of foods		
Resources Pictures, foods, games Glow foods – fruits, vegetables		
Lesson Outline Set Induction/introduction Pictures of a healthy child and a child with the flu What is different about these pictures? Which foods do you think prevent us from being sick? Today we will find out. Teacher reviews go and grow foods. **Section 1 - Identifying Glow foods** Experimental group – students play the Bingo – they identify the foods as Glow foods. Students name the foods. Students state whether foods come from plants or animals. **Section 2 - Observing Glow foods using the senses; their origin, where grown** Examples of real glow foods, pictures from Bingo board or other sources. Students describe what the foods look like, taste, smell. Teacher can introduce the words Fruits, Vegetables. Teacher asks what fruits and vegetables they like to eat and points out the ones grown in Trinidad and Tobago and the ones that come from other places. **Section 3 - Distinguishing Glow foods from other foods** Students can play bingo again – teacher calls randomly – students determine which are Glow foods and which are not. Teacher finds out from students which of the Glow foods grown in Trinidad and Tobago they have seen or tasted previously. Or Students are provided with pics of a meal or several foods and they distinguish the Glow food from other types.		
Closure		
Lesson Evaluation Problem – Mary does not like to eat fruits or vegetables – tell her why she should eat them. Choose 2 fruits or vegetables that you like to eat.		
Follow up activity		
Next Lesson topic		
Notes & Comments		

Appendix 2

Classroom Observations of a Food Bingo Class

Observation Process

One author was assigned to each class during observation. The authors sat to the back of the classroom so they would not interrupt the lesson and tried to be as unobtrusive as possible. The authors recorded the lesson activities using field notes, and guided by an observational protocol. The observations occurred on May 10, 2017. The teachers previously taught two lessons. The observed lesson represented their 3rd lesson of the unit (see Timeline – Figure 2).

The table below provides a description of the Grow Foods lesson.

Table of Observations for the Lesson on Grow Foods

Topic	Grow Foods
Classroom environment & resources	Bingo board game Colouring sheets Students sit in groups of 3 around 7 flat–topped wooden desks.
Length of lesson	20 minutes
No of students	21
Introduction	Teacher recaps Go foods and Glow foods. The teacher questions students to elicit examples of each food type and their function. She uses two students of different heights and questions students on how one student will meet the other.
Lesson body	She introduces the terms "protein" and "Grow foods". She reinforces the term by spelling GROW, students also spell orally and the teacher writes GROW on the board. Children use the Bingo boards to identify the grow foods.
Food Bingo intervention	Students play Bingo. They are familiar with the procedure. As they cover a row or column, they shout Bingo. The items covered are grow foods (shrimp, fish, peanut butter). They name the item and say what food group they belong to when questioned, e.g. chicken and turkey belongs to Meats.
Closure and end of class assessment	The teacher asks students to name Grow foods and state their function. Students choose a Grow food from a packet that each child has. The children stick the pictures in their science copy book. The teacher then distributes worksheets where students identify the type of food and colour the foods.

Appendix 3: Students' Perceptions of Playing Food Bingo

Opinionnaire: Open Ended Questions

….one thing I liked….one thing I did not like

Students' voices	Positive themes	Students' voices	Negative themes	In vivo codes
"It had different fruits" "It had lots of food" "It was showing glow food" "Was which food I liked"	**Appreciation of food variety**	"I did not like the fruit"	**Specific preference**	▪ Different foods ▪ Favourite/not favourite food ▪ Food groups
"It was putting the cards on the picture" "We have to say Bingo" "Holding the tabes (tabs)"	**Active learning**	"It was boring" "I did not get to hold the chit"	**Insufficient engagement**	▪ Boredom ▪ Not getting a chance ▪ Holding and doing ▪ Saying Bingo
"I was playing with my friend" "They had groups"	**Collaborative learning**			▪ Playing with friends ▪ Working in groups
"I love it because we won" **"We get to win"** **"I come first in the game"**	**Game success**	"I did not get Bingo" "The next team was winning" "When we losed (lost)"	**Losing**	▪ Winning ▪ Coming first ▪ Losing
"It was fun and nice and we had a good time" **"It was exciting"** **"It makes me feel happy"**	**Emotional satisfaction**			▪ Having a good time ▪ Fun ▪ Excitement ▪ Happy feelings
Fun, **easy**	**Appropriately challenging**	"It was rushing" "It was difficult" "I had to shout bingo"	**Stressful game climate**	▪ Rushing ▪ Shouting ▪ Difficult

Appendix 4

Table of Lesson Objectives, Level of Objectives, Marks, and Test Items

Objectives	**Cognitive level**	**Total score by category**	**Item description**
Identification of food category	Knowledge	3 mks	Identification of: Q 2a – Go foods Q 3a – Grow foods Q 4a – Glow foods
Identification of food function	Understanding	6 mks	Functions of: Q 2b – Go foods Q 3b – Grow foods Q 4b – Glow foods
Identification of a food containing all food groups	Application	1 mk	Identifying a mixed nutrient food. Q 5 (milk)
Identification of healthy food choices	Application	2 mks	Q 6b Identification of a healthy snack (fruit) Choosing a healthy meal Q 8 (rice, chicken, vegetables, orange juice)
Total score for all items		**12 mks**	