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Exploring Grade Ten Students' Perceptions of the Effectiveness of the Integrated Science School-Based Assessment in a Secondary School in Region 6, Guyana: A Preliminary Study

Nicholas De France [1], Lakhnarayan Kumar Bhagarathi [2, 3, 4, *], Andre Indardat [1], Aarif Baksh [4], Bibi Rafeena Ally-Charles [5], Chalasa Cossiah [4], Phillip N. B. Da Silva [2, 4] and Ferial Pestano [4]

[1] *Faculty of Education and Humanities, University of Guyana, Turkeyen Campus, Greater Georgetown, Guyana.*
[2] *Institute for Marine and Riverine Ecologies and Economies, University of Guyana, Berbice Campus, John's Science Centre, Corentyne, Berbice, Guyana.*
[3] *Faculty of Natural Sciences, University of Guyana, Turkeyen Campus, Greater Georgetown, Guyana.*
[4] *Faculty of Natural Sciences, University of Guyana, Berbice Campus, Tain, Corentyne, Berbice, Guyana.*
[5] *College of Medical Sciences, University of Guyana, Turkeyen Campus, Greater Georgetown, Guyana.*

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Abstract

This study explores students' perceptions of the effectiveness of the Integrated Science School-Based Assessment (SBA) within the Caribbean Secondary Education Certificate (CSEC) framework. Grounded in educational theories that support continuous assessment, the SBA aims to foster critical thinking, practical application, and independent learning through hands-on experiments and collaborative projects. Despite these intended benefits, limited empirical evidence exists on how students perceive the SBA's role in enhancing academic performance, particularly with regard to gender differences. This research addresses this gap by examining how students view the contribution of the Integrated Science SBA to their CSEC performance and whether perceptions differ between male and female students. A quantitative research design was employed, utilizing a structured 20-item Likert-scale questionnaire administered to a stratified random sample of thirty-five (35) Integrated Science students from a secondary school. The instrument demonstrated high internal consistency (Cronbach's alpha = 0.81). Descriptive statistics showed generally positive perceptions of the SBA, with students agreeing that the SBA enhances understanding of scientific concepts, critical thinking, and exam readiness. However, areas of concern included clarity of instructions and adequacy of teacher support. Independent samples t-tests revealed no statistically significant differences between male and female students' perceptions across all questionnaire items, indicating a shared consensus on the SBA's effectiveness regardless of gender. These findings support the conclusion that the Integrated Science SBA positively impacts students' academic experiences and outcomes in a gender-neutral manner. Despite its small sample size and context-specific focus, the study provides valuable insights for educators and policymakers. It recommends clearer guidance, enhanced teacher support, extended task timelines, and increased opportunities for collaborative learning. Addressing identified concerns could further strengthen the SBA's role as a meaningful component of the Integrated Science curriculum.

Keywords: School-Based Assessment; Integrated Science; Science Education; Caribbean Secondary Education Certificate; Student Perceptions; Gender Differences; Educational Outcomes

* Corresponding author: Lakhnarayan Kumar Bhagarathi

1. Introduction

1.1. School-Based Assessment (SBA)

The concept of SBA is rooted in the educational theory that continuous assessment can provide a more accurate and comprehensive measure of student learning compared to traditional, high-stakes examinations. SBAs are designed to assess students over a period, involving various tasks that require the application of theoretical knowledge to practical scenarios. This approach is intended to develop critical thinking, problem-solving skills, and the ability to conduct scientific inquiries, all of which are essential competencies for students in the 21st century [9].

The Integrated Science SBA specifically aims to bridge the gap between theoretical instruction and practical application. By engaging students in hands-on experiments, research projects, and collaborative tasks, the SBA seeks to enhance their understanding of scientific principles and processes [21]. This form of assessment is also aligned with contemporary educational goals that emphasize skills such as collaboration, communication, and independent learning [19].

Despite the theoretical benefits of SBAs, there is limited empirical evidence on how students perceive these assessments and their effectiveness in enhancing learning and exam performance. Understanding student perceptions is crucial because it can inform educators about the strengths and weaknesses of the SBA, guiding improvements and ensuring that the assessment method meets educational objectives. This research addresses this gap by exploring the perceptions of students regarding the Integrated Science SBA within the CSEC framework. It also seeks to determine if there are any significant differences in perceptions between male and female students, which could highlight potential areas for targeted interventions [22].

1.2. Importance of School-Based Assessment (SBA)

The concept of SBA is rooted in the educational theory that continuous assessment can provide a more accurate and comprehensive measure of student learning compared to traditional, high-stakes examinations. SBAs are designed to assess students over a period, involving various tasks that require the application of theoretical knowledge to practical scenarios. This approach is intended to develop critical thinking, problem-solving skills, and the ability to conduct scientific inquiries, all of which are essential competencies for students in the 21st century [9].

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1.3. Effectiveness of School-Based Assessments (SBAs) on Academic Performance

Onyango (2012) [32] investigated the influence of SBA on performance in Kenya's Primary Teacher Education examination. The study found a weak but positive relationship between SBA and final examination scores, with the inclusion of SBA scores positively affecting students' grades, especially as the weighting of SBA increased.

Osadebe (2015) [34] conducted a comparative analysis of senior secondary school students' performance with SBA scores of continuous assessment and promotion examinations in Nigeria. The study revealed that students performed better in continuous assessments, suggesting its effectiveness in evaluating students' academic progress.

In Malaysia, Abdullah et al. (2016) [1] evaluated the effectiveness of SBA among science teachers using the Context, Input, Process, and Product (CIPP) model. The study concluded that while the process dimension of SBA implementation was high, other dimensions were moderate, suggesting areas for improvement in SBA practices.

Fareo (2020) [17] studied the influence of continuous assessment on academic performance of secondary school students in Biology in Nigeria. The research indicated a significant relationship between continuous assessment scores and academic performance, affirming the role of continuous assessments in enhancing student achievement.

Issaka et al. (2020) [25] explored the benefits of SBA in learning Social Studies in Ghana. Despite most teachers not having attended workshops on SBA, they implemented it in assessing students and recognized its advantages in teaching and learning, recommending further training for effective utilization.

Azid et al. (2022) [5] examined the incorporation of higher-order thinking skills (HOTS) in SBA and its effect on students' mathematics achievement in Malaysia. The study found that integrating HOTS into SBA contributed significantly to students' mathematics scores, highlighting the importance of cognitive skill development in assessments.

In Pakistan, Das et al. (2022) [15] conducted a quasi-experimental study involving 486 secondary school students to assess the impact of formative assessment on academic achievement. The findings indicated a statistically significant improvement in students' performance, emphasizing the positive role of formative assessments in enhancing learning outcomes.

In Nigeria, Ilobi et al. (2022) [23] investigated the effect of SBA strategies on senior secondary school students' performance in economics. The study revealed that students exposed to SBA strategies, including quizzes, observations, assignments, projects, and peer assessments, performed better than those who were not, underscoring the efficacy of SBA in improving academic performance.

Adjei et al. (2023) [2] investigated the impact of performance-based assessment strategies on pre-service teachers' self-efficacy and academic achievement in general physics in Ghana. The quasi-experimental study demonstrated that performance-based assessments significantly improved students' problem-solving abilities and confidence in studying physics.

Surman et al. (2024) [44] examined the predictive capacity of SBA on students' mathematics performance in Ghana's Basic Education Certificate Examination (BECE). Analyzing data from 150 mathematics teachers, the study found a strong predictive relationship between internal exam scores and BECE performance, highlighting the critical role of SBA in forecasting academic outcomes.

Collectively, these studies underscore the positive impact of SBA on students' academic performance across diverse educational settings. While the effectiveness of SBA varies based on implementation strategies and contextual factors, the overarching consensus is that well-structured SBA practices enhance learning outcomes, foster critical thinking, and better prepare students for summative evaluations.

1.4. School-Based Assessments (SBAs) in Science Education

School-Based Assessments (SBAs) are designed to evaluate students over an extended period through various tasks, promoting continuous learning and application of knowledge [9]. Research has shown that SBAs can enhance critical thinking and problem-solving skills, as they require students to engage with practical and theoretical aspects of their studies [19] [43]. Hofstein and Lunetta (2004) [21] emphasized the importance of laboratory experiences in science education, noting that hands-on activities help students develop scientific reasoning and inquiry skills.

In the context of Integrated Science, SBAs facilitate a deeper understanding of scientific concepts by bridging the gap between classroom learning and real-world application [11]. This alignment with constructivist learning theory supports the idea that students construct knowledge through active engagement and reflection [36]. Vygotsky's Social Development Theory further supports the collaborative aspects of SBAs, where peer interactions enhance learning [45].

One of the primary benefits of SBAs is their ability to enhance critical thinking and problem-solving skills among students. Traditional assessments often focus on rote memorization and the ability to recall information under timed conditions. In contrast, SBAs require students to apply their knowledge in various contexts, encouraging deeper cognitive engagement. According to Harlen and James (1997) [19], this continuous assessment process enables students to develop a more profound understanding of the subject matter, as they must analyze, synthesize, and evaluate information regularly. Stiggins (2002) [43] adds that such assessments foster a learning environment where students are more likely to engage in metacognitive activities, reflecting on their learning processes and outcomes.

SBAs, particularly in science education, provide students with opportunities to engage in laboratory experiences that are crucial for developing scientific reasoning and inquiry skills. Hofstein and Lunetta (2004) [21] highlighted that hands-on activities in the laboratory help students understand scientific concepts more concretely and develop skills in scientific inquiry. These activities require students to formulate hypotheses, conduct experiments, analyze data, and draw conclusions, thereby fostering a more holistic understanding of the scientific method. This practical engagement with science enables students to connect theoretical knowledge with empirical evidence, making their learning more meaningful and robust.

Moreover, the iterative process of conducting experiments, where students must often repeat procedures to verify results or refine their techniques, mirrors the practices of professional scientists. This repetition not only reinforces learning but also imparts a sense of perseverance and resilience, which are critical attributes for scientific inquiry. The ability to critically analyze data and draw evidence-based conclusions is a fundamental skill that SBAs help to develop, preparing students for further education and careers in scientific fields.

Another significant benefit of SBAs is their ability to bridge the gap between classroom learning and real-world application. Brookhart (2004) [11] argues that when students see the relevance of their academic work to real-world problems and scenarios, they are more motivated to learn and apply their knowledge. This is particularly important in subjects like Integrated Science, where understanding scientific principles can lead to practical applications in everyday life. For example, students might engage in projects that address environmental issues, health-related experiments, or technological innovations, thereby seeing the direct impact of their studies on the world around them.

This real-world application is a cornerstone of the constructivist learning theory, which posits that students learn best when they can connect new information to their existing knowledge base and see its relevance to their own lives [36]. By engaging in projects that have tangible outcomes, students are more likely to retain the information and develop a deeper understanding of the scientific concepts being taught. This approach also helps to cultivate a sense of responsibility and agency in students, as they see how their actions and ideas can contribute to solving real-world problems.

Understanding student perceptions of School-Based Assessments (SBAs) is crucial for evaluating their effectiveness and ensuring that they fulfill their intended educational purposes. Black and Wiliam (2009) [10] emphasize that formative assessments, including SBAs, are most effective when students understand their purpose and perceive them as fair and beneficial. This perception directly impacts how students engage with the assessments and their overall learning experience.

Brookhart (2004) [11] found that when students view assessments as supportive and aligned with their learning goals, they are more likely to engage positively with them. This positive engagement is essential for maximizing the benefits of SBAs, such as enhanced critical thinking, problem-solving skills, and deeper understanding of the subject matter. When students perceive SBAs as tools that genuinely contribute to their learning, they are more likely to put in the effort required to succeed, leading to better academic outcomes and personal development.

However, not all students perceive SBAs positively. Some studies indicate that students may experience significant stress and anxiety due to the continuous nature of these assessments [19] [20]. Unlike traditional examinations, which occur at specific intervals, SBAs require ongoing effort and engagement. This continuous pressure can be overwhelming for some students, leading to increased levels of stress and anxiety. Stiggins (2002) [43] points out that this stress can impact students' overall perception of the SBA's effectiveness, potentially undermining its intended benefits. If students feel constantly evaluated, it may lead to burnout and a negative attitude towards learning.

Furthermore, the clarity of instructions and the quality of feedback are critical factors influencing student perceptions of SBAs. Sadler (1989) [40] argues that for formative assessments to be effective, students must receive clear, actionable feedback that guides their learning and improvement. If instructions for SBA tasks are ambiguous or if feedback is vague and unhelpful, students may feel frustrated and confused, diminishing their perception of the SBA as a fair and supportive tool for learning. The quality of feedback is particularly important in helping students understand their strengths and areas for improvement. Effective feedback should be specific, timely, and constructive, providing students with a clear path forward. When students receive high-quality feedback, they are more likely to see the value in the assessment process and engage more deeply with their learning. Conversely, poor feedback can lead to misunderstandings, decreased motivation, and a lack of trust in the assessment process.

School-Based Assessments (SBAs) provide a holistic approach to student evaluation by integrating various tasks over an extended period, promoting continuous learning and practical application of knowledge. Research indicates that SBAs enhance critical thinking and problem-solving skills by engaging students with both theoretical and practical aspects of their studies, particularly in Integrated Science where they bridge classroom learning with real-world applications [11] [36] [45]. Laboratory experiences within SBAs foster scientific reasoning and inquiry skills, preparing students for advanced education and careers in scientific fields [21].

However, understanding student perceptions is crucial for evaluating the effectiveness of SBAs. Positive perceptions, where students see these assessments as fair and beneficial, significantly enhance engagement and motivation [9] [11]. Conversely, continuous assessments can induce stress, and the clarity of instructions and quality of feedback are critical

in shaping these perceptions [19] [20] [40]. Ensuring SBAs are perceived positively can maximize their educational benefits, making it essential to address factors that impact student perceptions and experiences.

In Malaysia, Abdullah et al. (2016) [1] utilized the Context, Input, Process, and Product (CIPP) model to evaluate SBA among secondary science teachers. The study found that while the process dimension of SBA implementation was rated high, other dimensions such as context, input, and product were at moderate levels. Teachers acknowledged the benefits of SBA but highlighted the need for ongoing training and support to enhance its effectiveness.

In Kenya, Malongo (2015) [27] investigated the impact of school-based practical assessments on learner achievement in biology. The quasi-experimental study revealed that students exposed to practical process skills, including observation and experimentation, performed significantly better than those who were not, emphasizing the importance of hands-on assessments in science education.

Opateye and Ewim (2022) [33] conducted a study in Nigeria focusing on the impact of research- and assessment-based instructional modes on senior high school students' achievement in chemistry. The findings indicated that students exposed to assessment-based instructional modes achieved higher scores compared to those in research-based and conventional instructional settings, suggesting the efficacy of assessment-driven teaching strategies.

In Trinidad and Tobago, Benjamin (2014) [7] employed action research to assess the use of performance assessment in a Form 3 integrated science class. The study demonstrated that performance assessments significantly improved students' interest and academic performance in science, fostering a more engaging and effective learning environment.

These studies collectively underscore the positive impact of SBA on science education. By incorporating practical and performance-based assessments, educators can enhance student engagement, foster deeper understanding of scientific concepts, and improve academic achievement. However, the successful implementation of SBA requires adequate training, resources, and support for teachers to effectively integrate these assessments into their instructional practices.

In summary, while SBAs offer numerous educational benefits, their effectiveness largely depends on how students perceive and engage with these assessments. Ensuring that SBAs are perceived as fair, beneficial, and supportive can maximize their potential in enhancing student learning outcomes and preparing students for real-world applications of their knowledge. Future research should continue to explore ways to mitigate the stress associated with continuous assessments and improve the clarity and quality of feedback, thereby fostering a more positive and effective learning environment for all students.

In current education, assessment methodologies are principal in shaping student learning experiences and outcomes. Traditional assessment methods often rely heavily on standardized testing, which, while valuable, may not fully capture a student's understanding and application of knowledge. The Integrated Science School-Based Assessment (SBA), implemented within the Caribbean Secondary Education Certificate (CSEC) curriculum, represents a progressive step towards a more holistic and continuous evaluation method. This research investigates student perceptions of the effectiveness of the Integrated Science SBA, with particular attention to its impact on exam performance, critical thinking, and engagement with scientific concepts.

Despite the theoretical benefits of SBAs, there is limited empirical evidence on how students perceive these assessments and their effectiveness in enhancing learning and exam performance. Understanding student perceptions is crucial because it can inform educators about the strengths and weaknesses of the SBA, guiding improvements and ensuring that the assessment method meets educational objectives. This research addresses this gap by exploring the perceptions of students regarding the Integrated Science SBA within the CSEC framework. It also seeks to determine if there are any significant differences in perceptions between male and female students, which could highlight potential areas for targeted interventions [22].

Despite the extensive literature highlighting the pedagogical benefits of School-Based Assessments (SBAs), there is a notable gap in empirical research focusing on student perceptions, particularly within the Caribbean Secondary Education Certificate (CSEC) Integrated Science curriculum. While studies have demonstrated that SBAs can enhance critical thinking, problem-solving abilities, and the application of theoretical knowledge [9] [19] [20], there is limited understanding of how students view these assessments and their impact on learning outcomes. This research aims to address this gap by providing empirical data on students' perceptions of the SBA. By understanding students' perspectives, educators can identify strengths and weaknesses in the current assessment framework and make informed decisions to improve educational practices, ultimately enhancing student learning and exam performance [43].

Additionally, this study is justified by its potential to inform policy development and address gender disparities in education. This research will provide valuable insights into the effectiveness of the Integrated Science SBA, contributing to policy discussions on assessment methods. Furthermore, by investigating gender differences in perceptions of the SBA, this study can identify specific areas where interventions may be needed to ensure equitable educational opportunities for all students, regardless of gender [22]. Addressing these disparities is crucial for fostering an inclusive learning environment that supports the success of every student.

This study aimed to provide insights into how the School-Based Assessment (SBA) influences students' academic experiences and outcomes, while also examining potential gender differences in these perceptions that may indicate underlying biases or varying educational needs. The specific objectives of this study are: (1) To examine students' perceptions of the role of the Integrated Science School-Based Assessment (SBA) in their performance on the CSEC examinations. (2) To determine whether significant differences exist between male and female students' perceptions of the Integrated Science SBA's effectiveness in predicting CSEC performance. The research questions guiding this study are: (1) How do students perceive the contribution of the Integrated Science SBA to their performance in the CSEC examinations? (2) Is there gender-based differences in students' perceptions of the Integrated Science SBA's effectiveness in predicting CSEC performance?

The hypotheses that guide this study are:

1.4.1. Null Hypotheses

- (H0 1): Students do not perceive the Integrated Science SBA as contributing significantly to their performance in the CSEC examinations.

- (H0 2): There is no significant difference between male and female students' perceptions of the effectiveness of the Integrated Science SBA in predicting CSEC performance.

1.4.2. Alternative Hypotheses

- (H1 1): Students perceive the Integrated Science SBA as contributing significantly to their performance in the CSEC examinations.

- (H1 1): There is a significant difference between male and female students' perceptions of the effectiveness of the Integrated Science SBA in predicting CSEC performance.

2. Methodology

2.1. Research Design

This study employs a quantitative research design to evaluate students' perceptions of the effectiveness of the school-Based Assessment (SBA) in Integrated Science. Its primary objective is to collect statistical data using a structured questionnaire, allowing for the quantification of students' views and the analysis of potential gender-based differences in perception.

2.2. Description of Sample

The study sample comprises thirty-five (35) students enrolled in Integrated Science at Secondary School A. The sample is intentionally diverse, including a balanced mix of genders and varying academic performance levels, to capture a wide range of student perspectives. This diversity enhances the generalizability of the findings to the broader student population. A stratified random sampling technique is employed to ensure equitable representation of both male and female students, as well as students across different academic strata. This approach minimizes sampling bias and strengthens the overall validity of the study.

2.3. Instrumentation

The primary data collection instrument is a self-administered questionnaire specifically designed for this study. It consists of twenty (20) items aimed at measuring students' perceptions of the SBA's effectiveness in enhancing content understanding, exam preparation, feedback reception, and overall satisfaction with the SBA process. Responses are recorded on a 4-point Likert scale, with options ranging from 1 (Strongly Disagree) to 4 (Strongly Agree).

2.4. Reliability of Instrument

To ensure the reliability of the questionnaire developed for this study, a pilot test was conducted with a group of students similar to those in the main study, but not included in the final sample. This preliminary phase aimed to assess the internal consistency of the questionnaire and identify any issues with the clarity or relevance of the items. Cronbach's alpha was used to evaluate the reliability of the instrument, yielding a value of 0.81, which indicates a high level of internal consistency and supports the questionnaire's suitability for the main study.

2.5. Procedure of Data Collection

Data collection was carried out during regular class hours, with students completing the questionnaire anonymously to promote honest and unbiased responses. The administration of the questionnaire was designed to take approximately fifteen (15) minutes. Prior to participation, students were informed about the purpose of the study, the voluntary nature of their involvement, the anonymity of their responses, and their right to withdraw from the study at any time without penalty.

2.6. Data Analysis

The collected data were analyzed using IBM SPSS (Statistical Package for the Social Sciences) version 23.0 software. Descriptive statistics were employed to summarize the sample characteristics and provide an overview of the responses to each questionnaire item. To assess the internal consistency of the questionnaire, Cronbach's alpha was calculated based on the pilot study data. T-tests were conducted to perform inferential analysis, comparing the mean scores of male and female students across the questionnaire items to determine if there were statistically significant differences in their perceptions.

3. Results and Discussion

3.1. Presentation of Data and Analysis

Table 1 Mean and Standard Deviation of Questionnaire Items.

Descriptive Statistics				
Items	**N**	**Mean**	**Std. Deviation**	**Variance**
Q1	35	3.11	0.676	0.457
Q2	35	3.17	0.664	0.440
Q3	35	3.17	0.664	0.440
Q4	35	3.00	0.840	0.706
Q5	35	3.20	0.677	0.459
Q6	35	3.11	0.832	0.692
Q7	35	2.91	0.658	0.434
Q8	35	3.20	0.677	0.459
Q9	35	3.23	0.731	0.534
Q10	35	3.11	0.758	0.575
Q11	35	3.11	0.718	0.516
Q12	35	3.20	0.719	0.518
Q13	35	3.20	0.901	0.812
Q14	35	3.20	0.759	0.576
Q15	35	2.94	0.802	0.644
Q16	35	3.06	0.725	0.526
Q17	35	2.97	0.747	0.558

Q18	35	2.54	0.701	0.491
Q19	35	3.37	0.731	0.534
Q20	35	3.23	0.770	0.593

Table 1 presents the descriptive statistics for the 20 questionnaire items regarding the effectiveness of the Integrated Science SBA. The mean scores for most items are around 3, indicating that students generally agree on the positive impact of the SBA. Specifically, items such as Q2 (Mean = 3.17, SD = 0.664) and Q5 (Mean = 3.20, SD = 0.677) show agreement that SBA tasks resemble exam questions and that completing these tasks enhances critical thinking skills.

However, some items display notable variability, as reflected in the standard deviations. For instance, Q4 (Mean = 3.00, SD = 0.840) and Q13 (Mean = 3.20, SD = 0.901) have higher standard deviations, suggesting varied opinions on the effectiveness of applying theoretical knowledge in practical contexts and the perceived fairness of the SBA, respectively. Additionally, Q18 (Mean = 2.54, SD = 0.701) has the lowest mean score, indicating less agreement on the clarity of the instructions and guidelines provided.

Items Q7 (Mean = 2.91, SD = 0.658) and Q15 (Mean = 2.94, SD = 0.802) show slightly lower mean scores, suggesting that some students feel less supported by their teachers during SBA preparation and have mixed feelings about the time allocated to complete SBA tasks. In contrast, items such as Q19 (Mean = 3.37, SD = 0.731) and Q20 (Mean = 3.23, SD = 0.770) reflect stronger agreement regarding the benefits of collaboration and the fairness of grading criteria.

Overall, the descriptive statistics indicate general agreement among students about the positive aspects of the Integrated Science SBA. However, certain areas of variability in student perceptions suggest that further attention is needed to address these concerns and enhance the overall effectiveness of the SBA.

Table 2 Frequency Distribution of Responses for each Questionnaire Item

Items	**Statement**	**SD***	**D***	**A***	**SA***
Q1	Understanding of Material: The SBA tasks have improved my understanding of Integrated Science concepts.	2	8	21	4
Q2	Exam Preparation: The types of tasks in the SBA resemble those I expect to encounter in the CSEC exam, helping me prepare effectively.	2	5	20	8
Q3	Application of Theory: The SBA tasks allow me to apply theoretical knowledge in practical situations successfully.	1	6	19	9
Q4	Critical Thinking: Working on SBA tasks has enhanced my critical thinking skills in Integrated Science.	3	9	18	5
Q5	Feedback Quality: The feedback I receive on my SBA submissions is useful for understanding the material better.	1	6	19	9
Q6	Teacher Support: My teacher provides significant support and guidance during SBA preparation and execution.	2	6	20	7
Q7	Impact on Exam Results: I am confident that performing well on my SBA will improve my CSEC exam results.	2	7	20	6
Q8	Adequacy of Resources: The resources provided for completing the SBA, such as lab equipment and materials, are adequate.	2	6	18	9
Q9	Teamwork Skills: Collaborating on SBA tasks has improved my teamwork skills.	2	7	19	7
Q10	Satisfaction of SBA Structure: I am satisfied with the structure and conduct of the Integrated Science SBA at my school.	2	8	20	5
Q11	Curriculum Alignment: The content of the SBA closely matches the curriculum taught in our class.	2	6	20	7
Q12	Engagement in Learning: The SBA makes learning Integrated Science more engaging and interesting.	1	4	20	10

Q13	Fairness of Assessment: I believe the SBA is a fair method to assess our knowledge and skills in Integrated Science.	1	4	18	12
Q14	Preparation for further Studies: Participating in the SBA has prepared me better for further studies in scientific subjects.	2	9	16	8
Q15	Motivation to Study: Completing the SBA tasks motivates me to improve my performance in Integrated Science.	2	8	19	6
Q16	Adequate Time for Tasks: The time provided to complete the SBA tasks is sufficient.	2	7	19	7
Q17	Quality of Materials: The materials provided for the SBA are of high quality and relevant.	2	9	19	5
Q18	Clarity of Instruction: The instructions and guidelines provided for the SBA are clear and easy to follow.	2	7	20	6
Q19	Peer Learning: Working with peers on SBA tasks has deepened my understanding of scientific concepts.	2	5	20	8
Q20	Consistency of Grading: The grading criteria for the SBA are applied consistently, ensuring fairness.	2	5	20	8

Key: SD*-Strongly Disagree, D*-Disagree, A*-Agree, SA*-Strongly Agree

Table 2 presents the frequency distribution of responses for each questionnaire item, categorizing responses into Strongly Disagree, Disagree, Agree, and Strongly Agree. The majority of responses for most items fall under the "Agree" category, indicating a generally positive perception of the Integrated Science SBA among students. For example, Q1 shows that 21 out of 35 students agree that the SBA has enhanced their understanding of core concepts, with only a small fraction strongly disagreeing (2) or disagreeing (8). Similar trends are seen in other items like Q5 and Q9, where a high level of agreement demonstrates that students find the SBA tasks relevant and beneficial for exam preparation and teamwork skills.

However, some items exhibit variability in responses. For instance, Q4 shows a higher number of students disagreeing (9) and a lower number strongly agreeing (5), suggesting mixed feelings about the application of theoretical knowledge in practical contexts. Likewise, Q14 presents a relatively higher number of disagreements (9) compared to strong agreements (8), indicating that some students are uncertain about their overall satisfaction with the SBA structure.

Items Q12 and Q13 stand out with higher frequencies of "Strongly Agree" responses (10 and 12, respectively), indicating strong student consensus regarding the alignment of SBA activities with the curriculum and the fairness of the assessment process. On the other hand, Q18, while receiving majority agreement (20), also shows notable disagreement (7), highlighting concerns about the clarity of the instructions and guidelines provided.

Overall, the frequency distribution in Table 2 reflects a generally positive student perception of the SBA, with some areas showing more varied opinions. These variations suggest opportunities for improvement in clarity, support, and the practical application of the SBA.

In Malaysia, Masek and Nasaruddin (2016) [28] conducted a survey among 336 lower secondary students, revealing that while students recognized the potential benefits of SBA, their overall readiness and perception were moderate. The study emphasized the need for enhanced training and support to improve SBA implementation.

Kamarulzaman (2013) [26] explored the role of SBA in cultivating critical thinking skills among Malaysian primary school students. Through interviews with science teachers, the study found that SBA, when effectively implemented, could enhance students' critical thinking abilities. However, challenges such as heavy teacher workloads and insufficient training were noted as barriers.

In the Caribbean context, Persad and Maharaj-Sharma (2020) [35] investigated the impact of literacy strategies on Form 1 secondary students' motivation and performance in Integrated Science in Trinidad and Tobago. Their study demonstrated that incorporating literacy strategies within SBA frameworks significantly improved student motivation and academic performance.

Beaumont-Walters and Soyibo (2001) [6] analyzed Jamaican high school students' performance on five integrated science process skills. The study revealed low overall performance, with significant differences based on grade level and school type, suggesting the need for targeted interventions within SBA to address these disparities.

Ogunkola and Samuel (2011) [31] examined perceived difficult topics in the Integrated Science curriculum among lower secondary school students in Barbados. Their findings indicated that both students and teachers identified specific challenging areas, highlighting the importance of SBA in addressing these difficulties through tailored assessments.

Issah (2021) [24] conducted a case study at Lawra Senior High School in Ghana, focusing on the use of practical work to improve students' attitudes and performance in Integrated Science. The study concluded that hands-on SBA activities positively influenced student engagement and academic outcomes.

Collectively, these studies underscore the multifaceted impact of SBA on student performance in Integrated Science. While SBA has the potential to enhance critical thinking, motivation, and academic achievement, its effectiveness is contingent upon adequate teacher training, resource availability, and student readiness. Addressing these factors is crucial for optimizing the benefits of SBA in science education.

Table 3 T Test Results Comparing Male and Female Students Perception.

Item	T-Value	d.f.	p-value
Q1	0.971	33	0.339
Q2	0.975	33	0.337
Q3	-0.043	33	0.966
Q4	-0.4	33	0.692
Q5	-1.861	33	0.072
Q6	-0.023	33	0.982
Q7	-0.231	33	0.818
Q8	-1.837	33	0.078
Q9	0.860	33	0.397
Q10	-0.915	33	0.367
Q11	0.439	33	0.664
Q12	0.654	33	0.518
Q13	1.289	33	0.207
Q14	-0.264	33	0.793
Q15	-0.404	33	0.689
Q16	-0.474	33	0.639
Q17	1.152	33	0.258
Q18	0.109	33	0.914
Q19	-1.757	33	0.088
Q20	-0.049	33	0.961

Table 3 presents the t-test results comparing male and female students' perceptions of the Integrated Science SBA for each questionnaire item. The t-values, degrees of freedom (d.f.), and p-values are provided for all 20 items. The majority of p-values are greater than 0.05, indicating no statistically significant difference between male and female students' responses for most items. For example, Q1 ($t = 0.971$, $p = 0.339$) and Q2 ($t = 0.975$, $p = 0.337$) suggest that both genders perceive the SBA similarly in terms of enhancing their understanding and its relevance to exam preparation.

A few items approach statistical significance but do not meet the conventional threshold. For instance, Q5 (t = -1.861, p = 0.072) and Q8 (t = -1.837, p = 0.078) indicate potential gender differences in perceptions of critical thinking improvement and resource sufficiency, respectively, though these differences are not statistically significant. Items such as Q3 (t = -0.043, p = 0.966) and Q6 (t = -0.023, p = 0.982) show very high p-values, reinforcing that male and female perceptions are nearly identical for these aspects.

In contrast, Q19 (t = -1.757, p = 0.088), which has the lowest p-value, also does not reach statistical significance but suggests a possible gender difference in how students perceive the benefits of group work, albeit not significant at the 0.05 level. Overall, these results indicate that there are no significant gender differences in students' perceptions of the SBA across most items, highlighting a general consensus among students regardless of gender.

This research aimed to assess students' perceptions of the Integrated Science School-Based Assessment (SBA) and its impact on their performance in the CSEC exams, as well as to explore potential gender differences in these perceptions. The majority of students expressed a positive perception of the SBA's contribution to their exam performance, with high mean scores across most items, suggesting agreement that the SBA tasks help with understanding core concepts, applying theoretical knowledge, and preparing for the CSEC exams. Despite some variability in responses, the overall trend supports the Alternative Hypothesis (H1), which posits that students perceive the SBA as significantly contributing to their performance on the CSEC exams, thus rejecting the Null Hypothesis (H0).

The t-test results indicated no statistically significant differences between male and female students' perceptions, as shown by the p-values greater than 0.05 for all items. This consistent lack of significant difference supports the Null Hypothesis (H0), suggesting there is no significant gender-based difference in perceptions regarding the SBA's effectiveness in predicting CSEC performance, thereby rejecting the Alternative Hypothesis (H1).

Similarly, Afuwape and Oludipe (2008) [3] examined Integrated Science achievement among Nigerian pre-service teachers. Their study revealed no significant differences between male and female students' examination scores, indicating that gender did not play a pivotal role in academic performance in Integrated Science.

Sakyi-Hagan and Hanson (2022) [41] investigated gender differences in performance among pre-service science teachers at the University of Education, Winneba, Ghana. Analyzing examination results from five Integrated Science courses, they found no significant gender gap in achievement, suggesting that both male and female pre-service teachers performed comparably in Integrated Science.

Contrastingly, Buabeng (2020) [13] analyzed BECE Integrated Science results from Junior High Schools in Cape Coast, Ghana, over five years. The study identified a statistically significant difference favoring boys, suggesting that male students outperformed their female counterparts in Integrated Science examinations.

In Malaysia, Md-Ali (2023) [29] explored gender differences in the implementation of SBA. The study found no significant gender disparities in knowledge, skills, and challenges related to SBA among teachers. However, male teachers emphasized the importance of school support more than female teachers, indicating subtle gender-based perceptual differences in SBA implementation.

Furthermore, Surman et al. (2024) [44] assessed the predictive capacity of SBA on students' mathematics performance in large-scale examinations. While focusing on mathematics, the study found no significant gender differences in SBA practices among teachers, suggesting that gender did not influence the effectiveness of SBA in predicting exam performance

Collectively, these studies suggest that while gender-based differences in perceptions and effectiveness of Integrated Science SBA exist in certain contexts, they are not universally observed. Factors such as educational environment, teacher support, and cultural influences may mediate these differences. Continued research is essential to understand the underlying causes and to develop strategies that ensure equitable educational outcomes across genders.

4. Conclusion

In conclusion, the Integrated Science SBA is generally perceived by students as beneficial in enhancing their understanding and performance in the CSEC exams, with no significant gender differences in these perceptions. This highlights the overall effectiveness of the SBA in preparing students for their exams and underscores its role as a valuable component of the Integrated Science curriculum. Further efforts to standardize support and resources could address the areas of variability identified, ensuring all students benefit equally from the SBA experience.

This research investigated students' perceptions of the effectiveness of the Integrated Science SBA and its impact on their CSEC exam performance. The findings revealed that students generally perceive the Integrated Science SBA as significantly enhancing their understanding of core concepts, improving critical thinking, and better preparing them for exams. The analysis showed no significant differences between male and female students' perceptions, indicating a consensus across genders. Overall, the positive perceptions underscore the SBA's role in fostering continuous learning and practical application of knowledge. These insights affirm the SBA's value as an essential component of the Integrated Science curriculum, contributing positively to students' academic experiences and outcomes.

4.1. Concerns and Limitations

4.1.1. The results of this study would have been limited due to:

- Sample size - The study involves a relatively small sample size of 35 students. While efforts have been made to ensure a diverse representation of genders and academic standings, the limited number of participants may not fully capture the breadth of student experiences and perceptions.
- Self-Reported Data: The study depends on self-reported data collected through a questionnaire. Self-reported data can be subject to various prejudices, such as social desirability bias, where respondents may answer questions in a manner they believe is expected or favorable rather than reflecting their true opinions.
- Context-Specific Findings: The study was conducted within a specific secondary school (Secondary School A), which may have unique characteristics that influence the findings. Factors such as school culture, teacher effectiveness, and available resources can vary significantly between schools, potentially affecting the generalizability of the results to other educational settings.

4.2. Recommendations

- To further enhance the effectiveness of the Integrated Science SBA, several recommendations are proposed
- First, improving the clarity and comprehensiveness of instructions and guidelines for SBA tasks is essential to ensure that all students fully understand the requirements and expectations.
- Additionally, increasing the consistency and constructiveness of feedback, alongside ensuring that teachers provide adequate support throughout the SBA process, can significantly help students better navigate their tasks and enhance learning outcomes.
- Reevaluating the time allocated for completing SBA tasks to ensure it is sufficient and balanced can also minimize student stress and promote a thorough understanding of the material.
- Moreover, encouraging more collaborative projects and group work within the SBA framework can foster teamwork skills and peer learning, which were positively perceived by students.
- Regular assessments to address areas with high variability in student responses, such as practical application and resource sufficiency, are crucial to ensure a more uniform positive experience for all students.

Compliance with ethical standards

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Disclosure of conflict of interest

The authors hereby declare that there is no conflict of interest associated with this manuscript.

Statement of ethical approval

Before conducting the pilot study, a formal request for permission to conduct research was submitted to the Deputy Dean of the Faculty of Education and Humanities at the University of Guyana. Following approval, the Chief Education Officer (CEO) of the Ministry of Education (MOE) granted permission through a formal letter. This letter was then taken to the Regional Educational Officer (REO) of region 6 for endorsement, after which it was presented to the selected school before the research process commenced.

Statement of informed consent

All authors confirm that informed consent was obtained from all individual participants included in the study.

Confidentiality of Participants

Student participants were not required to provide any identifying information, such as their names, signatures, contact numbers, or any details that could trace back to them. The school involved in this research was not identified but is referred to as "Secondary School A" throughout the study to ensure anonymity and confidentiality.

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