THE IMPACT OF LITERACY STRATEGIES ON FORM 1 SECONDARY STUDENTS'MOTIVATION AND PERFORMANCE IN INTEGRATED SCIENCE

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In this work, literacy strategies were used to teach a unit of integrated science to a group of 30 form 1 secondary school students of ages 12-14 in Trinidad and Tobago. Student motivation questionnaires and pre and post intervention scores were used to determine (1) the effect of literacy strategies on students' levels of motivation in Integrated Science, and (2) the impact of literacy strategies on the academic performance of the students in Integrated Science. Pre and post test scores as well as student motivation questionnaires were used to assess the impact of the intervention on students' levels of performance and motivation levels. Comparison of pre and post intervention scores revealed that 83% of the class scores improved after the intervention. Statistical analysis using t-test also showed that the use of literacy strategies had a positive impact on both performance and motivation levels. The findings from this study offer promise for the use of literacy strategies for improving motivation and student performance in Integrated Science.

Introduction

The Minister of Education of Trinidad and Tobago, revealed that on average 10% of students who wrote the CSEC (Caribbean Secondary Education Certificate) examination in 2018 did not achieve a passing grade in any subject (Gioannetti, 2018). In a parallel observation of performance at the primary school level, the Trinidad and Tobago Unified Teachers Association (TTUTA) noted a similar trend in respect of the Secondary Entrance Assessment (SEA) examination and commented that 2,595 students scored less than 30% in the 2018 SEA examination(TTUTA, 2018). These figures are suggestive of an underlying learning issue among a large percentage of primary school students. In the Trinidad and Tobago context students in both these categories are classified as remedial (or below grade level) and are often branded as students for whom the formal curriculum is unsuitable (Doughty, 2018). Students with low SEA scores in

language are often placed in remedial classes when they enter secondary school. The intent is that remediation will help them overcome their reading, numeracy and comprehension challenges. Teachers of remedial classes have attested that their students are overwhelmed by text and, even if text materials are narrated to them, most are unable to comprehend ideas, concepts and relations. Furthermore, they are unable to provide responses to lower order questions based on text materials they have interacted with (Alexander, 2008).

In Trinidad and Tobago, students are placed in secondary schools based on their SEA scores. The SEA examination assesses students' performance in Language Arts, Mathematics and Creative Writing. Although science is taught at every level of the primary school system, science is not tested in the SEA examination. Despite science not being assessed at the end of primary school training, all students entering secondary school are required to study Integrated Science (a thematic subject which focuses on a blend of content from the 3 main science subjects - biology, chemistry and physics), for the first three years of their secondary school training. Science teachers have observed that the remedial students experience great difficulty interacting with science content. Poor literacy skills hinder their understanding of basic science concepts, and negatively impact the development of fundamental scientific literacy. Their low scientific literacy makes science learning very challenging for most remedial students and the result is that they consistently perform poorly in science assessments. In addition, their language and comprehension deficiencies seem to demotivate them to the extent that they are reluctant to engage and participate in science learning. Irvin, Meltzer, Dean, and Mickler (2009) have reported that science students who have literacy challenges and who suffer a sense of de-motivation, which may or may not be associated with their literacy challenges, are consistently poor performers in science. In fact, Glynn, Brickman and Taasoobshirazi (2011) have stated that students are motivated to learn when they understand what is told to them, and that highly motivated science students are more likely to develop sound conceptual understandings during science lessons, and demonstrate high levels of achievement. In other words,

students who are highly motivated are likely to do well in science courses and the converse is also true.

Recognising the effect of the low literacy scores earned by a notable fraction of SEA graduates on their levels of motivation to learn science, and hence on their development of scientific literacy, this study sought to explore the impact of using specific literacy strategies during the teaching of a unit of science entitled 'Energy', on the levels of motivation and performance of a group of Form1 science students.

Background

Literacy is a critical component of the digital age and is one of the four domains that have been identified as a 21st century skill that must be acquired by the future generation, to overcome the challenges faced in scientific and technological literacy (Turiman, Omar, Daud, & Osman, 2012). In the context of this work, literacy refers to the ability of secondary school students to completely read, write, think about, discuss and present text- based information and ideas using a wide variety of print formats, including electronic and multimedia (Wise, 2009). Literacy therefore, is an essential skill upon which all other academic successes hinge (Wise, 2009). In spite of this fundamental acknowledgement, Schleicher (2019), reporting on PISA results for 2018, stated that over ten million fifteen-year-old students were not able to complete the most basic reading tasks. PISA defines literacy as understanding, using, evaluating, reflecting on and engaging with texts in order to achieve one's goals, to develop one's knowledge and potential and to participate in society. Bybee, McCrae and Laurie (2009) reporting on PISA (2006) found that motivation to engage in science learning is linked to the development of scientific literacy which subsequently translates into performance outcomes in science. Being literate in science means more than just being a proficient reader. It means that students are capable of reading scientific text, decoding it, and processing it for application. Reading science text and textbooks require the same critical thinking, analysis, and active engagement as performing hands-on science activities (Finneran, 2017). One of the goals of the science class therefore should be to

promote scientific literacy even while developing science process skills.

Literacy strategies such as, read aloud, Know-Wonder-Learn (KWL) and concept mapping, are common supporting techniques used by teachers to enhance student learning. The main purpose of using a literacy strategy is to help students connect ideas and organise scientific information that may otherwise seem overwhelming. In fact, literacy strategies such as those described above are well aligned to the views expressed by Piaget, which suggest that the human brain learns best when it is able to make meaningful connections among concepts and organise these in ways that can allow for logical retrieval (Artelt, Schiefele and Schneider, 2001).

Students possess varying abilities and different learning styles, so their academic performance is linked to the extent to which the format of lessons presented in the classroom aligns with their abilities and their learning styles. Literacy strategies are designed to target specific learning styles and academic levels (Alharbi, 2015). In that context Seddon (2017) found that integrating literacy into a science classroom can create more meaningful instruction and learning. Learning approaches, whether they include literacy strategies or otherwise, which align with students' abilities and learning styles, have the potential to activate prior knowledge and impact student learning (Lewis & Wray, 2000). Manoli & Papadopoulou (2012) showed that graphic organisers such as concept maps used in science class, can motivate student engagement and boost comprehension skills, because they provide a framework around which students can organise information in ways that can facilitate easy retrieval. In addition, Monahan (2012) explained that there is a close relationship between reading comprehension, learning of science content knowledge and academic performance in science assessments.

Literature Review

Theory of Motivation

As proposed by Maslow, all humans are motivated by a hierarchy of needs (1943). These needs are arranged such that basic needs are met before higher ones, based on sociological status and level at any given point in time. The underlying assumption in this hierarchy of needs is the understanding that needs and accompanying behavior are multi-motivated. Maslow's work suggests that a student's deficiencies (in this work the lack of literacy skills) must be addressed first before growth and learning can occur; for only then can a student focus on curriculum and apply knowledge to develop their full potential (McLeod, 2018).

Seifert (2010) defines student motivation as a direct function of a student's expectation for academic success and the value students place on academics. In a 2016 study on the declining trends in student performance in the Netherlands, student motivation was found to be a major contributor to student performance. Wijsman, Warrens, Saab, van Driel, & Westernberg (2016), hypothesised that motivation and student performance are interconnected. In fact, Bryan, Glynn & Kittleson (2011) applied the social cognitive theory to examine what motivates high school students to learn science, and revealed that self-efficacy was the component most related to achievement. Much earlier, Bandura (1977) hypothesised that people who have a low self-efficacy for achieving a task may avoid it, put little effort into completing it and give up easily when they encounter difficulties. Motivation is boosted when students recognise that they can accomplish tasks and make progress during their learning, and as Schunk (1991) reported, when students work on assignments and become more skillful, they develop a sense of self-efficacy for performing well.

Student Motivation, Student Performance and Literacy Strategies

Science literacy and scientific literacy are components for understating science content. Both terms, science literacy and scientific literacy, rest on a foundation of content knowledge and basic literacy skills. Visone (2009) suggests that tests of content-knowledge, such as standardised or benchmark science tests, may be assessing reading ability more than content knowledge. Croner (2003) found that many students have difficulty in science because they are passive readers, readers who receive information without

understanding. In the course of reading subject content, a passive reader would not think about the subject, would find the text overwhelming and would generally not be curious about the material. Passive readers are often distracted, may not comprehend (are unable to provide meaningful responses about the content in the text), do not reread, do not ask questions about the text and cannot make connections among ideas and/or concepts discussed or described in the text. (Schunk, 1991). In the Trinidad and Tobago context it has been noted that many level one secondary school students are passive readers and that they lack effective reading comprehension skills (De Lisle, 2012).

Reading strategies is one of the four factors that influence metacognition during reading. Metacognition, according to Croner (2003, p. 106), "is an awareness of how one thinks, and incorporating literacy strategies in science learning can improve students' metacognition and understanding of major concepts." Using graphic organisers in a science class as a reading strategy can promote student engagement, boost comprehension skills, and develop students' abilities to make predictions and identify patterns (Manoli & Papadopoulou, 2012). For example, graphic organisers facilitate comprehension of the bigger picture. Another commonly used strategy, the K-W-L, first published by Ogle (1986), was effectively used to provide a mental framework for students through which they were able to activate background knowledge in preparation for the upcoming lesson (Crowther, 2010). Exit slips are another strategy that is simple and quick and can help teachers make decisions about what needs to be revisited or elaborated on in following lessons. (Finneran, 2017).

Seddon (2017) studied strategies for integrating literacy into a science classroom and found that it created more meaningful instruction and learning and that through the use of literacy strategies educators gained insights into the value of formative assessment and the ways in which such assessments can be used in their day to day instruction. In addition, Monahan (2012) found that there was a close relationship between reading comprehension and the ability to learn and be assessed on science content knowledge. In particular, the use of the Scientific Reading Intervention Model (SRIM) was found to result in noted improvements in scientific

literacy through targeted reading strategies which developed students' reading abilities and resulted in improved comprehension of scientific text (Finneran, 2017).Overall, therefore, the literature has shown that the infusion of literacy strategies in science learning can promote motivation and hence encourage science learning.

Methodology

This study is set in North-Eastern Trinidad and participants include students from a government-controlled secondary school with a school population of 700 students. In the lower form classes (Form 1 - Form 3), there is usually a minimum of 35 students per class with mixed academic abilities. The study focused on two main research questions:

1. What is the effect of lessons taught with the incorporation of literacy strategies, on Form 1 students' levels of motivation towards Science?
2. What impact does the use of literacy strategies used during the instruction of a unit of work have on Form 1 students' levels of performance in Science?

This study adopted a one-shot pre- post-test action research approach (Mills, 2007). It was deemed the most suitable approach because the researcher is the class teacher and she embarked on the research with the aim of improving her classroom practice. The intention was to explore the utility of literacy strategies in the learning context in relation to student motivation and academic performance.

Data Collection

In this study the method of convenience sampling was used as the target group was accessible to the researcher who taught the class at the school. The participants comprised one class of 30 Form 1 lower secondary school science students. Their ages ranged from 12-14 years and the class consisted of 20 girls and 10 boys. The group was mixed in terms of ethnicity and previous academic performance. The class was taught Integrated Science by one teacher who was also their form manager. This Form 1 class had Integrated Science

timetabled four times per cycle (a cycle was 6 days). The four teaching sessions consisted of one double period and three single periods with each period being 35 minutes long.

Students' scores obtained from a unit test on measurement, prior to the intervention was used as the baseline scores for performance in Science. A motivation questionnaire was administered to the students before the start of the intervention. Upon completion of the unit of work, a unit test was administered as a post-test to determine the effect of the intervention on the students' performance. The pre-intervention motivation questionnaire was administered before the start of the study and this was re-administered after students were taught the unit of lessons, to determine if there were any changes in the students' motivation toward Science.

The unit of science consisted of eight lessons that were taught over a four-week period. In each lesson at least one type of literacy strategy was incorporated. All strategies used were in alignment with the objectives of the lesson. An outline of the unit of work consisting of eight lessons and the corresponding literacy strategies used are shown in Table 1.

Table 1: Outline of Lessons Taught in the Unit of Integrated Science

Lesson No.	Lesson Topic	Specific Objectives	Type of literacy being addressed	Literacy Strategy Implemented
1	Matter and Energy	-Classify the three states of matter in terms of shape and volume - Illustrate the arrangement of the particles in solids, liquids and gases	Comprehension and Vocabulary	Read Aloud, KWL
2	The effect of energy on matter	- To determine if temperature is affected by increasing heat - To determine the effect of increasing heat	Comprehension and Vocabulary	Concept Map

		on the state of matter of water		
3	Forms of Energy I	- Name different forms of energy and give examples - Classify mechanical vs non-mechanical forms of energy	Comprehension and Vocabulary	Concept Map
4	Forms of Energy II	- Name different forms of energy and give examples - Classify mechanical vs non-mechanical forms of energy	Reading, Comprehension and Vocabulary	Read Aloud
5	Law of Conservation of Energy	- Explain the law of conservation of energy - Apply energy conversions to living and non-living things	Comprehension and Vocabulary	KWL Graphic Organizer
6	What's the big deal about plants?	- Explain how plants convert light energy into chemical energy - Recall the word equation for photosynthesis	Comprehension and Vocabulary	Concept Map
7	What happens to energy in nature?	- Explain that green plants are the only organisms that can convert sunlight energy to chemical energy and hence are producers of all food chains - Construct food chains to show	Comprehension and Vocabulary	Exit Slip

		how energy is passed on from organism to organism		
8	How do energy sources impact our environment?	- Discuss the need for the implementation of renewable energy sources	Comprehension and Vocabulary	Concept Map

Research Question 1 was answered by analyzing quantitative data obtained by using the Student Motivation Questionnaire II (SMQ II) in its entirety as developed by Glynn, Brickman, & Taasoobshirazi (2011). Studies done using this instrument with both science and non-science majors indicated that it is valid, reliable and efficient for assessing components of students' motivation to learn secondary school science courses.

SMQ II was completed twice by the participants, n = 30, once before the start of the intervention (giving the pre-intervention motivation score, (PREIMS)) and the second time after the entire unit was taught (giving the post-intervention motivation score, (POSTIMS). These scores are the summation of five motivation items given as: never (0), rarely (1), sometimes (2), often (3) or always (4) and a possible total of 100 or a percentage of 100 converting the values into a standard score.

Research question 2 was also explored through the use of quantitative data derived from the unit post-test and students' baseline scores. The students had not been previously exposed to this unit of Science therefore, a pre-test on this topic would not have been meaningful. For that reason, students' baseline results from the previous end of term examination were used as the pre-test results (to give the pre-intervention (PREI) score). The post-test was administered when the unit of work was completed using the instructional strategies (giving the post-intervention (POSTI) score). The assessment given was based on the unit of lessons taught and consisted of questions of varying degrees of difficulty. These questions ranged from simple lower order (knowledge and comprehension) to complex higher order (application and analysis)

in accordance with the designed table of specification (TOS) shown in Table 2.

Lesson No.	Remembering	Understanding	Applying	Analyzing	Evaluating	Creating	Total	%
1 – Matter and Energy	1	1					2	**12.5**
2 – The effect of energy on matter			1		1		2	**12.5**
3 – Form of Energy I	1	1					2	**12.5**
4 – Forms of Energy II	1	1					2	**12.5**
5 – Law of Conservation of Energy		1	1				2	**12.5**
6 – What's the big deal about plants?	1	1					2	**12.5**

7 – What happens to energy in nature?	1					1	2	**12.5**
8 – How does energy sources impact our environment?		1				1	2	**12.5**
Total	5	6	1	0	2	2		
Percentage	**31.3**	**37.5**	**18.8**	**0**	**12.5**	**12.5**		**100%**

Table 2: *Table of Specification (TOS) as Outlined by the Unit Plan on Energy*

Data collected from both the Student Motivation Questionnaires (SMQ II) as well as the summative achievement test were analyzed quantitatively. Descriptive and inferential statistics were analyzed and discussed to reveal findings and relations using computer generated software.

In this study, a paired t-test was used to analyse data pertaining to both research questions as the data were the result of one intervention on a single group of students. The use of this test was established by other researchers in similar circumstances (Wanakacha, Aloka and Nyaswa, (2018) and Owuor (2018)). T and P values were generated and compared to the suggested alpha value of 0.05 for educational research (Mertler, 2014), and an increase in students' levels of motivation as well as an improvement in their overall test scores was obtained.

Findings

The SMQ II, was completed with one class before the intervention and again upon completion of the intervention (four weeks later), to reveal what students thought about their experience in Science. Figure 1 represents the results for student motivation and compares the pre and post intervention SMQII scores for each student. Generally, there was an 83% increase in motivation scores amongst

the class, where, only 17% of the students' motivation scores decreased post intervention.
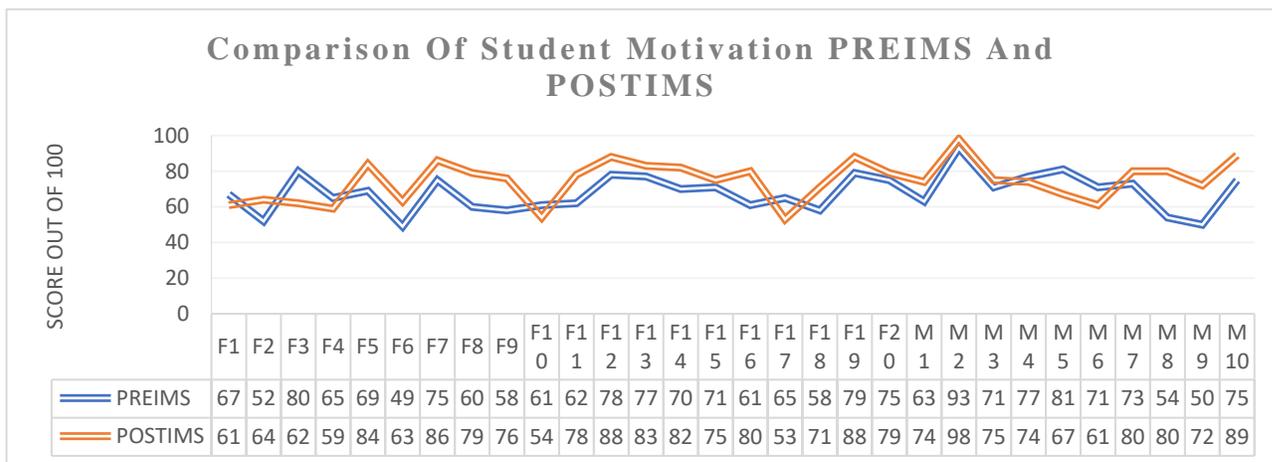
Comparison Of Student Motivation PREIMS And POSTIMS

	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12	F13	F14	F15	F16	F17	F18	F19	F20	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10
PREIMS	67	52	80	65	69	49	75	60	58	61	62	78	77	70	71	61	65	58	79	75	63	93	71	77	81	71	73	54	50	75
POSTIMS	61	64	62	59	84	63	86	79	76	54	78	88	83	82	75	80	53	71	88	79	74	98	75	74	67	61	80	80	72	89

Figure 1Line Graph comparing Student Motivation Scores

Pre and Post Intervention

An analysis of the pre-intervention motivation scores of the students revealed that the majority (67%) of the class could be classified as highly motivated according to the SMQ II categories and that no student ranked in the relatively low motivation category (Table 3).

Post-intervention categories revealed that no students were classified as having relatively low motivation towards science. The moderate and high categories decreased by 16% and 11% respectively (Table 3) This was attributed to the fact that five students moved up in motivation category from moderate to high. The very high category grew by 27% with eight students moving from high to very high and one from moderate to very high. Seven of the thirty students' motivation decreased post intervention.

Table 3: Showing the percentages of the pre and post motivation scores for the four motivation categories

	Pre-Intervention		Post-Intervention	
Motivation Category	No. of Students	Percentage	No. of Students	Percentage
Relatively low	0	0	0	0

0-39				
Moderate 40-59	7	23.3	2	6.67
High 60-79	20	66.7	17	56.7
Very High 80-100	3	10	11	36.7

Table 4showsthe values of mean, median, mode and standard deviation of motivation scores pre and post intervention. The average score increased by 6.5%, the middle score increased by 6%, the most occurring score increased from 75 to 80 and the standard deviation increased by .4%. This is illustrated in the box and whisker plots of Figure 2.

Table 4: Central Tendencies for Students Scores in SMQII Pre and Post Intervention

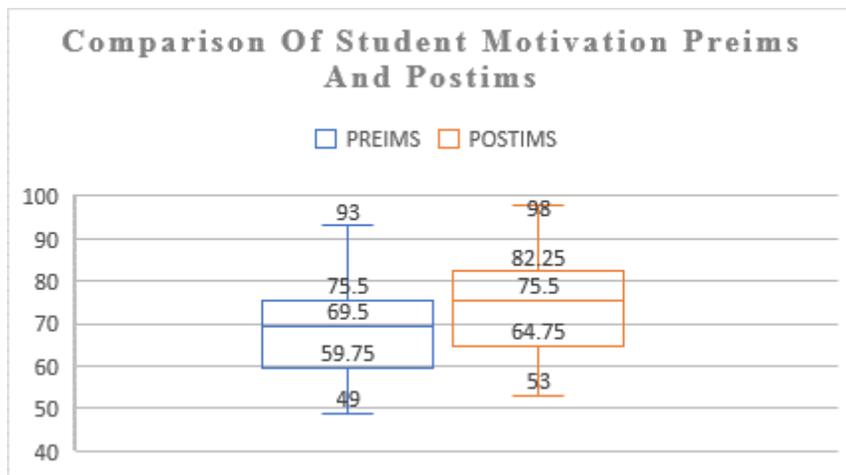| Central Tendencies	PREI	POSTI	Difference
Mean	68	74.5	6.5
Median	69.5	75.5	6
Mode	75	80	5
Standard Deviation	10.3	11.1	0.7

Figure 2: Comparing Box and Whisker Plots for Student Motivation Toward Science Pre and Post Intervention

The t value of a two-tailed pair sample for 29 degrees of freedom was calculated to be 3.40, whilst the P value is 0.00198

which is less than the significance level of 0.05. Therefore, the intervention statistically had a significant impact on student motivation toward science.

Student Performance was measured using marks obtained from an end of unit examination against PREI end of term I marks for each student. Figure 3 compares examination scores out of 100 for each student in the class. Generally, there was an 83% increase in student performance with 17% of the students' scores decreasing post intervention. The pre and post intervention scores were analysed to produce mean, median, mode and standard deviation as shown in Table 5. Although the standard deviation increased POSTI, the mean score was 17.6% higher as depicted in Figure 4.
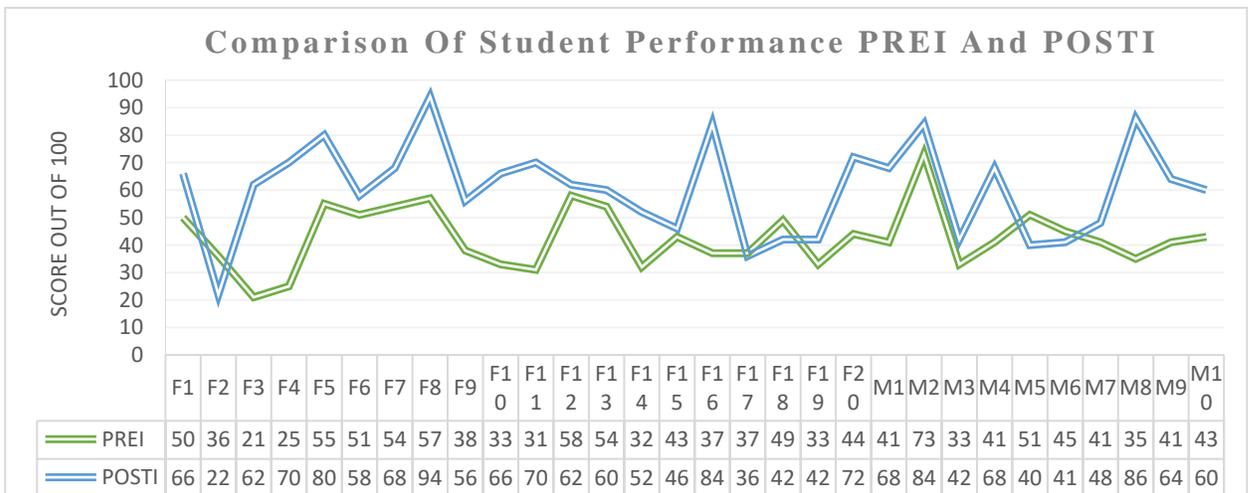

Comparison Of Student Performance PREI And POSTI

	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12	F13	F14	F15	F16	F17	F18	F19	F20	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10
PREI	50	36	21	25	55	51	54	57	38	33	31	58	54	32	43	37	37	49	33	44	41	73	33	41	51	45	41	35	41	43
POSTI	66	22	62	70	80	58	68	94	56	66	70	62	60	52	46	84	36	42	42	72	68	84	42	68	40	41	48	86	64	60

Figure 3: Line Graphs showing Comparison of PREI and POSTI Unit Examination Scores per Student

Although the lowest score only changed by 1%, the highest score obtained increased by 21%. The average score also increased by 21%. Scores for each quartile of PREI benchmark scores were lower than POSTI unit examination scores as depicted in Figure 4.

Table 5: Showing Central Tendencies in Student Performance Pre and Post Intervention

Central Tendencies	PREI	POSTI	Difference
Mean	42.7	60.3	17.6
Median	41.0	62.0	21.0
Mode	41.0	68.0	27.0
Standard Deviation	11.0	16.8	5.8

In analysing the objectives, the percentage of marks obtained for each student for each taxonomy level assessed was analyzed to produce central tendencies for each level as shown in Table 6. In the end of unit examination 58% of the questions tested *remembering,* 34% tested *understanding* and 8% tested *application of knowledge*. Students scored highest in *applying* taxonomy, second in *remembering* and third in *understanding*. Fairly large standard deviation marks were obtained and that implies that students' scores were widely scattered about the mean.
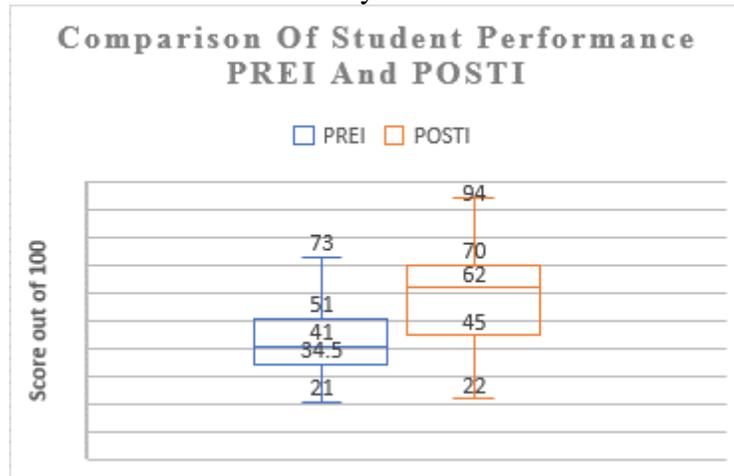

Figure 4: Box and Whisker Plots comparing Student Performance Pre and Post Intervention

Table 6: Analysis of the percentages obtained for the cognitive taxonomy level assessed in the end of unit examination

Order	Remembering	Understanding	Applying
Mean	61.0	52.9	90.0
Median	60.3	58.8	100.0
Mode	65.5	76.5	100.0

Standard Deviation	16.3	24.2	28.3

The results of a paired t-test computation found t to be 2.04 and P = 6.59 x 10^{-6} which is < 0.05. Therefore, statistically there was a significant difference in the mean student performance in the unit of work after using literacy strategies.

Discussion

The infusion of literacy strategies appeared to have had a significant impact on the motivation of the students since student motivation for the class increased by 83%. This was confirmed by the t-Test statistic that showed that when the mean PREIMS scores were compared to the mean POSTIMS score there was a significant difference in mean motivation scores pre and post intervention. These results are aligned with the findings of Glynn & Muth (1994) and Schunk (1991), both of which showed that the use of literacy strategies in science lessons led to improved students' motivation. However, because this study is limited to a single classroom in a single school, further, more widespread studies are needed to comprehensively establish a link between motivation and the use of literacy strategies in science teaching in the Trinidad and Tobago context.

The infusion of literacy strategies appeared to have had a positive impact on student performance in lower form Integrated Science. The comparison of the end of term I examination scores (PREI) and POSTI unit examination scores revealed that scores for the class improved by 83%. The paired t-test revealed that there is a statistically significant difference in mean student performance scores post intervention. These results are supported by work done by Finneran (2017) which reported improved reading comprehension among students; Seddon (2017) which showed that more meaningful science learning occurred; and Monahan (2012) who revealed a positive correlation between reading comprehension and the ability to learn science.

Taken together, there are four students (F8, F16, M2 and M8) out of the class of thirty that stand out as having done extremely

well in both motivation and performance in science scores. Through informal observations, these four have been consistently working through the unit of work and thus show maximum growth in the class. It is possible that extending the period of the study may have provided an opportunity to influence a greater number of students.

Limitations

Qualitative data such as student reflections could have been employed to challenge the students to think deeper about the role literacy strategies play in their motivation toward science. An in-depth analysis of the SMQII could have revealed insight into the specific components of motivation which may have been responsible for the overall lack of motivation toward science. As explained by Glynn (2011) the SMQII looks at five motivation components: intrinsic motivation, career motivation, self-determination, self-efficacy and grade motivation. This work did not examine which components were most influential in determining students' overall levels of motivation, but this examination can certainly be the focus of further work in this area.

An exploration of the differentiated learning types of the students before the intervention would have informed which literacy strategies were most matched to students' learning styles; e.g. more ICT-based literacy strategies may have wider appeal among the students. This oversight may have impacted the results obtained but can be a point of consideration for future research in this area. A closer look at the formative assessments given and the effort placed on completing worksheets may also be a factor worth considering in any further work. It may be that more time is needed for students to complete the formative assessment tasks.

Conclusion

The results of this study imply that the incorporation of literacy strategies during the teaching of a unit of science to a group of Form One (1) Integrated Science students has a positive impact on student motivation and student performance. The literacy strategies employed facilitated improvements by supporting students' reading,

vocabulary and comprehension of science content. As mentioned earlier, these findings are consistent with those revealed in other similar works (Monahan (2012); Seddon (2017); Finneran (2017)). While the findings of this work are instructive for contexts in which secondary school science students experience difficulties learning science due to literacy challenges, the approach described cannot be successfully implemented in the absence of relevant teacher training. Science teachers would need to interact in a formal way with literacy professionals to detect the nature of the literacy challenges students face and subsequently to identify appropriate literacy intervention strategies. Even further, science teachers may need support and guidance in the implementation process. The recommendation therefore is that targeted professional development for teachers who are required to teach science to remedial students or students with literacy challenges is necessary. In addition, access to resources and relevant teaching aids to effectively facilitate teachers' efforts in this regard are critical.

Finally, it is important to acknowledge that this study was conducted with a single, purposively selected group of students at a single school and while the findings are positive in this case, they cannot be generalized for all secondary school students experiencing challenges learning science. This work therefore presents a good starting point from which further investigations in this area can emerge.

References

Alexander, R.J. (2008). Essays on pedagogy. London: Routledge.

Alharbi, M. A. (2015). Reading strategies, learning styles and reading comprehension: A correlation study. *Journal of Language Teaching and Research*, 6(6), 1257-1268.

Artelt, C., Schiefele, U., & Schneider, W. (2001). Predictors of reading literacy. *European Journal of Psychology of Education*, 16(3), 363-383.

Bandura, A. (1977). *Social learning theory*. New York: General Learning Press.

Bybee, R., McCrae, B., & Laurie, R. (2009). PISA 2006: An assessment of scientific literacy. *Journal of Research in Science Teaching*, 865-883.

Croner, P. E. (2003). Strategies for teaching science content reading. *The Science Education Review*, 104-119.

Bryan, R. R., Glynn, S. M., & Kittleson, J. M. (2011). Motivation, acheivement, and advanced placement intent of high school students learning science. *Science Education*, 95(6), 1050-1064.

Crowther, D. (2010). Science for English language learners. In A. Rodriguez (Ed.), *Science education as a pathway to teaching language literacy* (pp. 163-196). Rotterdam: Sense Publishers.

De Lisle, J. (2012). Secondary school entrance examinations in the Caribbean: Legacy, policy, and evidence within an era of seamless education. *Caribbean Curriculum, 19,* 109-143.

Doughty, M. (2018, September 8). Zero in on zero passes . *Trinidad and Tobago Newsday*. Retrieved from https://newsday.co.tt/2018/09/08/zero-in-on-zero-passes

Finneran, M. L. (2017). *Improving scientific literacy through reading strategies: An action research study.* College of Education: University of South Carolina.

Gioannetti, A. (2018, August 13). Garcia: 1,486 TT students got zero CSEC passes. *Trinidad and Tobago Newsday*. Retrieved from https://newsday.co.tt/2018/08/13/garcia-1486-tt-students-got-zero-csec-passes

Glynn, S., & Muth, K. (1994). Reading and writing to learn science: Acheiving scientific literacy. *Journal of Research in Science Teaching*, 31(9), 1057-1073.

Glynn, S., Brickman, P., & Taasoobshirazi, G. (2011). Science motivation questionnaire II: Validation with science majors and nonscience majors. *Journal of Research in Science Teaching*, 48, 1159-1176.

Irvin, J., Meltzer, J., Dean, N. &Mickler, M. (2010). *Taking the lead on adolescent literacy. Action steps for schoolwide success.* Thousand Oaks, CA: Corwin Press.

Lewis, M., & Wray, D. (2000). *Literacy in the secondary school.* London: David Fulton.

Manoli, P., & Papadopoulou, M. (2012). Graphic organizers as a reading strategy: Research findings and issues. *Creative Education*, 3, 348-356.

Maslow, A. H. (1943). A theory of human motivation. *Psychological Review*, 50(4), 370–396.

McLeod, S. (2018). Maslow's hierachy of needs. *Simply Psychology.* Retrieved from https://simplypsychology.org/simplypsychology.org-Maslows-Hierarchy-of-Needs.pdf

Mertler, C. A. (2014). *Action research: Improving schools and Empowering educators* . Thousand Oaks: Sage.

Mills, G. E. (2007). *Action research: A guide for the teacher researcher.* Columbus: Pearson.

Monahan, K. T. (2012). *Read, retrieve, connect and use: An intervention strategy for science and scientific literacy.* Doctoral Program in Educational Leadership: Lynn University, College of Education, Florida.

Ogle, D. (1986). K-W-L: A teaching model that develops active reading of expository text. *The Reading Teacher*, 39, 564-570.

Owuor, N. A. (2018). Class size and student achievement: A parametric paired t-test. *UKH Journal of Social Sciences*, 2(1), 19-24.

Schleicher, A. (2019). PISA 2018 Insights and interpretations. *OECD*, 1-64. Retrieved from https://www.oecd.org/pisa/PISA%202018%20Insights%20 and%20Interpretations%20FINAL%20PDF.pdf

Schunk, D. H. (1991). Self-efficacy and academic motivation. *Educational Psychologist*, 26, 207-231.

Seddon, M. (2017). Strategies for integrating literacy into a science classroom. Graduate Research Papers: University of Northern Iowa UNI Scholarworks.

Seifert, T. (2010). Understanding student motivation. *Journal of Educational Research*, 46(2), 137-149.

TTUTA. (2018, August 21). Reflecting on CSEC results. Trinidad and Tobago: Trinidad and Tobago Newsday.

Turiman, P., Omar, J., Daud, A. M., & Osman, K. (2012). Fostering the 21st century skills through scientific literacy and science process skills. *Social and Behavioral Science*, 59, 110-116.

Visone, J.D. (2009) The validity of standardized testing in science, *American Secondary Education*, 38(1), 46-61.

Wanakacha, C. K., Aloka, P. J. O., &Nyaswa, P. (2018). Gender differences in motivation and teacher performance in core functions in Kenyan secondary schools. *Academic Journal of Interdisciplinary Studies,* 7(1), 89-95.

Wijsman, L. A., Warrens, M. J., Saab, N., Van Driel, J. H., & Westernberg, P. M. (2016). Declining trends in student

performance in lower secondary education. *European Journal of Psychology Education*, 31, 595-612.

Wise, B. (2009). Adolescent Literacy: The cornerstone of student success. *Journal of Adolescent and Adult Literacy*, 52(5), 369-375.