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ABSTRACT

This study assessed the extent to which the science content knowledge, process skills, and attitudes of some Grade 7 students improved after the implementation of the Jamaican reform of secondary education (RSEO) science curriculum. Relationships among gender, school location, and student performance were also investigated. The study sample of 156 students (72 boys, 84 girls) was selected from 3 rural and 3 urban schools in Jamaica. Data was collected from a validated hands-on science process skills test, a standardized multiple choice content test, and an adapted attitudes to science test. Results indicate that the students exhibited highly positive attitudes toward science on the pre- and posttests, there were no gender differences in performance on the tests, and there are weak but positive significant correlations among school location and test performance. Contains 17 references. (DDR)

An Evaluation of Seventh Graders' Performance on a Jamaican Science Project

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Abstract

This study assessed the extent to which the science content knowledge, process skills and attitudes of some 7th graders had improved after following the Jamaican reform of secondary education (ROSE) science curriculum. The relationship among their gender and school location and performance were also investigated. The study sample of 156 students (72 boys, 84 girls) were selected from three urban and three rural schools in Jamaica. A validated hands-on science process skills test (SPST), a standardized multiple choice science content test (SCT) and an adapted attitudes to science test (AST) were used to collect data using a pretest-posttest design. Results indicated that the students' pre and posttest performance on the SCT and SPST was low; they displayed highly positive attitudes to science on the pre and posttests; there were no gender differences in their performance on the three tests, but urban students significantly outscored their rural counterparts on the pretest AST, pre and posttests SCT and posttest SPST; there were weak, positive, significant correlations among the students' school location and performance on pretest AST, pre and posttests SCT and posttest SPST.

Introduction

Over the years, students' poor performance in the Caribbean Examinations Council's (CXC) secondary education certificate examinations especially in language, mathematics, and science and in the Ministry of Education's secondary school certificate examinations has been a source of concern for many Jamaicans. Students' unpreparedness for life and the world of work is also a national concern. This concern and the felt need to produce secondary school leavers with improved knowledge and skills constitute one justification for the initiation of the reform of secondary education (ROSE) project in 1993. The provision of an access to equitable and quality secondary education is one overarching goal of the ROSE project (Government of Jamaica/World Bank, 1993a). As an aspect of the reform, new curricula for grades 7-9 were developed in five subject areas: mathematics, language arts, social studies, integrated science, and resource and technology while career education is infused in these subjects.

The field-testing of the science curriculum began in 1991, while its implementation started in September 1993. By June 1997, 131 schools were implementing the curriculum.

The ROSE grades 7-9 science curriculum is designed to produce "scientifically literate persons." To attain this objective, the teachers implementing the curriculum are expected to "focus not only on knowledge but also on process skills" (Government of Jamaica/World Bank IV, 1993b). This is because the process skills not only help in developing students' cognitive, psychomotor and affective skills, but specifically to promote the development of students' problem-solving and critical thinking skills. The

science curriculum strongly underlines students' practical activities. It is through these activities that students are expected to develop problem-solving and critical thinking skills (Government of Jamaica/World Bank IV, 1993b). Essentially, the student-centered science curriculum is similar to some modern science curricula (e. g. Science 5-16 in the UK, DES, 1985; Project 2061; Scope, Sequence and Coordination, and Science, Technology and Society in the USA, Yager & Lutz, 1994). Against this background, if the ROSE science curriculum had been implemented as expected, students who have followed it are expected to do well on all its domains. This conjecture was tested in this study.

The ROSE science lessons are expected to be mainly student-centered with students engaged in hands-on, minds-on tasks in order to develop their science process and critical thinking skills. Teachers implementing the curriculum usually do a two-week course designed to train them in the use of the project's suggested methodologies and curriculum materials. This is further supported by regular visits to the ROSE schools by five science teacher-trainers who observe science lessons and provide feedback to the teachers. Consequently, grades 7-9 ROSE students are expected to have more exposure to science practical tasks than their nonROSE peers. But recent report from the ROSE science teacher-trainers indicated that many ROSE teachers were not implementing the science curriculum as expected. Soyibo and Johnson (1998) reported that the ROSE science teacher-trainers perceived the ROSE science teachers as using the lecture method (100%), rarely using the lecture-demonstration method (60%), occasionally allowing their

students to do practical tasks (60.00%) and not allowing their students to use free exploration/discovery (100%).

A review of the literature indicates that only a few studies have been done on Jamaican grades 7-9 students' performance in integrated science. Clayton-Johnson (1993) reported that more than two-thirds of Jamaican 8th graders scored "average" marks in integrated science, while Soyibo (in press) reported that Jamaican 7th graders' performance on a test of science process skills was barely "average". The 1993 Jamaican, Ministry of Education, Youth and Culture's assessment of 7th graders' performance on ROSE science test showed that the students' posttest scores in the project schools were significantly higher than in the control schools. But the students' science process skills and attitudes were unassessed. This study is , therefore, deemed significant as (a) it evaluates the extent to which the science curriculum had improved the 7th graders' science content knowledge, process skills acquisition, and attitudes to science, (b) the authors are unaware of any published studies on the evaluation of 7th graders' process skills and attitudes to science after they have used the curriculum.

The relationships among students' gender and school location and performance on these three areas are considered pertinent partly because many previous findings on these two variables are inconclusive. Several studies document gender differences in mathematics and science and indicate that males outperform females in relevant achievement tests (e.g. Chipman, Bush & Wilson, 1985; Comber & Keeves, 1973; Forrest, 1992; Third International Mathematics and Science Study, 1996). Some studies have recorded no gender differences in students' science achievement and attitudes to

science (e. g. Clayton-Johnson, 1993; Greenfield, 1996; Soyibo & Pinnock, 1997). Conversely, Swire (1992) reports that female 7th graders significantly outscore their male peers on some integrated science concepts. The American Association of University Women (AAUW) (1992), notes that although female students receive equal or even better grades in science courses, they show less interest in this subject than male students. Similarly, Weingburgh's (1995) meta-analysis of the literature for two decades indicates that boys have more positive attitudes toward all types of science than girls.

Concerning the link between school location and students' science performance, the findings of a number of studies are equally conflicting. While many studies have shown that students who attend urban schools tend to do significantly better in science than their rural peers (e.g. Dobson, 1994; Glasgow, 1986; Simpson & Marek, 1988; Soyibo & Thorpe, 1995), a few studies have reported the reverse situation (e. g. Swire, 1992).

Purpose

This study sought to assess the extent to which (a) the science content knowledge, some process skills and attitudes to science of selected 7th graders had improved after using the ROSE science curriculum, (b) there were significant differences in the pre and posttests' students' science knowledge, process skills and attitudes to science linked to their gender and school location, and (c) there were any significant relationships among the students' pre and posttest scores and their gender and school location.

Research Questions

Answers were sought to the following questions:

1. What is the general performance of the 7th graders on the science content knowledge, science process skills and attitudes to science pre and posttests ?
2. Are there any significant differences in the students' pre and posttest scores on the three tests (a) regardless of their gender and school location, (b) linked to their gender and school location ?
3. Are there any significant relationships among the students' gender and school location and their pre and posttest scores on the three tests ?

Methodology

Design A pretest/posttest design (with no control group) was used as the prime purpose of the study was to establish the degree to which certain learning outcomes occurred in the students who had followed the ROSE science curriculum.

Sample The main study sample consisted of 156, 7th graders (in intact classes) selected from six high schools (three rural and three urban) in Jamaica. The composition of the pretest sample is as follows: science content test (SCT) 72 boys, 84 girls; science process skills test (SPST) 40 boys, 52 girls, and attitudes to science test (AST) 47 boys, 56 girls. The posttest sample consisted of 72 boys, 84 girls for SCT; 72 boys, 84 girls for SPST; and 72 boys, 84 girls for AST. Their mean age was 12 years. The pilot sample consisted of 108, 8th graders. Five of the sampled schools had been using the science curriculum for at least one year and the sixth school for three years prior to this study.

Science Content Test (SCT) Students' science content knowledge was determined by their scores on the SCT which was a standardized 60-item multiple choice test based on the ROSE grade 7 science curriculum constructed by the Jamaican Ministry of Education, Youth and Culture. The maximum score was 60. The test time (including the AST) was 105 minutes.

Science Process Skills Test (SPST) The SPST consisted of seven hands-on items covering three of the 13 process skills in the ROSE grade 7 curriculum. The three process skills tested and the measurable behaviors expected to be displayed by the students (Nneji, 1991) were: observing - measured by 2 items and three behaviors (identifying objects in the environment; describing given processes/activities; recording observations); classifying - measured by 3 items and 2 behaviors (grouping objects based on their observable behaviors; assigning properties to given groups of objects); and inferring - measured by 2 items and 2 behaviors (specifying evidence that supports causalities; inferring causalities).

The steps taken in developing the SPST were adapted from Smith and Welliver (1990) as follows: (a) Skills identification The ROSE grade 7 science curriculum was examined to identify the process skills prescribed for development in the students in respect of each subunit's specific objective. This was done, by completing a grid with skills listed along the upper horizontal border and the subunits in the left vertical column. (b) Skills selection was based on two factors: frequency of occurrence and complexity of a skill. The complexity of a skill was based on Molitor and George's (1976) classification of process skills into three levels: collecting, analysing and using data. For

this study, observing and classifying were selected as the skills for the lowest level (collecting data), while inferring was selected as the most common skill for the second level.

Format and content determination Whereas a pencil and paper test would allow for an easier testing mode and facilitate testing larger samples and content (Nneji, 1991; Smith & Welliver, 1990), the hands-on format was used in this study because it was more closely related to the mode suggested for instructing the students sampled. Only the contents of units 2 and 3 (out of the 6 units) in the curriculum were pretested because none of the sampled schools had taught them.

Validation The instrument was validated by three experts: two science educators and one expert in test construction. The items required the students to work individually and record their answers in the spaces provided on the question paper. The test time was 90 minutes and 57 was the maximum score.

Scoring One of the authors scored the pilot ahd main study students' scripts. The guidelines of Gott, Geoff and Flouds (1988) were utilized in developing the mark scheme. An independent assessor scored 36 of the subjects' posttest scripts. The interrater reliability coefficients between the assessor's and the scoring of one of the authors ranged from 0.87 to 1.

Attitudes to Science Test (AST) The final AST consisted of 25 items with five options from "Strongly agree" to "Strongly disagree". Fourteen of them were adapted from the scales of Clayton-Johnson (1993) and Shrigley, Misiti and Hanson (1991), while the other 11 items were constructed by the authors. The items covered five indicators specified in

the curriculum: curiosity, cooperation, persistence, usefulness of science and interest in science. The items were scored on a 5-point scale and 125 was the maximum score. The Cronbach alpha coefficients of the items ranged from 0.48 to 0.95.

Procedure For the pilot study, the SPST and the AST (with 29 items) were administered to 108, 8th graders in three urban high schools. For the SPST only 6 items were first pilot-tested in September 1995. Based on the observations made during the first pilot, and feedback from three experts, adjustments were made to 3 of the items and the instrument was re-pilottested in November 1995. The seventh item was tested during the re-pilottest. Final adjustments were made after the second pilottest and the SPST was pretested along with the SCT and AST near the end of the first term in December 1995. The instruments were posttested in January 1996.

Results and Discussion

TABLE 1 HERE

The first purpose of this study was to determine the extent to which the subjects' science content knowledge, science process skills and attitudes to science had improved after using the ROSE curriculum. The subjects' means and standard deviations on the tests are shown in Table 1. The subjects' mean scores on the SCT (pretest 24.53 or 41%, posttest 28.74 or 48%) and SPST (pretest 22.10 or 39%, posttest 28.57 or 50%) are low. Their mean scores on the AST (pretest 94.82 or 76%, posttest 96.95 or 77%) suggest that they had highly positive attitudes toward science before and after their introduction to the ROSE curriculum. However, the percentage increases in the subjects' mean scores

on the SCT (17.97), SPST (29.20) and AST (2.20) suggest that the science curriculum had only a slight improvement on their performance on the three tests and that its impact on their positive attitudes to science was almost negligible. These findings were unexpected but are supported by Soyibo and Johnson's (1998) finding regarding ROSE grade 7 students' low performance on the same science test (mean = 25.07 or 41.80%).

TABLE 1 HERE

To determine whether or not there were significant differences in the students' pre and posttest scores on the three tests, regardless of their gender and school location, t-tests were computed. The results, which are shown in Table 1, indicate that there were significant differences in the subjects' pre and posttest scores on the SCT and SPST. But as stated earlier, the increases in their posttest scores over their pretest scores do not suggest that the ROSE science curriculum had substantially improved the subjects' performance on the three tests as expected.

TABLES 2 & 3 HERE

To establish if there were any significant differences in the subjects' pre and posttest scores linked to their gender and school location, t-tests were computed. The results are displayed in Tables 2 and 3. Table 2 data indicate that there were no gender differences in the students' performance on the three tests. This finding is supported by that of Soyibo and Johnson (1998) in respect of grade 7 ROSE and nonROSE students' performance on the same science test and the findings of some other researchers (e.g. Clayton-Johnson, 1993; Greenfield, 1996; Soyibo & Pinnock, 1997). But it conflicts with many previous findings (e.g. Chipman, Bush & Wilson, 1985; Third

International Mathematics and Science Study, 1996). Table 3 data suggest that urban students significantly outscored their rural peers on (a) pretest AST, (b) pre and posttests SCT and (c) posttest SPST. The finding on the students' SCT performance was supported by that of Soyibo and Johnson (1998).

It is contentious to claim that the observed differences in the subjects' performance linked to their school location was mainly due to the slight differences discernable in their teachers' teaching qualification and experience. For example, whereas all the three science teachers in the sampled urban schools were trained primarily to teach science in grades 7-9, only one of the three rural teachers was trained primarily for primary school teaching. In short, the actual possible origins of the differences in the students' performance linked to their school location were not investigated in this study. These should be addressed in future studies on the topic.

TABLE 4 HERE

To ascertain if there were any significant relationships among the students' gender, and school location and their pre and posttest scores on the three tests, Pearson's product-moment correlation coefficients were computed. The results are shown in Table 4. Table 4 data suggest that while the relationships among the students' gender and their pre and posttests' scores were not statistically significant, the correlations between their school location and pretest AST, pre and posttests SCT and posttest SPST scores were positive and statistically significant. Although these relationships were significant, they were weak suggesting that other factors besides school location contributed to the students' performance on the three tests. Hence, any future evaluation of the ROSE programme

needs to determine the effects of extraneous factors such as gender, school location, school type, teacher qualification and teaching experience and students' socioeconomic background on ROSE students' outcomes. Table 4 data indicate that (a) there were no significant differences in the students' pre and posttests' scores on all the tests linked to their gender, and (b) urban students significantly outscored their rural counterparts on pretest AST, pre and posttests SCT and posttest SPST. Thus, these findings further confirm the results in Tables 2 and 3 discussed earlier.

Conclusions and Implications

This study is significant because the students' low performance on all the three domains investigated is cause for concern. This finding suggest that the ROSE science curriculum has not improved the sampled students' learning outcomes in these areas contrary to expectation. This is an indictment on the effectiveness of the implementation of the science curriculum. This study's finding, among other things, has implications for the need to re-examine the modality for the training of the teachers specially trained to implement the curriculum and the need to review the nature and efficacy of the role of the science teacher- trainers. The finding that the urban students significantly outperformed their rural counterparts on all aspects of the investigation also has implications for a re-examination of the role of the science teacher-trainers and the training and motivation of teachers who have to teach science in the rural schools.

Further, urban and rural students (and school type, which was not investigated) were likely to be different regarding their science knowledge, attitudes to science and

science process skills acquisition. This might be due to factors related to teacher training and experience, differential intellectual abilities of the students, and educational resources available to the science teachers and their students. The possible impacts of these factors on students' outcomes should be investigated in future studies on this topic. It is arguable that it is too early to convincingly and confidently evaluate the efficacy and flaws of the ROSE program particularly in respect of grade 7 ROSE students who had barely used it for about one term. Future studies should, therefore, take a longitudinal perspective of the students' outcomes on the program and their teachers' effectiveness.

Limitations

The study's sample size was small and restricted to the eastern side of the country. Future studies should involve larger samples extended to all the nation's regions.

This study was limited to some schools involved in the ROSE program. To actually gauge the relative effectiveness of the ROSE science curriculum, it would be worthwhile to compare ROSE and nonROSE students' performance on the instruments used in this study.

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Table 1 t-Tests on Students' Pre and Posttests' Scores

Dependent Variable	Pretest n	Mean	SD	Posttest n	Mean	SD	t
AST	103	94.82	10.72	156	96.95	11.37	1.53
SCT	156	24.53	8.56	156	28.74	8.83	4.34*
SPST	92	22.10	7.25	156	28.57	8.00	6.60*

*p < .05 AST = attitudes to science test, SCT = science content test, SPST = science process skills test

Table 2 t-Tests on Boys' and Girls' Mean Scores

	Pretest n	Mean	SD	t	Posttest n	Mean	SD	t
AST								
Boys	45	94.45	10.42		71	97.08	12.89	
Girls	56	95.18	11.02	0.34	84	96.81	9.84	0.14
SCT								
Boys	72	23.40	9.94		72	28.29	10.22	
Girls	84	25.49	7.09	1.54	84	29.13	7.48	0.60
SPST								
Boys	40	20.76	7.81		65	27.31	8.38	
Girls	52	23.50	6.52	1.17	80	29.60	7.58	1.73

Table 3 t-Tests on Urban and Rural Students' Mean Scores

	Pretest				Posttest			
	n	Mean	SD	t	n	Mean	SD	t
AST								
Rural	54	91.39	11.22		54	96.79	11.74	
Urban	49	98.45	9.50	3.43*	49	97.27	8.56	0.24
SCT								
Rural	78	21.83	8.02		78	24.78	7.16	
Urban	78	27.22	8.67	3.02*	78	32.69	8.63	4.91*
SPST								
Rural	49	20.26	6.80		73	26.10	7.74	
Urban	43	24.19	7.27	1.81	72	31.03	7.52	3.08*

*p < .05

Table 4 Correlation Coefficients Relating Dependent to Independent Variables

	Dependent Variables					
	Pretest			Posttest		
Independent Variables	AST	SCT	SPST	AST	SCT	SPST
Gender	.09	.12	.10	.09	.05	.14
School Location	.32*	.32*	.14	.12	.45*	.31*

*p < .05

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