Science classroom learning environments and student attitudes in Singapore, Australia and the South Pacific

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The science laboratory classroom environments of secondary schools and the attitudes of secondary science students in Singapore, Australia and countries of the South Pacific were compared in this study. A prevalidated version of the Science Laboratory Environment Inventory (SLEI) was used to assess the students' perceptions of their learning environments while adapted versions of the Test of Science-Related Attitudes (TOSRA) were used to measure their attitudes toward science. Analysis of data generated found similar science laboratory learning environments across most secondary schools, with one of the environment scales, Open-Endedness, as the least favourable scale. The analysis also revealed that students in the South Pacific countries had particularly strong attitudes to science. The study raises the possibility that science teaching has its own culture independent of the culture(s) of the country, with an inherent resistance to local adaptation of 'imported' curricula.


Introduction

Discussion concerning perceived differences between countries was stimulated by the results from the Second International Science Study (SISS). Differences among countries in areas of economic output and students' achievement in science were so appreciable that it attracted
some attention (Rosier & Keeves, 1991). Walberg's (1981) educational productivity model suggests that the three distinct groups of variables, namely, student aptitude, instructional environment and educationally stimulating psychosocial environment, require optimisation in order to maximise affective, behavioural and cognitive outcomes. However, instead of taking into account all of these variables, society tends to observe only selected, and what often are perceived as more easily observable aspects of the model, such as student achievement and the perceived quality of the school (e.g., resources). The educational productivity model predicts that an important determinant of student learning is the classroom learning environment. The science laboratory learning environment was thus an important aspect of this study.

Background

The educational systems of the countries being compared in this are not exactly the same. The systems in the South Pacific countries and Singapore are centralised while Australia's is more state controlled. An overview of the different systems is summarised in this section.

The Singapore educational system

In Singapore, the curriculum is prescribed by the Ministry of Education because of the common national examinations that have to be taken and passed at various levels. It comprises 6 years of primary education and 4-5 years of secondary education. For those who do well at the end of secondary school, they may proceed on to 2 years of pre-university education.

An important feature of the system is that streaming (i.e., dividing students into different curriculum tracks or courses according to their ability) is practised. However, no matter what stream the student is in, English language, Mathematics, Science and the Mother Tongue (i.e., Mandarin, Malay or Tamil), are compulsory subjects.

The Australian educational system

In Australia, the curriculum in government schools is largely determined by the local state education departments but in some states, individual schools have a fairly substantial involvement in determining the curriculum.

In most Australian states, a two-level education system functions. There are seven or eight years of primary education (K-6/7) and six or five years of secondary education. However, some states operate a senior high school structure for the last two years of high school.
Most private schools can determine their own curricular but to meet state requirements, they have to meet particular criteria. This results in a fairly similar curriculum operating in both government and non-government schools. For their students to qualify for university entrance, each school has to meet state requirements and usually sit common state-wide examinations.

Science is compulsory in the lower secondary schools but can be optional in the final year of high school.

The educational system of the South Pacific countries

The countries in the South Pacific which participated in this study are Cook Islands, Fiji, Papua New Guinea, Solomon Islands, Tuvalu, Vanuatu and Western Samoa. Their educational systems are centrally controlled by their respective governments. All of them operate a two-level education system comprising 6-8 years of primary education and 4-7 years of secondary education.

Methodology

Sample

The student sample consisted of Year 10 students in both government and non-government schools in all the countries studied except Singapore. There were 1592 from Singapore, 1594 from Australia and 3637 from the South Pacific. All the students in the sample studied Science as one of their curriculum subjects.

Instruments

This study compared students' perceptions of the science laboratory classroom learning environment and their attitudes towards science in all the countries. Data about the science laboratory learning environment were collected using the Science Laboratory Environment Inventory (SLEI) designed by Fraser, McRobbie and Giddings (1993) while students' attitudes towards science were assessed using modified forms of the Test of Science-Related Attitudes (TOSRA) designed by Fraser (1981). The SLEI was also modified for use in both Singapore and the South Pacific.

The forms of the SLEI used in this study, like the original, consisted of 35 items, with seven items in each of the five scales: Student Cohesiveness, Open-Endedness, Integration, Rule Clarity, and Material Environment. Items are arranged in a cyclic order. A five-point scale, with the alternatives of Almost Never, Seldom, Sometimes, Often and Very Often, is used for the responses. Out of the 35 items, 13 of them are worded and scored in the reverse manner.
Results

Science laboratory learning environments

Table 1 contains the results on the internal consistency (alpha reliability coefficient) of the SLEI data for the present study. The coefficient is reported for the sample of students which is class or individually based. It shows that for the sample of students as individuals, the alpha coefficient ranged from 0.41 to 0.72 for Singapore schools, 0.71 to 0.86 for Australian schools and 0.48 to 0.58 for schools in the South Pacific. When the class is taken as the unit of analysis, the alpha coefficient ranged from 0.54 to 0.87 for Singapore schools, 0.74 to 0.91 for Australian schools and 0.57 to 0.82 for schools in the South Pacific. It is not surprising that the alpha reliability was consistently greater when the class was used as the unit of analysis. This is because the aggregation that occurred when the class mean was the unit of analysis resulted in a lower variance and consequently improved the reliability. The reliability data in Table 1 suggest that the versions of each SLEI scale used in the three countries in the study has acceptable reliability.

Table 1: Item Mean and Cronbach Alpha Reliability for Australian, Singapore and South Pacific Science Classrooms

The students' scale item means were also tabulated in Table 1 and plotted in Figure 1. The pattern of this plot was consistent with those found in past researches (Fraser, 1982, 1986; Fraser, Giddings & McRobbie, 1991), with Open-Endedness as the least favourable scale.

Figure 1: Plot of SLEI Scale Item Means for Students

Figure 1 shows that with that with the exception of Open Endedness, South Pacific students perceived a more favourable learning environment than did their Singapore and Australian counterparts. When comparing the Singaporean and the Australian students' perceptions, the former perceived their learning environment more favourably than the latter in the areas of Student Cohesiveness and Rule Clarity, while the Australian students perceived greater Open Endedness and better Material Environment than their Singaporean counterparts. Some interesting points to note from these comparisons are:

The relatively large difference between the students' perceptions of the learning environment between the South Pacific and, Singapore and Australian classrooms could be explained by the differences in the level of economic development of the countries. Singapore and Australia
are considered 'developed' nations as contrasted with the countries in the South Pacific which are in the 'developing' category.

Both Singapore and the South Pacific students perceived Open Endedness less favourably than their Australian counterparts. This difference in perception could be a result of the differences in the educational systems. Australia does not have a centralised system while the other two have. A centralised system with a prescriptive type of curriculum, bounded by common national examinations, could reduce the divergence of practical experiments that could be conducted.

Student Cohesiveness and Rule Clarity are also perceived more favourably in the Singapore and South Pacific science laboratory classrooms. This could stem from a culture difference - western versus non-western.

Integration was viewed much more favourably by South Pacific students than by their Singapore and Australian counterparts. This could be due to differences in the way the curriculum was delivered.

Science Attitudes

A summary of the analysis of the attitude data is given in Table 2. The attitude mean for each country is reported in the table.

Table 2: Item Mean and Cronbach Alpha Reliability for Australian, Singapore and South Pacific Science Classrooms

As shown in Table 2, differences in attitudes do exist among the different countries. The South Pacific students seem to have the best attitude towards science, while the Australian students have the worst. These differences could be explained in terms of differences in cultural values. When compared to Singaporeans and the people of the South Pacific countries, Australians seem to put less emphasis on the value of education. In addition, science is given great emphasis in Singapore and South Pacific curriculum. For instance, in Singapore, science is a compulsory subject taken by all students in primary and secondary school. This emphasis helps to increase the importance of the subject, which in turn enhances the students' attitude towards the subject. The same is probably true for South Pacific.

Conclusion

The use of the actual version of the SLEI in Australia and its adaptations to the Singapore and South Pacific contexts produced a valid and reliable instrument for assessing perceptions of science laboratory classroom environments. In the countries studied, the
overall science learning environment was viewed favourably except for a low perception of the Open Endedness scale. Of all the countries, South Pacific students perceived their learning environment most favourably in four out of five dimensions, with Open Endedness being the exception. When comparing the Singaporean and the Australian students' perceptions, the former perceived their learning environment more favourably than the latter in the areas of Student Cohesiveness and Rule Clarity, while the Australian students perceived greater Open Endedness and better Material Environment than their Singaporean counterparts.

When comparing the students' attitude towards science, the South Pacific scored the highest, followed by Singapore and then by Australia. It would seem that the more developed the country, the weaker the attitude of the students towards science.

The findings from this study seem to suggest that science teaching may have its culture which is independent of the culture(s) of the country. This was especially true for the Open Endedness dimension of the science laboratory classroom environment. In all three countries, irrespective of whether it is western or non-western, a low level of Open Endedness was found. This finding is consistent with those from previous studies involving the SLEI (Fraser, Giddings & McRobbie, 1992) and reinforces an international pattern in which science laboratory classes in schools are dominated by closed-ended activities (Hodson, 1988).

An extension of this study would be to examine if there exists an association between the nature of the classroom environment and the students' attitudes towards science. The use of both quantitative and qualitative methods will help to better understand this environment-attitude linkage as well as the "why" of the existence of such relationships.

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