Culturally-Sensitive Factors in the Learning Environment of Science Classrooms in Brunei Darussalam

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Abstract: The aims of this study were to validate the psychometric properties of the Cultural Learning Environment Questionnaire (CLEQ) when used in a new context, to evaluate cultural learning environment factors among lower-secondary students, and to investigate gender and age differences in students' perceptions on the CLEQ. The CLEQ includes the seven culturally-sensitive scales of Gender Equity, Collaboration, Deference, Competition, Teacher Authority, Modelling and Congruence. The sample consisted of 912 Grade 8 students (51% male; 49% female; mean age of 14.1 years) from coeducational schools in Brunei Darussalam. When data from administering the CLEQ were analysed, its factorial validity, alpha reliability, discriminant validity, and ability to differentiate between schools and classrooms were supported. Overall students perceived that both sexes were treated equally by moderately authoritarian teachers, that their classrooms were highly collaborative, competitive and modelled science and that science learning was associated with their out-of-school experiences. Students' perceptions of classroom environment were not influenced by their age or sex. Needed research for improving cultural learning environments in science classes is recommended.

Keywords: Age differences, Brunei Darussalam, culture, learning environment, science classrooms, sex differences, questionnaire.

INTRODUCTION

Differences in patterns of interaction with the physical world between societies and their cultures during their historical developments greatly influence science and science teaching and learning [1-3]. Research [2-8] has shown that the cultural values of both teachers [3, 6, 9] and students [4, 5, 9] influence classroom teaching and learning processes. Teachers' and students' behaviours and classroom interactions can modify the classroom learning environment [4, 5]. Moreover, students' science misconceptions are culture sensitive [10, 11]. Learners' cultural backgrounds have been observed to have a greater effect on education than the subject-matter content and teaching processes [8, 12]. Hodson [7] believes that the task of teaching is to help all children to acquire knowledge, interests, skills, attitudes and ways of thinking, while respecting their particular beliefs and experiences. Curriculum developers can use the rich cultural backgrounds of teachers and students to develop culture-sensitive pedagogies and curricula that don't reflect the cultural dominance of majority groups that still exists even in developed countries [13].

There are numerous methods and approaches available for improving interactions in a multicultural classroom [14-17] and for guiding modifications to a country's existing school curriculum. However, these modifications to the curriculum require educators to (1) know the make-up of the community, (2) select the important dimensions of culture that need to be addressed in a given curriculum and (3) know the existing influences of these dimensions on educational programs [14, 18].

An analysis of past research on cultural dimensions reveals that Moos [19] has identified relationship, personal development, and system maintenance dimensions, whereas Hofstede [20] has identified masculinity/femininity, individualism/collectivism, uncertainty/avoidance and power/distance as the most important dimensions of culture. Schwartz [21, 22] reported that individualism and collectivism could provide valid explanations about cultural differences in cultural values in a society. Fisher and Waldrip [4] proposed gender equity, collaboration, competition, deference, congruence, modelling, communication and teacher authority as culturally-sensitive factors that cover the dimensions proposed by Moos [19] and Hofstede [20] and which are important influences on classroom teaching and learning. Furthermore, this information is important for making appropriate adjustments to the existing educational system in order to optimise its functioning to the expected level. Therefore, cultural dimensions proposed by Fisher and Waldrip [5] were selected for investigation in this study.

Research from developed and developing countries demonstrates that gender equity in science education is still a cause of concern [23-25], with male and female students not being treated equally in coeducational schools [40]. Bruneian culture is collectivist in that hierarchical order is highly respected and collaboration is valued more than competition [15]. Although competition and collaboration (a key feature of constructivist teaching) are components of culture [20-22, 26], in Brunei, traditional teaching in classrooms limits

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collaborative working and encourages competition [27]. It has been reported that, despite students' coming from a collectivist society, schools still promote individualism [15]. Asian teachers have also been reported to be authoritarian, directive and strict, while valuing helping/friendly and admonishing behaviours, and not valuing freedom and responsibility [15, 28, 29]. These teachers, when teaching traditionally, encourage modelling and discourage congruence [5]. In contrast to the above, teacher authority in Bruneian non-government secondary schools [30] has been reported to be comparable to in Australian schools [5]. Research has also shown that respondents' perceptions are influenced by demographic variables [4, 5, 31, 32].

In Brunei, high levels of gender equity, collaboration, competition and low levels of teacher authority, congruence and modeling have reported in classrooms of undergraduate students [31]. Many of these emphases are similar to those found in some developing and developed countries [32]. However, at the lower-secondary level, Bruneian society does not approve of the free mixing of genders and therefore male and female students sit in different rows, which affects the classroom learning environment. We therefore decided to investigate the above factors in lower-secondary classrooms in Brunei. The identification of culturally-sensitive factors in the learning environments of multicultural classes potentially could guide the use of the multicultural make-up of science classes in optimising teaching and learning processes.

AIMS

The aims of our research were to (1) determine the validity and reliability of the Cultural Learning Environments Questionnaire (CLEQ) when used in the new context of Bruneian lower-secondary science classes, (2) evaluate culturally-sensitive factors in lower-secondary students' learning environments and (c) investigate sex and age differences in students' perceptions of the cultural learning environments in science classes.

ASSOCIATED CLASSROOM LEARNING ENVIRONMENT RESEARCH

The research reported in this article and the questionnaire that we used to assess students' perceptions (namely, the Cultural Learning Environment Questionnaire, CLEQ), are consistent with the burgeoning field of classroom learning environments [33, 34]. A hallmark of this field is the existence of numerous frequently-used and extensively-validated questionnaire that assess students' learning environment perceptions, including, the Science Laboratory Environment Inventory (SLEI) [35], Constructivist Learning Environment Survey (CLES) [36], Questionnaire on Teacher Interaction (QTI) [37] and What Is Happening In this Class? (WIHIC) [38]. These instruments have been used as a source of process criteria in the evaluation of educational innovations [39], in studies of associations between classroom environment and student outcomes [40], and in teacher action research aimed at improving classroom environments [41].

CULTUTRAL DIVERSITY IN BRUNEI

A great deal of diversity exists within each culture and subculture. The country in which our study was conducted, Brunei, is small in size (area of 770 square kilometers and divided into four districts), but rich in cultural diversity because of variations within the Bruneian population and temporary immigrant populations. In 2004, Brunei had about 80,000 (about 23% of the total population) temporary workers from many countries. The distribution of ethnic communities in the four districts of Brunei is very specific. For example, in Tutong district, one can find more people from Dusun and Tutong communities, whereas more Ibans are settled in Temburong district. More expatriates are working in the Brunei-Muara district followed by the Belait district. The Brunei population, however, mainly consists of Malay, Kedayan, Murut, Tutong, Belait, Dusun, Iban, Bisaya, Kelabit and Chinese communities. According to the Government of Brunei Darussalama the population (357,800 people estimated for 2004) of Brunei Darussalam consists of 52% males and 48% females. On the basis of race (locally ethnicity is labeled as race), Brunei has 66.3% Malay, Kedayan, Tutong, Belait, Bisaya, Dusun and Murut, 11.2% Chinese, 6% Iban and Dayak Kelabit, and 11.8% other races [23]. Brunei Darussalam's total population was projected to increase to 389,000 by 2006 and to 436,500 by 2011 [42, 43].

METHOD

The sample consisted of 912 Form 2 science students (14.1±1.1 years old) from coeducational schools in Brunei Darussalam (51% males and 49% females). Because National school enrolment data, including those for science subjects, show that the number of males is slightly higher than females, the gender distribution in this sample is also in line with that in the national population. Academically, girls outperform boys.

The instrument (CLEQ) used in this study, developed by Fisher and Waldrip [4], has 35 simply-worded items in seven scales. The content, language and constructs of the CLEQ have been validated in previous studies in Brunei [30, 36, 44]. The CLEQ's seven scales are Gender Equity, Collaboration, Teacher Authority, Competition, Deference, Modelling, and Congruence. Table **1** clarifies the meaning of these constructs by providing for each scale a scale description and sample item. Gender Equity refers to the extent to which students perceive that males and females are treated equally. The Gender Equity scale encompasses the idea that comments from male and female students in class are treated as being equally important, that excellent teachers can be from both genders, that students like to be taught by them, that students respect them, and that male and female students are equally capable in classroom activities and discussions. This scale is associated with the Relationship dimension in Moos' [19] human environment classification and to the Masculinity and Femininity factor in Hofstede's [20] cultural dimensions (see Table **1**). The Collaboration scale covers students' group work, discussion and collaboration with each other as a team to make group decisions during classroom learning. Teacher Authority deals with students asking the teacher difficult questions and challenging the teacher's views through disagreement and sound argument about the scientific issues during classroom teaching. Competition covers statements dealing with students competing with each other to do better than their classmates, the importance of competition, and students experiencing anxiety when they are unable to perform to

Table 1. Descriptive Information for Each Scale of the Cultural Learning Environment Instrument

Scale	Description	Sample Item	Moos Dimension	Hofstede Cultural Dimension
Gender Equity	The extent to which students perceive that males and females are treated equally	I feel that comments in class by male and female students are equally important. (+)	Relationship	Masculinity Femininity
Collaboration	The extent to which students perceive that they collaborate with other students rather than act individually	I feel it is important for the class to work together as a team. (+)	Relationship	Individualism
Deference	The extent to which the students feel that they defer to the opinions of others	I try to say what I think the teacher wants rather than give my own opinion. (+)	Relationship	Uncertainty Avoidance
Competition	The extent to which the students are competitive with each other	I like to compete against the other students. (+)	Personal development	Individualism
Teacher Authority	The extent to which the students perceive that the teacher has authority in the classroom	It is OK for me to disagree with the teacher. (-)	System maintenance	Power Distance
Modelling	The extent to which the students expect to learn by a process of modeling	I like teachers to show me what to do. (+)	Personal development	Uncertainty Avoidance
Congruence	The extent to which the students perceive that learning at the institution matches their learning/ application at home	What I learn at the institution helps me at home. (+)	System maintenance	Uncertainty Avoidance

(+) These items are scored 1, 2, 3, 4 and 5 respectively, for the responses Strongly Disagree, Disagree, Not Sure, Agree and Strongly Agree.
(-) These items are scored in the reverse manner.

their expected level. Deference involves students deferring their views to teachers' and other students' views by focusing on what the teacher and other students expect and on giving correct responses to all questions asked by the teachers. The Modeling scale covers students' tendency to expect teachers to show and tell them what to do and to copy what teacher and peers are doing in their class. Congruence covers the importance of students' prior knowledge that they bring to class in learning at school as well as what they learn at school in dealing with day-to-day problems and the level of consistency between what is learned at school and at home.

Each item is responded to on a five-point scale with the extreme alternatives being Strongly Disagree to Strongly Agree. Students are asked to indicate to what extent they agree that each item describes their classroom. A high scale score represents more prominence of that behaviour, except for the scale for which a high value reflects low teacher authority.

The CLEQ was administered to students with the help of their teachers. Based on age, the students were grouped into the three categories of ≤13 years (n=300), 14 years (n=365), and ≥15 years (n=229). The statistical significance of difference in CLEQ scores according to student sex and age was explored using ANOVA and t tests, whereas effect sizes were used to express the magnitudes of these differences in standard deviation units. According to Cohen [45], effect sizes of 0.2, 0.5 and 0.8, respectively, can be classified as low, medium and high.

RESULTS

The results section is divided into two subsections dealing with: validation of the CLEQ in lower-secondary school settings; and culturally-sensitive factors in lower-secondary science students' learning environments. Validating the CLEQ in a new setting was important before using questionnaire responses to answer Research Questions 2 and 3.

Validation of the CLEQ

Our validation of CLEQ involved five separate aspects: (i) content, construct and language validity; (ii) factor structure; (iii) reliability; (iv) discriminant validity; and (v) ability to differentiate between different schools.

Content, Construct and Language Validity

The content, language and construct validity of the CLEQ when used in the Bruneian context were evaluated in earlier studies [31, 44]. However, readability analysis is reported here because the sample in this study consisted of Year 8 students for whom English was the second or third language. Readability analyses revealed a Flesch Reading Ease score of 79.6 and a Flesch-Kincaid grade level of 4.6. The instrument also contained 5% of passive sentences. These standards were derived from native English speakers. Although the sample in this study consisted of Year 8 students, three grades above the grade level of 4.6, it should be remembered that English was students' second or third language. Local research has revealed that students' English reading competency is about 6 years below that of native speakers [46]. Although the CLEQ contains short words and sentences for ease of reading, some students' levels of language competency could have affected their ability to comprehend some items.

Factor Structure

Factor analysis was conducted to examine the internal structure of the set of 35 CLEQ items. Using SPSS, principal components analysis with varimax rotation was used to

generate orthogonal factors. Because factor analysis is based on an orthogonal model, we chose varimax notation in order to preserve orthogonality. The selection of varimax rotation met the goals and purposes of our study, and it has been widely used in educational research [4, 30, 31]. Moreover, Barker and Barker [47] stated that various rotation methods available in factor analysis produce very similar results. Because the CLEQ was designed with seven scales, a seven-factor solution was tried first. However, factor loading for Items 11–15 representing the Deference scale did not group together. Elimination of these items and also Item 28 from the Modelling scale led to a six-factor solution for the remaining 29 items (see Table **2**) in the same order as that reported in previous studies by Fisher and Waldrip [5] and Dhindsa and Khadija-Mohd-Salleh [30]. Table **2** shows the factor loadings for six CLEQ factors using the individual student as the unit of analysis. Table **2** shows that every item had a factor loading of at least 0.30 on its own scale and, with the exception of Items 16 and 31, less than 0.30 on all other scales. The percentage of variance extracted and eigenvalues (rotation sum of squared loadings) associated with each factor also are recorded at the bottom of Table **2**. The communality values (h^2) reported in Table **2** represents the fraction of variance explained by each item when grouped into a factor.

Reliability

The internal consistency reliability of each CLEQ scale was evaluated using Cronbach's alpha coefficient as shown in Table **3**. The alpha reliability values of 0.53 to 0.69 for the

Table 2. Factor Analysis Results for a 29-Item Version of the CLEQ

	Factor Loadings						
Item	**Gender Equity**	**Collaboration**	**Competition**	**Teacher Authority**	**Modelling**	**Congruence**	h^2
1	0.69						0.50
2	0.68						0.50
3	0.42						0.27
4	0.50						0.33
5	0.54						0.30
6		0.74					0.56
7		0.78					0.64
8		0.53					0.36
9		0.50					0.40
10		0.63					0.43
16*	0.32		0.58				0.45
17			0.71				0.53
18			0.60				0.41
19			0.54				0.33
20			0.62				0.46
21			0.32	0.52			0.44
22			0.43	0.56			0.53
23				0.62			0.43
24				0.60			0.43
25				0.65			0.47
26					0.72		0.61
27					0.55		0.33
29*					0.73		0.58
30				0.31	0.34		0.27
31						0.56	0.38
32						0.69	0.53
33						0.61	0.42
34						0.68	0.50
35						0.68	0.51
% variance	4.89	6.45	15.71	5.94	7.07	4.30	
Eigenvalues	1.42	1.87	4.56	1.72	2.05	1.25	

Cut-off point = 0.3.
* Deleted items.
Items 11–15 assess Deference but were lost in the analysis.

six scales in our study were slightly lower than in previous research which reported a range of 0.68 to 0.81 for Bruneian upper-secondary science students from government schools [44], of 0.58 to 0.82 for Bruneian secondary science students from non-government schools [30], and of 0.69 to 0.86 reported in Australia by Fisher and Waldrip [4, 5]. Our alpha coefficients suggest that all CLEQ scales have reasonable reliability when used with Grade 8 science in Brunei, especially for scales containing a relatively small number of items. However, these values to some extent could have been influenced by the language competency of some students.

Discriminant Validity

The mean absolute partial correlation of a scale with other scales was used as a convenient measure of the discriminant validity of the CLEQ. As shown in Table **3**, discriminant validity values for different CLEQ scales ranged from 0.10 to 0.14. This suggests that CLEQ scales measures distinct, although slightly overlapping, aspects of the cultural learning environment. This discriminant validity range is consistent with previously-reported ranges of 0.11 to 0.18 for Bruneian upper-secondary science students from government schools [44], 0.06 to 0.18 for Bruneian secondary science students from non-government schools [30], and 0.09 to 0.18 reported for Australian secondary science students [4, 5]. The conceptual distinctions among the scales are therefore justified by both the factor analysis and the discriminant validity results.

Ability to Differentiate Between Schools

Like many other countries, Brunei's culture is based on the segregation of the population into areas. For example, Tutong district has more people from the Dusan and Tutong races. These sub-populations have distinct cultures including spoken dialects. Regional schools are dominated by these surrounding cultures. Because this cultural effect is anticipated to translate into the school and classroom levels, a good instrument should be able to pick up such expected differences.

In order to test the ability of CLEQ scales to differentiate between the perceptions of students in different schools or classes, a one-way ANOVA was conducted for each scale with either school membership or class membership as the independent variable. Table **3** shows for which scales ANOVA results for school differences and class differences were statistically significant. Also, for the significant cases, Table **3** shows the value of the eta^2 statistic, which represents the proportion of variance in students' CLEQ scales accounted for by school or class membership. With the exception of the Congruence scale for the between-schools analysis, Table **3** shows that every CLEQ scale was capable of differentiating significantly ($p<0.01$) between the perceptions of students in different schools and in different classrooms.

Culturally-Sensitive Factors in Lower Secondary Science Students' Learning Environment

Cultural Learning Environment in General

Table **4** shows the average item mean and average item standard deviation for each of the six CLEQ scales. The high mean values for Gender Equity (4.00), Collaboration (4.16), Competition (4.05), and Congruence (3.82) suggest that, in general, students' cultural learning environment was supportive of science learning. However, the high mean for Modelling (3.89) and low mean for Teacher Authority (3.22) suggest that modeled teaching by authoritarian teachers could mask the support of the other four factors to some extent. The range of mean values from 2.95 to 4.14 reported in Table **4** is comparable to Bruneian data for upper-secondary students in government schools [44] and for secondary students in non-government schools [30].

Sex Differences

Table **4** provides, separately for males and females, each CLEQ scale's average item mean and average item standard deviation, together with sex differences for each scale (effect size and statistical significance). Male and female students' perceptions were not statistically significantly different for Gender Equity, Competition, Modelling and Congruence, but were statistically significant for Collaboration and Competition in favour of female students. However, the small effect sizes (0.19 and 0.15 standard deviations) suggest that these sex differences are of little educational importance.

Age Differences

Table **5** provides the average item mean and average item standard deviation for each CLEQ scale separately for three separate age groups. As well, the statistical significance and effect size are shown for the comparison of age groups on scores on each CLEQ scale. CLEQ scale scores for ≤13 years, 14 years and ≥15 years old students' were not statistically significantly different for Gender Equity, Competition and Congruence scales, but were statistically significant for Collaboration, Teacher Authority and Modelling. Post-hoc analysis revealed that only four of the 18 possible comparisons were statistically significant.

Table 3. Alpha Reliability, Discriminant Validity and Eta Square Statistics

Scales	No of Items	Alpha Reliability	Discriminant Validity	Eta^2 (Schools)	Eta^2 (Classes)
Gender Equity	5	0.57	0.14	0.11 **	0.25 **
Collaboration	5	0.67	0.11	0.05 **	0.19 **
Competition	5	0.68	0.14	0.10 **	0.17 **
Teacher Authority	5	0.59	0.10	0.05 **	0.17 **
Modelling	4	0.53	0.12	0.04 **	0.17 **
Congruence	5	0.69	0.13	0.01	0.11 **

**$p<0.01$.

Table 4 Item Mean and Standard Deviation for the Whole Sample and for Males and for Females, and Sex Difference (Statistical Significance and Effect Size) for each CLEQ Scale

Scale	No of Items	All Mean± SD	Male Mean± SD	Female Mean± SD	Difference *p*	*Effect Size
Gender Equity	5	4.00 ± 0.66	4.02 ± 0.63	3.99 ± 0.68	0.441	-
Collaboration	5	4.16 ± 0.69	4.10 ± 0.68	4.23 ± 0.70	0.006	0.19
Competition	5	4.05 ± 0.72	3.99 ± 0.72	4.10 ± 0.72	0.027	0.15
Teacher Authority	5	3.22 ± 0.81	3.24 ± 0.81	3.19 ± 0.80	0.346	-
Modelling	4	3.89 ± 0.72	3.90 ± 0.73	3.89 ± 0.72	0.702	-
Congruence	5	3.82 ± 0.72	3.77 ± 0.71	3.86 ± 0.73	0.052	-

*Effect size values are provided for statistically significant differences only.

Table 5 Item Mean and Item Standard Deviation for Three Age Groups, and Age Differences (Statistical Significance and Effect Size) for each CLEQ Scale

Scale	Age-Based Mean and SD			ANOVA	Post-Hoc Analysis (Effect Size)*		
	≤13 Years	14 Years	≥15 Years	*p*	13 *vs* 14	13 *vs* 15	14 *vs* 15
Gender Equity	4.04 ± 0.69	4.02 ± 0.65	3.94 ± 0.62	0.166	-		-
Collaboration	4.24 ± 0.65	4.16 ± 0.73	4.07 ± 0.67	0.017	-	0.017 (0.26)	-
Competition	4.05 ± 0.75	4.07 ± 0.73	4.02 ± 0.67	0.750	-	-	-
Teacher Authority	3.13 ± 0.82	3.22 ± 0.78	3.33 ± 0.80	0.017	-	0.017 (0.25)	-
Modelling	3.79 ± 0.79	3.95 ± 0.70	3.97 ± 0.67	0.005	0.020 (0.25)	0.018 (0.24)	-
Congruence	3.80 ± 0.75	3.85 ± 0.70	3.81 ± 0.74	0.668	-	-	-

*Effect sizes are provided for statistically significant differences only.
n=300 of 13 years; 365 of 14 years, and 229 of ≥15 years.

However, modest effect sizes for these comparisons (ranging from 0.24 to 0.26 standard deviations) suggest that these significant differences are of limited educational importance.

DISCUSSION

Gender Equity

An overall mean value of 4.00 for gender equity in Table **4** suggests that students believed that male and female students were equally treated in their classes. This perception was held by students from both genders and three age groups (Tables **4** and **5**) and is consistent with our perceptions and those of other academics. In earlier research, mean values of 4.13 and 4.11 for Bruneian upper secondary students from government schools [44] and non-government schools [30] were reported, respectively. A higher value of 4.53 has been reported for gender equity for Australian secondary students [5]. These findings suggest that the CLEQ has been able to differentiate between classroom cultures in two countries, namely, Brunei with its majority Malay culture, Islam religion and Islamic values, and Australia with its multicultural western setting. The gender equity data are consistent with the openness in Bruneian society to women's education. The level of gender equity in Bruneian schools was comparable to that found in some developing and developed countries [32], but different from other reports that students of different genders were treated differently in some cultures even in the classroom setting [40]. However, the mean value of 4.00 in our study still suggests some scope for improvement in gender equity at the lower-secondary school level.

To further improve gender equity in classrooms, curriculum materials and teachers can help. The unfair representation of gender in favour of males in lower-secondary science textbooks reported by Elgar [25] also could have lowered the mean score on gender equity scale at lower-secondary level in our study. Gender bias in curriculum materials also could have led to lower perception scores.

Tobin and Gallagher [48] claim that teachers can improve and maintain gender equity in their classes by providing equal engagement opportunities, using unbiased selection procedures for males and females, and arranging students' seating orientation in class to facilitate more interaction. In Bruneian schools, however, male and female students sit in different rows because of religious and cultural contextual constraints, which certainly affect the seating orientation and group-work activities in a classroom. However, there is no research in the Bruneian context on the effects of separate seating arrangements for male and female students in the classroom on gender equity; such research is recommended. However, Sharizal-Lampoh [27] believes that, under the supervision of teachers and in presence of other students in a classroom situation, mixing of genders should be acceptable to society.

Research shows that helping/friendly teachers can enhance gender equity as long as there isn't too much freedom [5]. Bruneian teacher, like teachers from developing countries including Asia, typically are directive and highly value helping/friendly behaviour [28, 49]. These personal behaviours of teachers could have contributed to higher gender equity perceptions reported by students in our study, even though they were sitting in different rows and having limited freedom to mix with the opposite sex.

The above discussion suggests that gender equity in science classes could be enhanced by improving (1) gender representation in teaching resources, (2) inter-gender communication under supervised conditions and (3) teachers' classroom practices.

Collaboration and Competition

Mean values greater than 4.00 for both the collaboration (4.16) and competition (4.05) scales reported in Table **4** suggest that Bruneian students are highly collaborative and competitive when they are learning science. This view was expressed by students of both genders and three age groups. A similar pattern has been reported for Bruneian upper secondary students in government schools [44]. This finding is supported by Thomas' [15] claim that it is possible to be collectivist and individualistic at the same time depending on the task and social setting. By its nature, the Malay collectivist culture values collaboration [15], which could have contributed to the higher scores on this scale. Thomas [15] also stated that, despite students' coming from a collectivist society, schools are designed to emphasise individualism, which could help to improve competition scores.

Contrary to the above, Bruneian secondary students in non-government schools perceived learning in their science classes as more collaborative (mean of 4.13) than competitive (3.69) [30]. The higher mean value for collaboration in non-government schools can also be explained on the basis of Malay being a collectivist culture. The comparable levels of collaboration found both in our study in Brunei and in research in Australia [5] suggest that students from these two distinct cultures perceived equal extents of collaborative learning going on in their classes. However, the mean score for competition for Bruneian students (4.14) was much higher than that for Australian students (3.03). These differences possibly could have arisen because of differences in the interpretation of the meaning of competition in two countries.

Past research can guide improvements on these factors. Fisher and Waldrip [5] reported that, (1) when teachers showed leadership and were strict and admonishing, collaboration was enhanced and (2) when teachers showed leadership and were strict or uncertain or gave students responsibility, competition was enhanced. It has been reported that teachers from developing countries including Asia (also Brunei) typically are directive and strict [28, 49], which appears to be reflected in students' high perception scores for competitive and collaborative learning in the classes in our study. Curriculum departments can help to address these factors by encouraging cooperative teaching and learning in schools. Further research on how this culture could manage to put two opposing factors together, as well as what factors influence students' perceptions, is recommended. Further research is also recommended on how optimisation of competition and collaboration to equal levels in science classrooms can benefit students when learning science, especially in Brunei.

Teacher Authority

The scale mean of 3.22 for teacher authority suggests that the students in our study were undecided about whether to follow their teacher or work independently because they did not see their teachers as highly authoritarian. In past research, the mean value for teacher authority was 3.01 for Bruneian non-government school students [30] and 3.02 for Australian secondary students [5].

Dhindsa [44] noted that some CLEQ items start with "I feel.." and therefore require students to reflect on their feelings rather than their actions. Based on their feelings, students appear to have scored low on this item, thus contributing to greater teacher authority. Brunei is a hierarchical collectivist society in which a teacher's place is higher and more powerful than the student's and teaching style is mostly traditional. According to Thomas [15], the strong hierarchical feature of high power/distance will mitigate against group decisions. This factor might have prompted students in our study to record teachers as being more authoritarian. Because our data were collected in the presence of class teachers, this might have influenced students' responses to the CLEQ and therefore scores on the teacher authority scale. Moreover, the Bruneian culture is very considerate and so people generally do not like to speak against others. This inherent cultural characteristic might also have inflated students' scores for teacher authority to some extent.

Modelling

The mean value of 3.89 for modelling suggests that the students at this level were largely dependent learners. Responses from students of different age groups and genders support this result. Mean modeling scores of 3.76, 3.51 and 3.10, respectively, for secondary students from Bruneian government schools [44], Bruneian non-government schools [30] and Australian schools [5] have been reported. These results demonstrate that Bruneian students are more teacher-dependent learners than are Australian students. The traditional examination-oriented teaching styles and teacher behaviours appear to have contributed to scores on this scale. Research shows that modelling scores can be reduced by minimising helping/friendly, admonishing, and freedom and responsibility behaviours [5, 28, 29]. Because students also tend to copy their teachers as leaders [5], teachers can lower modelled and teacher-dependent learning in their classes through constructivist teaching, which emphasises students' understanding through the use of activities, sharing knowledge and reorganising thought. Recently the Brunei government has introduced a new education system, called SPN 21, that involves a revised curriculum for the nation [50]. This new education system was introduced in 2008 with the aim of moving teacher away from traditional student-centred teaching that could decrease modelled learning.

Congruence

A mean congruence value of 3.82 in our study suggests that students felt that learning at school was associated to some extent with the environment at home, which is helpful in resolving their day-to-day problems. Students from both genders and three age groups equally lent support to this finding. Mean values of 3.85, 3.55 and 3.43 have been reported for congruence for upper-secondary students in, respectively, Bruneian government schools [44], Bruneian non-government schools [30] and Australian schools [5].

It is relatively easy for teachers to relate science teaching to students' daily-life experience because the Brunei lower-secondary curriculum uses concrete daily-life experiences. Teachers can easily improve this by using project work involving community-related issues in their classes and by enhancing their leadership, friendly and helpful behaviours or strict, helping and friendly behaviours as suggested in the literature [5, 27, 48]. Therefore, relatively high mean values on these factors could have helped lower-secondary students to perceive higher levels of congruence in their learning in their classes and in its use in real-life situations.

CONCLUSIONS AND IMPLICATIONS

The findings of our study suggest that, in Bruneian lower-secondary science classes, highly collaborative, competitive and modelled science learning is occurring in an environment of high gender equity where moderately authoritarian teachers often relate science content to students' out-of-school experiences. This pattern exists irrespective of students' sex or age.

A major implication of this research is that identification of the dimensions of students' culturally-sensitive learning environments can provide us with an opportunity to make adjustments to school curricula in an attempt to optimise teaching strategies in order to align them to these cultural dimensions. Although the data show that cultural learning factors in students' learning environment are supportive of science learning in their classes, there is a scope for improvement. Although the introduction of SPN 21 is likely to help in improving the cultural learning environment, our research still is likely to be useful in guiding further adjustments to SPN 21. Moreover, research is needed into the effectiveness of SPN 21 revisions in terms of students' cultural learning environments.

School teachers can utilise this information to raise awareness of student preferences when selecting a balanced set of strategies and instructional approaches appropriate to the profile of the students. For example, male and female students in Brunei sit in different rows but, in some cases, males sit in the front and females sit behind the males. This arrangement has an effect on classroom seating orientation, which has been reported to influence classroom interaction [48]. Also the engagement opportunities provided to students and selection procedures used by teachers can encourage gender inequity in a classroom situation [48]. Teachers can overcome this behaviour by improving their classroom practices, especially by providing equal opportunities for male and female students.

Our research can guide adjustments to the school curriculum and teacher education programs in an attempt to optimise teaching and learning in multicultural classes. Bruneian society is collectivist and values collaboration. According to Thomas [15], the individualism and collectivism traditions provide educators with a valuable framework for understanding how a school with emphasis on individualism and achievement can meet the needs of students from a collectivist society. A shift from a traditional teaching style to constructivist teaching, which values collaboration in the classroom more than individualism, could promote group work and collaboration [27]. Constructivist teaching could help students and teachers to use a readily-available reserve of collaboration values in this collectivist society for effective teaching and learning of science in schools.

In our study, students in lower-secondary schools perceived high gender equity and modelled learning in their classes. Constructivist teaching and learning relies heavily on cooperative learning and group work. During constructivist teaching and learning, students learn to air views that are different from those of other students and to (a) be independent learners by reducing modeled learning in their classes, (b) improve their ability toward deference, (c) express their logic, and (d) increase their understanding of other cultures, cultural differences and problems faced during interaction between students from different cultures.

Teachers are responsible for addressing real concerns in multicultural education, including decisions about curriculum, selection of materials, and classroom language. Therefore, it is important that science teacher education programs educate teachers to cope with teaching in multicultural classrooms. Zeichner and Hoeft [51] reported that teacher education programs often do little to (a) recognise teachers' own beliefs, stereotypes and prejudices and (b) help teachers to recognise that students' personal and community lives affect classroom teaching. Teacher education programs should provide opportunities for teacher educators to use cultural differences in highlighting inconsistencies between teachers' beliefs and their actual and desired practices. The arrangement of teaching practice in schools for science teacher trainees should be optimised by providing them with experience in multiple schools and cultural settings. Moreover, it is important that teacher educators also have experience in teaching students from multicultural backgrounds.

The present study also revealed comparable means for collaboration and competition, which suggests that two opposing factors were equally valued in this culture, which is different from the developed world where collaboration and competition are inversely related. Therefore, redesigning the educational system in Brunei is likely to require special attention in order to maintain collaboration and competition at similar levels. Collaboration is important for learning and competition and for the development of the nation. Although it is common practice in developing countries, including Brunei, to invite experts from developed countries to redesign their educational systems, this practice should be considered carefully because these consultants would be experienced in working with communities that do not value collaboration and competition at comparable levels.

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CONFLICT OF INTEREST

None declared.

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