

CHAPTER FIVE

TEACHERS' INTERPERSONAL BEHAVIOUR INFLUENCES ON EXAMINATION RESULTS

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ABSTRACT

An elementary version of the Questionnaire on Teacher Interaction (QTI) and a scale for determining students' enjoyment of their science lessons were translated into Standard Malay. The instruments were validated with a sample of 3,104 students in 136 classrooms in Brunei Darussalam. Scale means showed that students enjoyed their science lessons. They perceived their teachers mostly as good leaders, helping/friendly, understanding and strict, seldom allowing student responsibility and freedom, seldom uncertain or dissatisfied and seldom admonishing. Associations between students' perceptions of their teachers' interpersonal behaviours and their external examination result in science were investigated for a subsample of students.

INTRODUCTION

The educational systems of developing countries have been characterised by rapid changes in structure and content. Much emphasis has been placed on cognitive aspects of learning while non-cognitive aspects have been either totally neglected or less emphasized (Harty & Hassan, 1983). The line of research in this study attempted to find links between these two aspects.

This study investigated students' perceptions of their science teachers' interpersonal behaviour in government primary schools in Brunei Darussalam, where limited data existed. In Brunei, science education had been given an important status in school curricula. The Ministry of Education had advocated improvements in the teaching and learning of science and mathematics, aiming to create the foundation of technologically oriented workforce in line with the needs of national development (Ministry of Education, 1999). Students in Brunei have experienced, highly qualified teachers and reasonably well-equipped science laboratories in secondary schools (Poh, 1996).

Accepted methods to improve academic achievement in science have included the promotion of more effective teaching strategies and creation of more positive attitudes towards the learning of science (Poh, 1996). It was also been accepted that an effective strategy for achieving better examination results was to create and maintain more effective learning environments through the development of more active and creative classrooms and greater reflectivity in teachers and pupils (Zaitun, 1999).

Educational research, particularly at the primary level, can identify factors that could lead to improved achievement. Students' perceptions of their science teachers' classroom behaviour and their enjoyment of science lessons were measured in this study using instruments especially developed for use with these Malay-speaking students. Instruments chosen for translation allowed for cross-country comparisons with similar studies in Singapore and Australia, where teachers' interpersonal classroom behaviour have previously been shown to influence both students' cognitive achievement and their enjoyment of science lessons.

THE QUESTIONNAIRE ON TEACHER INTERACTION (QTI)

Wubbels, Créton, and Hooymayers (1985) focused on the teacher variable for improving the learning environment, and developed a model to map teacher interpersonal behaviour. It was based on the model for interpersonal behaviour of Leary (1957). The Leary model with the two dimensions of influence and proximity, has been extensively investigated in clinical psychology and psycho-therapeutic settings and has proven to be a rather complete model to describe interpersonal behaviours (Foa, 1961). Wubbels et al. (1985) adapted the Leary model and developed a model for interpersonal teacher behaviours. They mapped the behaviours of teacher with a proximity dimension (Cooperation, C - Opposition, O) and an influence

dimension (Dominance, D - Submission, S). These dimensions can be represented in a coordinate system divided into eight equal sections as shown in Figure 1. Each sector of the diagram represents the following typical interpersonal behaviours of the teacher: Leadership, Helping/Friendly, Understanding, Student Responsibility/Freedom, Uncertain, Dissatisfied, Admonishing and Strict behaviours.

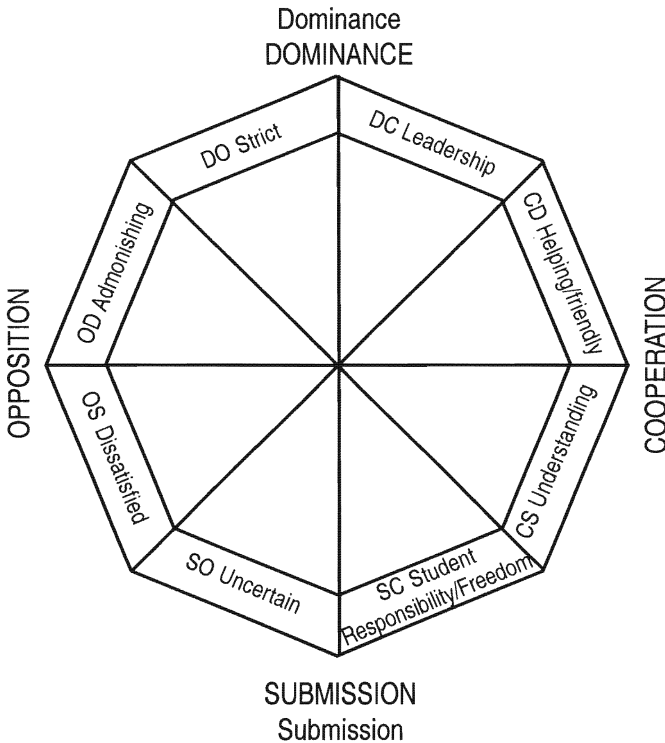


Figure 1. *The model for interpersonal teacher behaviour*
(Source: Fisher, Fraser, & Wubbels, 1993).

The *Questionnaire on Teacher Interaction* (QTI), which measures students' and teachers' perceptions of interpersonal behaviour, is based on this model (Wubbels & Levy, 1993). The instrument contains eight scales with the same names as the sectors of the model. Table 1 represents a description (Fisher & Rickards, 1997) and the sample item of each scale of the QTI that was found in this study to contribute most to that scale. The original version of the QTI developed in The Netherlands had 77 items

(Wubbels et al., 1985). Later, the QTI was reduced to 64 items for an American version (Wubbels & Levy, 1991) and to 48 items for the Australian version (Fisher, Henderson, & Fraser, 1995).

Scale name	Description of scale (The extent to which the teacher...)	Sample item
Leadership	...leads, organises, gives orders,determines procedure and structures the classroom situation.	This teacher talks enthusiastically about his/her subject.
Helping/Friendly	...shows interest, behaves in a friendly or considerate manner and inspires confidence and trust.	This teacher helps us with our work.
Understanding	...listens with interest, empathises,shows confidence and understanding and is open with students.	This teacher trusts us.
Student Responsibility and Freedom	...gives opportunity for independent work, gives freedom and responsibility to students.	We can decide some things in this teachers' class.
Uncertain	...behaves in an uncertain manner and keeps a low profile.	This teacher seems uncertain.
Dissatisfied	...expresses dissatisfaction, looks unhappy, criticises and waits for silence.	This teacher thinks that we cheat.
Admonishing	...gets angry, express irritation and anger, forbids & punishes.	This teacher gets angry unexpectedly.
Strict	...checks, maintains silence and strictly enforces the rules.	This teacher is strict.

Table 1. *Description of Scales and Sample Items for each Scale of the QTI*

The QTI has been shown to be a valid and reliable instrument when used in The Netherlands (Wubbels & Levy, 1993). When the 64-item USA version of the QTI was used with 1,606 students and 66 teachers in the USA, the cross-cultural validity and usefulness of the QTI were confirmed. Using the Cronbach alpha coefficient, Wubbels and Levy (1991) reported acceptable internal consistency reliabilities for the QTI scales ranging from 0.76 to 0.84 for student responses.

One main use of the QTI in The Netherlands involved investigation of relationships between perceptions on the QTI scales and student learning outcomes (Wubbels, Brekelmans, & Hooymayers, 1991). Regarding students' cognitive outcomes, the more that teachers demonstrated strict, leadership and helping/friendly behaviours, the higher were cognitive outcome scores. Conversely, student responsibility and freedom, uncertain and dissatisfied behaviours were related negatively to achievement.

The Australian version of the QTI containing 48 items was used in studies involving upper secondary science classes in Western Australia and Tasmania (Fisher, Fraser, & Wubbels, 1993; Fisher, Fraser, Wubbels, & Brekelmans, 1993; Fisher et al., 1995). These studies confirmed the reliability and validity of the QTI when used in upper secondary science classes. Student cognitive gains were least in classes where students perceived that the teacher was dissatisfied and gave them much freedom and responsibility (Rawnsley & Fisher, 1997). These initial studies strongly supported the validity and potential usefulness of the QTI within the Australian context, and suggested the desirability of conducting further and more comprehensive research involving the QTI. Initially, it was intended that this shorter Australian version of the QTI would be used in this study.

SCIENCE EDUCATION IN PRIMARY SCHOOLS IN BRUNEI DARUSSALAM

In government schools in Brunei Darussalam, the medium of instruction in lower primary school (years 1, 2, and 3) is Malay (except for the study of English language). Upper primary (years 4, 5, and 6) schooling is bilingual. Students study Malay language, Islamic religion, physical education, arts and handicrafts in Malay. They study English language, geography, history, mathematics, and science in English medium. Since 1992, upper primary students have been taught three lessons (25 minutes each) of science each week. The science syllabus is content-based, emphasizing recall of knowledge covering a wide range of topics of biology, physics, and chemistry. At the end of upper primary, all students sit five external, pen-and-paper Primary Certificate Examinations (PCE) in the subjects of Malay language, English language, mathematics, science, and General Paper, the latter four examinations being in English language. Results on these PCE are used to select and stream students for secondary schooling.

RESEARCH QUESTIONS

This study is part of a much larger study to monitor the teaching and learning of primary science in Brunei Darussalam. The questions of importance in this paper are:

1. How do primary school students in government schools in Brunei Darussalam perceive their science teachers' interpersonal behaviour?
2. Do primary school students in government schools in Brunei Darussalam enjoy their science lessons?
3. Are there any significant associations between students' science PCE result and their perceptions of their science teachers' interpersonal behaviour and enjoyment of science lessons?

METHOD

Pilot study

To ensure that the quantitative classroom learning environment instrument selected for this study was suitable for the culture (Smith, 1991) of Brunei, the first step was for a local educator to check the QTI for contextual authenticity. The QTI was viewed as relevant, valid, and potentially offering useful conclusions. The English language 48-item Australian version of the *Questionnaire on Teacher Interaction* (QTI) was administered to four intact classes containing 88 first-year secondary school ("Form 1") students whose first language was Standard Malay and second language was English. Although these 88 students were attending a bilingual government school with a reputation for high academic achievement, the students nevertheless requested a Malay translation. Even when a Malay translation was read aloud by a native speaker, students frequently requested explanations of meaning. Although the Malay translation of the QTI was satisfactorily back-translated into English by bilingual adults, some terms were not known by the students. For example the Malay words for "hesitant" and "confused" were not clearly understood. Thus, it appeared that, the language difficulty was two-fold. Not only did students find the English language difficult, but also many words, when translated into Standard Malay, were not in their vocabulary. The pilot study also highlighted the importance of cross-cultural functional equivalence of words and phrases. If effective classroom environment research was to be done, a version of the QTI, using simplified English translated into Standard Malay, was needed.

Goh and Fraser (1996) adapted the Australian, English language, high school version of the QTI to lower their reading level for use in primary schools. The same eight scales and similar 48 items were used to form the QTI (Primary) (Goh & Fraser, 1998). Both vocabulary and sentence structure were simplified. For example, "This teacher talks enthusiastically about her/his subject", was changed to "We all listen to this teacher." "This teacher is hesitant" became "This teacher doesn't seem sure." Secondly, the response format was simplified. The QTI (Primary) [QTIP] was validated with 1,512 students in 39 fifth-grade classes of 13 randomly selected primary schools in Singapore. Each of the eight scales exhibited satisfactory internal consistency, reliability, and predictive validity when both the student and the class mean levels of analysis were employed. This QTIP was chosen for translation into Standard Malay for this study.

Attitudes Towards Science

In some countries, it is possible to find trends of decreasing interest in science subjects in secondary schools by analysing the number of students choosing science subjects (Greenfield, 1996). Assessing student attitude towards science cannot be approached by this analysis of enrollment patterns in science subjects in Brunei Darussalam because science is a compulsory subject for many students until the end of their secondary schooling. Much recent attention to affective variables, particularly attitudes, in education research stems from the view that affective variables are as important as cognitive variables in influencing, possibly predicting, learning and other outcomes (Koballa, 1988). Evaluative quality is the central attribute of the attitude concept – like or dislike (Shrigley, Koballa, & Simpson, 1988), including terms such as interest, enjoyment, and satisfaction (Gardner & Gauld, 1990) and even curiosity, confidence, and perseverance (Shulman & Tamir, 1972). Shrigley (1983) states that it is generally agreed that attitude is not innate, but learned as part of culture.

Klopfer alleviated the semantic problems caused by the multiple meanings attached to the term "attitude" to science by classifying the following six categories of conceptually different attitudinal aims: manifestation of favourable attitudes to science and scientists; acceptance of scientific enquiry as a way of thought; adoption of "scientific attitudes"; enjoyment of science learning experiences; development of interest in science and science-related activities; and development of interest in pursuing a career in science (Shulman

& Tamir, 1972). The *Test of Science Related Attitudes* (TOSRA), designed to measure these scales separately, was written for use with secondary school students (Fraser, 1978, 1981). After examination of several science attitude tests, one of the TOSRA scales, from which the 7-item *Attitude To This Class* scale was devised, was selected for this study. This scale has been validated in Australia (Fisher, Rickards, Goh, & Wong, 1997a, b). The original name for this TOSRA scale, the *Enjoyment of Science Lessons* (ENJ) (Fraser & Fisher, 1982), was chosen for this study.

Translation

The items of the QTIP (Goh & Fraser, 1998) were translated by an adult, bilingual, native Malay-speaker into Standard Malay. The translator, fluent in both English and Malay, was a local primary school teacher aware of many of the language difficulties that school students encounter. Many discussions were held to ensure that original meaning was maintained. The translator also understood and discussed with the first author of this paper many of the cultural difficulties inherent in translation. The final translation was checked by several other adult bilingual first-language Malay-speakers and modified until agreement was formed. Back-translation procedures were then employed and did not suggest that rewording was needed for any particular item on the Malay version of the QTIP.

Response format

Many questionnaires use a 5-point Likert scale response format. Scoring involves allocating the numbers 1, 2, 3, 4, and 5 to the responses Strongly Disagree, Disagree, Not Sure, Agree, and Strongly Agree or the numbers 0 to 4 for the responses Always to Never for positive items and reverse scoring for negative items (Fraser, 1986). When Goh and Fraser (1996) simplified the QTI for use with primary school students, they simplified the response format to a 3-point Likert scale. They worded the options Mostly, Sometimes, and Seldom. It is important to note that the middle response is positive rather than neutral. These responses seemed ideal for the Malay translation of the QTIP (QTIE), numbering them 1 to 3.

Sample

The QTIE was administered to all Years 4, 5, and 6 primary school students in the 12 government schools in Brunei Darussalam that were involved in the specialist science teaching project. In order to make comparisons, the same questionnaire was also administered to all year 6

students in another 13 schools in the same geographical district of Brunei-Muara. In total, the sample consisted of 3,104 students in 136 classes. 2,542 students from Project schools and 562 students from non-Project schools completed the questionnaire. 924 students were in year 4, 840 were year 5 students and 1,340 were year 6 students. All non-Project school students were year 6. 1,490 boys and 1,573 girls completed the questionnaire.

Validity measurement

The congeneric measurement model was used for the calculation of reliability coefficients using the individual as the unit of analysis. Each scale was not merely calculated as a sum of each of the items in that scale. Rather, each scale was calculated as a sum of the items in that scale using the percentage contributions determined by PRELIS and LISREL computer programs (Jöreskog & Sörbom, 1988, 1989).

RESULTS AND DISCUSSION

Validation of the translated version of the QTIP

PRELIS and LISREL analyses showed that two items impacted negatively on their scale. Once these two items were deleted, further statistical analysis to determine internal consistency reliability revealed that the QTIE was indeed a valid and reliable instrument for use with these Malay-speaking elementary school students.

A learning environment instrument, ideally, should differentiate between perceptions of students in different classes. Students within a class usually view the classroom learning environment similarly, but differently from students in other classes. The instrument's ability to differentiate in this way was measured using one-way analysis of variance (ANOVA) with class membership as the main effect, showing that each of the scales did in fact significantly differentiate between classes (Scott & Fisher, 2001).

Students' perceptions of teachers' classroom behaviour

Scale means, reported in Table 2, show that students in this study perceived their teachers as mostly good leaders, helping/friendly, understanding and strict, seldom allowing student responsibility and freedom, seldom uncertain or dissatisfied and seldom admonishing.

This present study is the first investigations using the QTI to determine primary students' perceptions of their teachers' classroom behaviour in Brunei. Comparisons of these results with results from secondary school students in

Brunei and those from other countries is important and interesting in line with Wubbels' (1993) reasoning that a main aim of science is to search for universality of phenomenon. Comparisons with a similar study in Brunei of 644 upper secondary chemistry students' perceptions of their teachers' interpersonal classroom behaviour using the QTI (Riah, Fraser, & Rickards, 1997) revealed similar trends. The lowest scale score in both investigations in Brunei was the Uncertainty scale, with Student Responsibility and Freedom, Dissatisfied, and Admonishing scales also low. The highest scale means in both studies were for Leadership, with Helping/Friendly and Understanding also quite high. The culture of the society in Brunei must be an influencing factor contributing to the classroom behaviour of teachers and students (Zaitun, 1997).

Scale	Mean	Std. Dev.	<i>r</i>	β
Leadership	2.72	.40	.30***	.17**
Helping/Friendly	2.47	.40	.27***	
Understanding	2.46	.45	.28***	
S R Freedom	1.58	.36	.03	
Uncertainty	1.33	.36	-.30***	-.21***
Dissatisfied	1.44	.35	-.19***	
Admonishing	1.47	.40	-.08*	.12*
Strict	2.37	.54	.06	
Enjoyment	2.60	.40	.23***	
Multiple Correlation			R = .41	R ² = .16

*** $p = 0.000$, ** $p < 0.01$, * $p < 0.05$

N = 486 students in 26 classes

Table 2. Significant associations between achievement in science (PCE score) and QTIE scales in terms of simple correlations (*r*) and standardized regression coefficients (*b*)

The Brunei education system is similar to that of Singapore, and different from that of many other countries, with its highly centralised structure, mode of instruction mostly being expository, and evaluations of schools based solely on the students' academic performance on summative pen-and-paper examinations (Teh & Fraser, 1993). The only previous use of the QTI (Primary) was with a sample of 1,512 upper primary mathematics students in Singapore.

Students' perception results showed similar trends to the present study with the Leadership, Helping/Friendly, and Understanding scale scores high for both samples. The lowest scale score was for Uncertainty with the same other three scales also low (Goh, 1994) as was the trend for the present study in Brunei. Thus, the only two studies using the QTIP, in English and Malay languages, so far have revealed salient similarities for students' perceptions of primary science teachers' classroom interactions in two Asian countries with similar education systems.

Other studies using the QTI to measure students' perceptions of their teachers' interpersonal behaviour involved secondary students and so used one of the versions developed for secondary school students. A Singaporean study of 720 lower secondary science students also showed similar overall trends to this Bruneian sample of primary students' perceptions. Small differences included the score for Understanding scale slightly lower as well as Uncertainty and Dissatisfied scales slightly higher for the Bruneian sample than for the Singaporean students' perceptions (Fisher, Rickards, Goh, & Wong, 1997a, b).

ASSOCIATIONS BETWEEN COGNITIVE ACHIEVEMENT AND QTIE SCALES

A sample of students' science Primary Certificate Examinations (PCE) scores was linked with those students' perceptions of their teachers' classroom behaviour and enjoyment of science lessons. The sample was regarded as representative of the government primary schools in the Brunei-Muara district. Of the 486 students, 34 (7.0%) gained an A on their science PCE while 121 (24.9%) achieved a B, 110 (22.6%) were given a C, 117 (24.1%) gained a pass, and 104 (21.4%) failed.

Simple correlations (see Table 2) showed that seven of the nine scales were statistically significantly associated with these students' science PCE scores. Of these, five teaching behaviours were correlated strongly with students' cognitive achievement on the science PCE. Students gained higher marks for their science PCE with teachers who were perceived by their students to display certain classroom behaviors. The results from the present research investigation have important implications for classroom practice such that science teachers wishing to enhance students' cognitive achievement should strive to display less uncertain, and dissatisfied, as well as more leadership, helping/friendly, and understanding behaviors. Students' enjoyment of their

science lessons was strongly and positively associated with their results on the science PCE implying that students who enjoy their science lessons would be expected to achieve higher scores on their science PCE. The multiple correlation, (*R*) was 0.41, and the *R*² value of 0.16 indicated that 16% of the variance in students’ cognitive achievement on their science PCE was attributable to their perceptions of their teachers’ classroom behaviour and enjoyment of their science lessons.

Three of the nine scales retained their association with the standardized regression coefficients, suggesting that teachers wishing to promote increased results on the science PCE should attempt to show more leadership and admonishing behaviour and less uncertainty. Thus, the QTIE and ENJ scales were useful tools to determine alterable factors influencing primary students’ science PCE scores in Brunei.

ASSOCIATIONS BETWEEN QTIE & ENJOYMENT OF SCIENCE LESSONS IN BRUNEI

With the Enjoyment of Science Lessons (ENJ) scale as the dependent variable, simple correlations (*r*), reported in Table 3, revealed statistically significant associations (*p*<0.01) between students’ enjoyment of science lessons and all eight scales of the QTIE.

Scales	<i>r</i>	<i>β</i>
Leadership	.34***	.12***
Helping/Friendly	.49***	.30***
Understanding	.33***	.08***
S R Freedom	-.09***	
Uncertainty	-.28***	-.05**
Dissatisfied	-.30***	-.12***
Admonishing	-.32***	-.12***
Strict	.23***	.08***
Multiple R	<i>R</i> = .57***	<i>R</i> ² = .32

** *p*<0.01 *** *p*<0.001 *N* = 3,101 students

Table 3. Significant associations between QTIE scales and enjoyment of science lessons in terms of simple correlations (*r*) and standardised regression coefficients (*b*)

The multiple correlation, (R) was 0.57, which was statistically significant. The R^2 value of 0.32 indicated that 32% of the variance in students' enjoyment of their science lessons could be attributed to their perceptions of their teachers' classroom behaviour. Thus, the teachers' classroom interpersonal behaviour was an important factor in students' enjoyment of their science lessons.

Four scales were associated positively such that students enjoyed science lessons in which teachers displayed leadership, strict, helping/friendly, and understanding behaviours. Four QTIE scales were associated negatively revealing that students did not enjoy science lessons in which teachers showed uncertain, dissatisfied or admonishing interactions or allowed much student responsibility and freedom. Using the more conservative standardised regression coefficient (b), which measures the association when the effect of the other scales is held constant, it was found that helping/friendly teacher behaviour impacted more than other QTIE scales on students' enjoyment of their science lessons.

When teachers interacted with students in a more helping/friendly manner, students enjoyed their science lessons more. Other interpersonal behaviours impacted less but still statistically significantly such that if teachers were to be less dissatisfied, uncertain, and admonishing, as well as more understanding, students would be expected to enjoy their science lessons more. Enjoyment of science lessons in turn impacted on students' achievement on an examination, as shown in Table 2.

Referring to the model of interpersonal behaviour (Figure 1), it appeared that Bruneian primary school students' enjoyment of their science lessons was aligned with the Opposition-Cooperation or proximity dimension of teachers' classroom behaviour. The more cooperative teachers were, the more students enjoyed their science lessons and students' enjoyment decreased when teachers were more oppositional in their behaviour. Simple correlations also showed that Bruneian primary school students' enjoyment of their science lessons was aligned with the Dominance-Submission or influence dimension of teachers' classroom behaviour. Students enjoyed science classes with a more dominant and less submissive teacher. It is equally important to note the reciprocal and cyclical causal effects such that students' enjoyment, or motivation and enthusiasm, may foster certain interpersonal teacher classroom behaviour which in turn increases students' enjoyment of their lessons (Brekelmans, Wubbels, & Levy, 1993).

CONCLUSIONS

The primary goal of this study was to develop an instrument to measure elementary students' perceptions of their teacher's interpersonal behaviour in the classrooms of schools where Malay was the first language. This goal was clearly achieved in that the Malay translation of the elementary version of the Questionnaire on Teacher Interaction (QTI) demonstrated acceptable reliability and validity, showing ability to differentiate between classrooms and inter-scale correlations that fit the circumplex model, upon which the instrument is based.

Scale means showed that students in this study perceived their teachers as mostly good leaders, helping/friendly, understanding and strict, seldom allowing student responsibility and freedom, seldom uncertain or dissatisfied, and seldom admonishing. As this is the first study in primary classrooms in Brunei Darussalam, future researchers may replicate this validation in other classrooms in Brunei or in other countries where Malay language is common.

Another goal was to investigate associations between cognitive achievement on an external science examination and the QTIE scales. Significant simple correlations between six of the eight QTIE and the ENJ scales with students' achievement on their science examination were found. Leadership, helping/friendly, and understanding behaviours were positively correlated and uncertainty was negatively correlated. Several QTIE scales impacted significantly on students' achievement on the science PCE. The implication is that if these teachers were to display more leadership and helping/friendly behaviour and less uncertainty, a resultant positive effect on the students' science PCE would be expected. Simply, students' science examination results were higher in classes with teachers who showed more leadership and less uncertainty than other teachers. So if teachers were to display more leadership and less uncertainty to their students, students would achieve higher science examination results. Also students who enjoyed their science lessons achieved higher science examination results.

Students' enjoyment of science lessons was significantly correlated to students' perceptions of their teachers' classroom behaviour on all eight scales of the QTIE. Helping/friendly teacher behaviour impacted more than other QTIE scales on students' enjoyment of their science lessons. Thus, students enjoyed their science lessons more in classrooms where teachers displayed more helping/friendly behaviour. Conversely, if teachers were to display more helping/friendly behaviour students would enjoy their science lessons more.

There are several main findings that summarise the implications for teaching. Teachers' classroom behaviour influences both students' achievement on science examinations and also students' enjoyment of their science lessons. The results from the present research investigation have important implications for classroom practice such that science teachers wishing to enhance students' cognitive achievement should strive to display less uncertain, and dissatisfied, as well as more leadership, helping/friendly, and understanding behaviors. Students' enjoyment of their science lessons was strongly and positively associated with their results on the science PCE implying that students who enjoy their science lessons would be expected to achieve higher scores on their science PCE. Students' enjoyment of their science lessons is most affected by teachers' helping/friendly behaviour. So teachers are encouraged to be more helping/friendly in order to enhance students' enjoyment of their science lessons. Leadership, helping/friendly, and understanding behaviours were positively correlated and uncertainty was negatively correlated to students' achievement on science examinations.

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