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ABSTRACT

The purposes of this study were to describe the validation of a new instrument, the Teacher Communication Behaviour Questionnaire (TCBQ) and to show its use in assessing students' perceptions of their interactions with their teachers by focusing on their teachers' communicating behaviors. Participants were 1,202 students in grades 7 through 9 from 30 science classes in Taiwan. Quantitative and qualitative approaches were used in the development and validation process, and the questionnaire was then used to study the teachers' behaviors and their associations with students' perceptions and attitudes toward science and science academic achievement. Results show that all five scales of the TCBQ have satisfactory internal consistency reliability, discriminant validity, and factor validity. There were strong associations between the scales of the instrument and students' attitudes toward science. Two of the scales were associated with cognitive achievement. This instrument adds to research on teacher-student interactions by focusing on the use of challenging questioning to promote students' creative thinking ability and the use of verbal and nonverbal feedback to enhance students' attitude toward science and their academic achievement outcomes. (Contains 5 tables and 22 references.) (SLD)

The development and application of the Teacher Communication Behaviour Questionnaire in Taiwan science classrooms.

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ABSTRACT

The purposes of this study were to describe the validation of a new instrument, the *Teacher Communication Behaviour Questionnaire* (TCBQ), and its use in assessing students' perceptions of their interactions with their teacher by focussing on their teachers' communicating behaviours. The study described in this paper occurred in secondary science classrooms in Taiwan. Quantitative and qualitative approaches were used in the development and validation process of the TCBQ. The questionnaire was then used to investigate Taiwanese secondary science teachers' behaviours, and their associations with students' perceptions attitudes toward science and science academic achievement. Results shows that all five scales of the TCBQ were found to display satisfactory internal consistency reliability, discriminant validity, and factor validity. There were strong associations between the scales of the instrument and students' attitudes to science and two of the scales were associated with cognitive achievement. This instrument has added an additional aspect to research on teacher-student interactions by focusing on the use of challenging questioning to promote students' creative thinking ability and the use of verbal and non-verbal feedback to enhance students' attitude toward science and their academic achievement outcomes.

THEORETICAL BACKGROUND

Past research has confirmed the important contribution made by teachers in creating a classroom environment or atmosphere conducive for science learning. In particular, teachers make a major contribution towards creating a positive learning environment in science classes through their interaction or communication with students (Wubbels & Levy, 1993). Brophy and Evertson (1981) found that teachers' affective reactions to students (attachment, concern, indifference, rejection) influenced their behavior toward them. Furthermore, Stallings (1980) studied 87 secondary classrooms and reported that teachers who obtained poor achievement from students used more class time for non-interactive instruction (they graded papers or made lesson plans while their students worked on written assignment or read). The way in which a teacher interacts with students is not only a predictor of student achievement, but also is related to such factors as teacher job satisfaction and teacher burnout. Appropriate teacher-student interactions are important to prevent discipline problems and to foster professional development (Fisher, Fraser, & Cresswell, 1995; Wubbels & Levy, 1993). Student-teacher interactions also have been shown to be particularly important in a "constructivist" classroom, where emotion plays a more prominent role (Watts & Bentley, 1987). Other research has indicated that positive interactions and relationships between teachers and students promote student interest and outcomes in science (Wubbels & Levy, 1993).

Classroom interactions occur rapidly in a classroom and teachers are usually not aware, or not able to describe or remember what happens in their interactions with students. For example, Good and Brophy (1974) interviewed teachers and confirmed that teachers usually were not aware how many questions they asked students and what kind of feedback they provided. Unless we can help teachers identify their interactions in teaching, and make them aware of what happens in class, it is difficult to promote positive science classroom interactions. Therefore, the authors decided to develop a questionnaire which focused on aspects of teacher-student interactions in the secondary science classrooms.

It is possible to ask teachers for their perceptions of their classrooms, however these usually differ in some respects from those of students (Cooper & Good, 1983; Fraser, 1998; Wubbels & Levy, 1993). In this study, it was decided to focus on student perceptions. Therefore, the purpose of this study was to establish a questionnaire which would allow a study of student perceptions of teacher behavior in a large number of science classes at the same time. In the longer term, it is hoped to develop a better understanding of teacher behavior occurring in science classrooms in both Taiwan and Australia.

Two major resources were utilized in the development of this new questionnaire. The Dutch researchers (Wubbels, Creton, & Holvast, 1988; Wubbels, Creton, & Hoomayers, 1992; Wubbels & Levy, 1993) investigated teacher interpersonal behavior in a classroom from a systems perspective, adapting a theory on communications processes developed by Waltzlawick, Beavin, and Jackson (1967). Within the systems perspective of communication, it is assumed that the behaviors of participants mutually influence each other. The behavior of the teacher is influenced by the behavior of the students and in turn influences the student behavior. Thus, a circular communication process develops. This 'systems approach' assumes that one cannot communicate when in the presence of someone else. Based on this systems approach, the *Questionnaire on Teacher Interaction* (QTI) (Wubbels & Levy, 1993) was developed. The items of the QTI and the literature describing its previous use were an important source of information when developing a new questionnaire for use in secondary science classrooms teacher-students interaction.

Previous teacher-student interaction work by one of the authors was used as the other source of information (She, 1997, 1998; She & Barrow, in press). This systematic classroom observation research involved the use of questioning and verbal and non-verbal reinforcement in the teachers' interactions with students. Past research studies have shown these two interactive behaviors have had a considerable effect on students' achievement (e.g., Good & Brophy, 1974, 1991; Walberg, 1984). According to these teacher-student interaction studies, questioning is the key factor in the interactions that occur between teachers and their students. Questions have been shown to be an important and integral part of learning, and questions asked by teachers can become indices of the quality teaching (Carlsen, 1991; Smith, Blakeslee, & Anderson, 1993). Deal and Sterling (1997) suggested that effective classroom questions promote relevance, encourage ownership, help students interpret their observations, and link new learning to what students already know. Thus, the scales and items of our new questionnaire also were based upon this previous work on classroom teacher-student interaction, particularly, the work of She (1997, 1998).

The result was the development of the *Teacher Communication Behaviour Questionnaire* (TCBQ) containing five scales: Challenging Questioning (CQ), Encouraging and Praising (EP), Supporting Non-verbally (NV), Understanding and Friendly (UF) and Controlling (CO). The initial version of the TCBQ contained 60 items altogether, with 12 items belonging to each of the five scales. The set of items passed through several successive revisions including reactions solicited from students about the readability and comprehensibility of items and whether they were responding to the items on the basis intended by the developers. This led to some modifications to questionnaire items. Table 1 contains a description of the meaning of each of the five scales and a sample item from each scale.

Table 1
Description of Scales and a Sample Item for Each Scale of the TCBQ

Scale Name	Description of Scale	Sample Item
Challenging Questioning	Extent to which the teacher uses higher-order questions to challenge students in their learning	This teacher asks questions that require me to apply what I have learned in class in order to answer.
Encouraging and Praising	Extent to which the teacher praises and encourages students	This teacher praises me for asking a good question.
Supporting Non-Verbally	Extent to which the teacher uses non-verbal communication to interact positively with students.	This teacher smiles at me to show support while I am trying to solve a problem.
Understanding and Friendly	Extent to which the teacher is understanding and friendly towards the students	This teacher understands when I doubt something.
Controlling	Extent to which the teacher controls and manages student behavior in the classroom.	This teacher requires us to be quiet in his/her class.

Further extensive field testing and instrument validation procedures led to a final version of the TCBQ consisting of 40 items altogether, with eight items in each of five scales. Each item is responded to on a five-point scale with the alternatives of almost never, seldom, sometimes, often, and very often.

In this study, we particularly focused on the validation of this new questionnaire and its application in an investigation of students' perceptions of their teachers' communication behaviours in secondary schools science classrooms in Taiwan and the associations between these perceptions and the students' attitudes toward science and their academic achievement.

METHOD

The TCBQ was administered to a sample of 1202 grades 7-9 students from 30 biology/physical science classes in Taiwan. . The data were analyzed to check the internal consistency, discriminant validity, ability to differentiate between classrooms, and a priori factor structure of the TCBQ.

In order to determine the practical viability of the TCBQ scales with students, we examined what perceptions students had of the scales and the items. How did they interpret each scale? What did they think an item meant? Were the students viewing the concepts behind each scale in a similar manner to the original developers? This was particularly important as the quantitative analyses of data suggested that in some classes a diverse range of students' views existed. A semi-structured interview was used during which students first were asked to comment generally about the nature of their science class. The questions then focused on the teacher's use of challenging questions, praise and encouragement, non-verbal support, understanding and friendly behaviour, and controlling behaviour, i.e., the scales which were assessed in the TCBQ. We then referred to student responses to various items to see if the

involved in the interview component of the study were selected according to the students' responses to the questionnaire and 50 students were interviewed for a minimum 15 minutes.

The TCBQ was then used in an application to determine whether their were any associations with student outcomes. To obtain some outcome measures, 836 of the students in the sample responded to four attitude scales from the Test of Science Related Attitudes (TOSRA) (Fraser, 1981). These scales were Social Implications of Science, Enjoyment of Science Lessons, Leisure Interest in Science, and Career Interest in Science. To provide a measure of cognitive achievement the end of semester results of 242 of the students were obtained. Simple and multiple correlation analyses were used to determine whether there were any associations between students' perceptions of their teachers' behaviours and their attitude to class and cognitive achievement.

VALIDATION OF THE TCBQ

The first step in the modification and validation of the TCBQ involved a series of factor analyses to examine further the internal structure of the set of 57 items which had survived the item analyses. Principal components analysis with varimax rotation was used to generate orthogonal factors. These factor analyses led to a decision to delete 17 items, either because they were loaded on more than one factor, or their loading was lower than 0.31. The 40-item five-factor instrument shown in Table 2 was decided upon as the optimal structure for the final version of the TCBQ. Every one of the 40 items in the final version is retained in exactly the same scale to which it was assigned when the instrument was originally developed. Apart from the deletion of certain items, the factor analyses have confirmed the validity of the original structure of the questionnaire without the need to change the scale allocation of any item or the name of any scale. Taken together, all of this evidence lends considerable support to the a priori factor structure of the 40-item, five-scale version of the TCBQ.

Table 2

Factor Loading of Items in the TCBQ

Old Item Number	Challenging Questioning	Encouraging & Praising	Supporting Non-Verbally	Understanding & Friendly	Controlling
1	52				
2	.65				
3	.70				
4	.73				
5	.65				
6	.68				
7	.72				
9	.52				
13		.54			
14		.50			
15		.56			
16		.56			
17		.69			
19		.52			
20		.60			
22		.65			
25			.46		
29			.67		
30			.70		
31			.74		
32			.70		
33			.75		
34			.75		
35			.69		
39				.55	
40				.65	
41				.59	
43				.72	
44				.76	
45				.75	
46				.71	
47				.49	
49					.48
50					.54
52					.64
53					.77
54					.79
55					.78
56					.71
57					.47

All loadings smaller than .3 have been omitted.

Analysis of responses to the TCBQ using the individual student as the unit of analysis revealed that each scale had very good internal consistency, with alpha coefficients ranging from 0.86 to 0.93 with the individual student as the unit of analysis. Another feature considered important in a classroom environment instrument is the discriminant validity of each scale of the instrument, that is, the extent to which the scale measures a dimension different from that measured by any other scale. In this study, the mean correlations of one scale with the other four scales ranged from 0.16 to 0.50. These values can be regarded as small enough to confirm the discriminant validity of the TCBQ, indicating that each scale measures a distinct, although somewhat overlapping, aspect of the teacher's communication behavior.

Also, the ability of a classroom environment instrument to differentiate between classes is important. 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. The results, depicted in Table 3, show that each of the scales did in fact significantly differentiate between classes ($p<0.001$). The amount of variance explained by class membership is reflected in the *eta*^{2} scores which ranged from 0.17 to 0.22..

Table 3
Internal Consistency (Cronbach Alpha Coefficient) Discriminant Validity (Mean Correlation with other Scales) and Ability to Differentiate Between Classrooms for the TCBQ

Scale	Alpha Reliability	Mean Correlation with Other Scales	ANOVA Results (eta^2)
Challenging Questioning	0.88	0.40	0.17**
Encouraging & Praising	0.90	0.50	0.19**
Supporting Non-Verbally	0.93	0.50	0.21**
Understanding & Friendly	0.91	0.46	0.22**
Controlling	0.86	0.16	0.21**

n=1202 *$p<0.01$

INTERVEW RESULTS

The interview data assisted us with the validation of the instrument and our understanding of the teachers' communication behaviours in secondary science classrooms in Taiwan. Fifty students were interviewed for a maximum of 15 minutes. Initially, students were asked whether they could tell us what the questionnaire was about. Among typical student comments were these two:

> *Yes they were about like the teachers methods and how the teacher gets things through.*

> *Yes, it was about the teacher and how she teaches.*

From the above and other questions that were asked, it was clear to the researchers that the students were able to read the TCBQ and had some idea what it was about.
The questions then became more focused and we referred to student responses to various items to see if the scales were actually assessing what they were supposed to be assessing. We were also seeking questions about why students gave the responses they did. The following student comments supported the content and construct validity of the scales of the TCBQ.

Challenging Questioning

Does your teacher ask questions very often?
Yes, the teacher asks a lot of questions.

What types of questions does your teacher ask?
The teacher asks questions that will make us think a while.
The teacher likes to ask us, "Why would it happen?", types of questions.
The teacher rarely asks us yes or no questions.

Why did you circle always or very often to these items?
Because the teacher always asks a lot of questions to all of us.

Could you tell me why you circled 4 for number 6?
(6. This teacher asks questions that require me to integrate information that I have learned.)
Because you need to understand the content you have learned in order to continue to answer the teacher's questions.

Encouraging and Praising

How does your teacher respond when you answer a question?
She will say" it is very good".

Very often, the teacher will clarify my ideas and expand to deeper concepts instead of praising my answer or using my thoughts as part of the lesson.
(This student circled 3 to both the teacher praises my answer and the teacher uses my thoughts as part of the answer)

Does your teacher encourage you to answer questions?
Yes, the teacher usually will ask students who know the answer to raise their hands to answer the questions.
Does the teacher give you hints if you do not know how to answer the questions?
Yes, sometimes she will help you to think of an answer.

Supporting Non Verbally

Does your teacher use some other ways to help you answer questions?
The teacher usually will nod her head or smile to us.

Why did you circle 5 for number 23?
(23. Without speaking, this teacher shows his/her enthusiasm about my questions through his/her facial expression.)
It is always like this, while you are talking, the teacher will show her enthusiasm through her eyes or face to show that she is expecting a good question.

Another student who circled 2 for this item said
Because I seldom ask the teacher questions.

Understanding and Friendly

Is your teacher friendly to you?

Yes, she is very friendly to us. She usually will not get angry unless we are too noisy.

(27. If I have something to say, this teacher will listen.)
Why did you circle 5?

For instance, we went to National Science Museum and the teacher listened to our talking while on the bus.

(29. This teacher is patient with me.)
Why did you circle 4?

Because this teacher is patient. If you have something you do not understand, the teacher will explain to you more than three times until you understand.

Controlling

Does your teacher have any expectations of you?

Yes, the teacher asks us to bring our books and other things to the class.

Do you think the expectation are too high for you?

No, I do not think so. She just likes to ask us to study hard.

Why did you circle 4 for this item?
(34. This teacher expects me to obey his/her instructions.)

You must follow the teacher's instructions during the laboratory or the teacher might be unhappy.

Another student who circled 5 said

Teacher would give us homework assignment which must be done because it will be discussed in the next class.

The interview data had assisted us with validation of the instrument. The quantitative analysis using factor analysis, reliability, the discriminant validity, and eta^2 of each scale, had indicated that most of the scales were acceptable. However, the interviews described above provided verification of the content and construct validity of the scales. The importance of examining students' perceptions of each item and scale, even though statistical evidence suggests that the scale is valid, was confirmed.

ASSOCIATIONS WITH STUDENT OUTCOMES

In order to investigate associations between students' perceptions of their teachers' behaviour and students' attitudinal and cognitive achievement outcomes, the data were analyzed using both simple and multiple correlation analyses. Tables 4 and 5 report these results separately for the attitudinal and cognitive outcomes, respectively. Whereas the simple correlation (r) describes the bivariate association between an outcome and a TCBQ scale, the standardized regression weight (b) characterizes the association between an outcome and a particular TCBQ scale when all other TCBQ dimensions are controlled.

Table 4.
Associations between TCBQ scales and students' attitudinal outcomes in terms of simple (r) and multiple (R) correlations

Scale	Strength of TCBQ Scale–Outcome Association							
	Social Implications of Science		Enjoyment of Science Lessons		Leisure Interest in Science		Career Interest In Science	
	r	*b*	*r*	*b*	*r*	*b*	*r*	*b*
Challenging Questioning	0.72**	0.42**	0.64**	0.24**	0.74**	0.40**	0.63**	0.20*
Encouraging & Praising	0.68**	0.03	0.76**	0.25**	0.88**	0.62**	0.82**	0.33*
Supporting Non Verbally	0.86**	0.60**	0.84**	0.37**	0.72**	0.06	0.87**	0.40*
Understanding & Friendly	0.70**	0.06	0.78**	0.25**	0.65**	0.02	0.78**	0.19*
Controlling	0.21**	0.02	0.22**	0.03	0.26**	0.02	0.22**	0.02
Multiple Correlation, *R*	0.95**		0.94**		0.95**		0.96**	
R^2	0.90		0.88		0.90		0.92	

*$p < 0.05$ **$p < 0.01$ N = 489

The results in Table 4 show that four of the TCBQ scales: Challenging Questioning, Encouraging and Praising, Supporting Non-verbally, and Understanding and Friendly were strongly correlated with the four attitudinal scales, however, a weaker correlation existed with the Controlling scale. Thus, the first four scales of the TCBQ have a great effect on the students' attitude toward their science lessons.

The multiple correlation (*R*) data reported in Table 4 indicate that associations were strongest between students' perceptions of the first three scales assessing teacher communicating behavior and attitudinal outcomes. In classes where the students perceived more challenging questions, received more encouragement and praise and received non-verbal support from their teachers, there was a more favorable attitude toward the science class.

As depicted in Table 5, the students' academic achievement outcome was significantly correlated with two scales of the TCBQ: Challenging Questioning and Understanding and Friendly. The multiple regression analysis indicates that Challenging Questioning was the scale most strongly associated with the cognitive achievement outcome when other TCBQ scales were mutually controlled.

Table 5
Associations Between TCBQ Scales and Students' Cognitive Achievement Outcome in Terms of Simple Correlations (r) and Standardized Regression Coefficient (b).

Scale	Strength of TCBQ Scale – Outcome Association	
	r	*b*
Challenging Questioning	0.33**	0.37**
Encouraging & Praising	0.12	-0.12
Supporting Non-Verbally	0.14	-0.01
Understanding & Friendly	0.19*	0.10
Controlling	-0.06	-0.13
Multiple Correlation, R and R^2		0.36** and 0.14**

*$p < 0.05$, **$p < 0.01$ n=242

CONCLUSIONS

This study has confirmed the reliability and validity of the TCBQ when used in Taiwan science classrooms. Thus the instrument can be used by science teachers and researchers in Taiwan to improve science teaching and student achievement. The study used a combination of quantitative and qualitative analyses. The quantitative data provided numerical descriptions of the reliability and validity of a new questionnaire while the qualitative assisted in the content and construct validation of the instrument. The qualitative data obtained by interviewing students helped us provide a much fuller explanation of our results which could not have been achieved from the quantitative data alone. The numerical data obtained from the questionnaire provided a picture of the classrooms, but our use of interviews enabled us to understand so much more. Finally, in keeping with previous learning environment research (Fraser, 1991; 1994; 1998; Wubbels & Levy, 1993), there were significant relationship between teacher behaviours and student attitudinal and cognitive achievement outcomes.

One of this study's major contributions is that a new teacher-student interaction instrument was developed and validated specifically for the science classes teacher communication behaviour. All five scales of the TCBQ were found to display satisfactory internal consistency reliability, discriminant validity, and factor validity. As well, further analyses supported the ability of the TCBQ to differentiate between the perceptions of students in different classrooms. In particular, this instrument has added an additional aspect to research on teacher-student interactions by focusing on the use of challenging questioning to promote students creative thinking ability and the use of verbal and non-verbal feedback to enhance students' attitudes toward science and their academic achievement outcomes.

The future development of both teacher and students' preferred versions of the TCBQ will further enhance the study of science classrooms. Discrepancies which occur between teacher and student perceptions on the TCBQ, could lead teachers to reflect on the cause of the discrepancy. Furthermore, the TCBQ is now being used in cross-cultural studies in both Taiwanese and Australian science classroom and this will provide cross-validation data on the TCBQ and allow interesting comparisons to be made.

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