Teacher-Student Interactions in a Technology-Supported Science Classroom Environment in Relation to Selected Learner Outcomes: An Indian Study

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The ultimate goal of teaching is to assist students to become independent and self-regulated learners capable of taking their own decisions. During this process the teacher has to perform many roles with main focus on communication with students. Thus teaching and learning can be considered a communication process. This communication process depends on the effectiveness of interpersonal behaviour of the students and teachers. In the modern educational scenario, technology is playing an important role not only in helping to establish this communication but also to enrich it. This study reports the use of Questionnaire on Teacher Interaction (QTI) for assessing the students' perceptions of their teachers' interpersonal behaviour in a technology- supported science classroom environment in an Indian school. Analysis of data of 705 students from 15 classes provides evidence for reliability and validity of the questionnaire in Indian settings to be used at the secondary level. The same data is also used for studying gender differences and the associations between students' perceptions of their teachers' interpersonal behaviour with three learner outcomes i.e. their attitude towards science, academic efficacy and academic achievement which have been reported as significant.

The teacher is considered a central figure in any classroom learning environment especially in Indian school settings, where the teacher controls the teaching-learning process and directs the activities of students on a day to day basis. Thus, the interaction which teachers have with their students determines the nature of their interpersonal relationship and enables the teacher to improve their teaching practices. Today teachers and students spend a substantial amount of time interacting with one another in the classroom. Educators are of the opinion that the classroom

learning environment becomes more progressive if the teachers and students share a healthy relationship. There are a numbers of variables that influence the learning environments in the classroom with the key variable being the student-teacher interaction. Getzels and Thelen (1960) suggested that teacher-student interaction is a powerful force that can play a major role in influencing the cognitive and affective development of students. With the advent of technology in the field of education at all levels, classrooms are now becoming technology-rich learning environments involving modern information and communication technologies, thereby impacting teacher-student interpersonal behaviour. The present study assesses the teacher-student interactions in a technology-supported science classroom in relation to three learning outcomes which are attitude towards science, academic efficacy and academic achievement.

OBJECTIVES OF THE STUDY

The main objectives of this study were: a) to establish the reliability and validity of the Questionnaire on Teacher interaction (QTI) (Wubbels & Levy, 1993) for use with urban Indian secondary school students; b) to investigate associations of students' perception of their teacher-student interactions with attitude towards science, academic efficacy and academic achievement in a technology-supported science classroom; c) to investigate whether gender differences occur in students' perception of their teacher-student interactions in a technology-supported science classroom.

BACKGROUND OF THE STUDY

The studies using the QTI as an instrument have demonstrated that the nature of relationship between teacher and his/her students is an important aspect of the learning environment (Fraser & Walberg, 1991) and despite being a very recent instrument, the behaviour patterns that are established in a classroom learning environment are relatively stable over time (Brekelmans, Holvast, & van Tartwijk, 1990; Fraser & Walberg, 1991). Creton, Wubbels, and Hooymayers (1993), Wubbels, Creton, and Holvast, (1988) and Fraser (1991) suggested that the circular communication processes that consist of behaviour as well as determine behaviour develop early in the year in a classroom. Once these behaviours have been developed and stability has been achieved in the classroom, both students as well as teachers resist change.

It has been suggested that students and their teacher should have interacted at least for a period of two to three months prior to the administration of the QTI to a target group as the items ask questions about the teacher's behaviour over a long period of time, not just during the current lesson (Brekelmans, 1989; van Tartwijk, Brekelmans, & Wubbels,

1993). It is also assumed that the nature and patterns of the teacher-student interpersonal behaviour that are established during this time are very likely to remain relatively stable for the remainder of the year (Fraser & Walberg, 1991). This conveys that the student-teacher interaction, and nature and patterns thereof will remain the same if the questionnaire is administered after the initial two to three months settling-in period (Brekelmans, 1989). However, for the study described in this thesis the survey data were collected towards the end of the academic session when students and teacher interaction patterns were well established.

The QTI (Wubbels & Levy, 1991, 1993) was designed to assess teacher-student interpersonal behaviour in lower secondary classroom and developed out of a need to measure secondary students' and teachers' perceptions of teacher behaviour. In early 1980s, the original version of the QTI in Dutch language was developed in four trials in The Netherlands and had 77 items, which were arranged in the eight scales corresponding to the eight sections of the model for interpersonal teacher behaviour (Wubbels, Creton, Levy, & Hooymayers, 1993). Nine to eleven items were included in each of the eight scales. These 77 items were derived from the 128 items of the ICL (Wubbel, Creton, & Hooymayers, 1992) and later these 128 items were modified, reworded and finally reduced to 77 items. The other change made from the ICL was change of response from 'yes' or 'no' to a five point Likert type response. Later, an American version of the QTI was developed in the English language, and had 64 items (Wubbels & Levy, 1991). The items deleted from the Dutch version were on the basis of correlation analysis of the 77-item version to 64 items in the American version.

An Australian version of 48 items followed these two pioneering versions of the QTI (Fisher, Fraser, & Wubbels (1993). This shorter version has six items in each of the eight scales. Table 1 represents the nature of the QTI by providing a scale description and a sample item for each of the eight scales. This 48-item Australian version of the QTI was used for this study.

TABLE 1

DESCRIPTION OF ITEMS FOR EACH SCALE IN THE QTI

Scale	Description
Leadership [DC]	Extent to which teacher provides leadership to the class and holds student attention.

Helping/ Friendly [CD]	Extent to which the teacher is friendly and helpful towards students.
Understanding [CS]	Extent to which the teacher shows understanding and care to students.
Student Responsibility/Freedom	Extent to which the students are [SC] given opportunities to assume responsibilities for their own activities.
Uncertain [SO]	Extent to which the teacher exhibits her/his uncertainty.
Dissatisfied [OS]	Extent to which the teacher shows unhappiness/dissatisfaction with the students.
Admonishing [OD]	Extent to which the teacher shows anger/temper and is impatient in the class
Strict [DO]	Extent to which the teacher is strict with demands of the students.

DESIGN AND PROCEDURE

A research and development approach was adopted for this study. The school chosen for this study was a 70-year old institute in Jammu (J&K State, India), which has over the years used various innovative methods in teaching different subjects and in recent times has taken a lead in the introduction of technology in the classroom to make the teaching-learning process more meaningful and effective. Therefore, this school provided the right atmosphere to study the learning environments of a technology-supported classroom and assess students' achievement, efficacy and their attitude towards science. The sample for the study was chosen carefully so as to be representative of the population and comprised of coeducational classes in order to permit an unbiased test of gender differences. The sample involved 705 students in 15 science classes from grade 6 to 11, spread in the age group of 11 to 17 years. The whole study was carried out in three stages. In the first stage low cost technology-supported classrooms were set up with provision of computers, televisions and digital content in general science. In the second stage, the science teachers were trained in the use of technology which was followed by teaching activities for a period of eight months, thereby exposing students to a technology-rich learning environment. In the third phase, the Questionnaire on Teacher interaction (QTI) was administered to assess perceptions that students have of their teachers' interpersonal behaviour in a technology-supported science classroom. The data thus collected was tabulated in an

excel file and statistically analysed using SPSS.

FINDINGS AND RESULTS

Validation of the QTI

The students' form of the Questionnaire on Teacher Interaction (QTI) was administered to 705 students, in 15 classes in a school in Jammu, who had studied science in a technology-supported learning environment to assess the student's perceptions of their interpersonal relationship with their teachers and also to understand teacher's behaviour in a technology-supported environment. In order to determine the reliability and validity of the QTI, three statistical computations were done. The first was the Cronbach alpha coefficient (Cronbach, 1951) which is a measure of internal consistency and analysis of variance (ANOVA) as an evidence of the ability of each scale to differentiate between the perceptions of students in different classrooms along with eta^2 statistics, and the second which provides an estimate of the strength of the association between class membership and the dependent variable. The third involved checking the circumplex nature of the QTI.

The statistical data for the QTI are presented in Table 2. The alpha reliability coefficients for the different scales of QTI using the individual as a unit of analysis ranged from 0.51 for the Strict scale to 0.79 for the Leadership scale. However, for the scale of Admonishing the alpha reliability coefficient reported a score of 0.53 which when recomputed after deleting of an item changed to 0.66. The item deleted for computation purposes was number 12, i.e., 'This teacher is too quick to correct us when we break a rule'. This item was then deleted in the application of the QTI in the research described in the thesis. The reliability results of the QTI were consistently above 0.50. This suggested that the QTI could be used as a reliable tool (De Vellis, 1991) in Indian classroom settings.

Table 2 reports the ANOVA results showing all the eight QTI scales differentiate significantly between classes ($p<0.001$, $p<0.01$). The eta^2 statistic for the QTI indicates the amount of variance in scores accounted for by class membership has also been indicated in Table 2. The scores ranged from 0.05 for the Dissatisfied scale to 0.23 for the Student Responsibility/Freedom scale which shows that the QTI instrument is able to differentiate between students' perceptions in different classrooms. Figure 1 represents the alpha reliability scores on the QTI in a graphical manner.

TABLE 2

Internal Consistency Reliability (Cronbach Alpha Coefficient) and Ability to Differentiate between Classrooms (ANOVA Results) for the QTI.

Scale Name	No. of Items	Alpha Reliability		Anova eta^2
		Bef.	Aft.	
Leadership (DC	6		0.79	0.19**
Helping / Friendly (CD)	6		0.73	0.11**
Understanding (CS) Student	6		0.68	0.14**
Responsibility /Freedom (SC)	6		0.57	0.23**
Uncertain (SO)	6		0.68	0.17**
Dissatisfied (OS)	6		0.68	0.05*
Admonishing (OD)	6	0.53	0.66	0.09**
Strict (DO)	6		0.51	0.11**

** Significant at $p<0.001$ *   Significant at $p<0.01$
Bef. : Before Deleted Item   Aft.: After Deleted Item   n=705
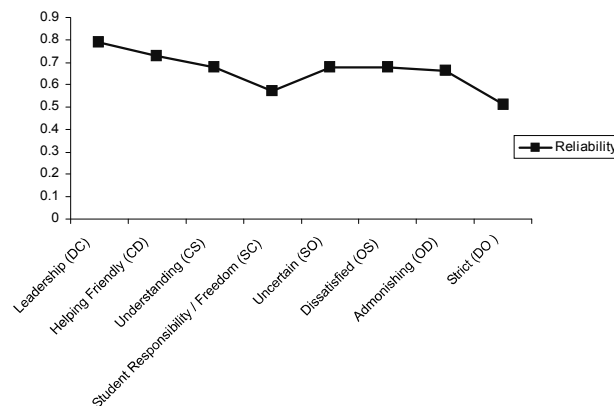Admonishing scale: deleted item 3

Figure 1. Cronbach alpha reliability scores on the QTI.

A further analysis was also carried out to explore the inter-scale correlations between the different scales of the QTI. The QTI is based on a circumplex model in which the scales are arranged to form a circular pattern of the eight dimensions of interpersonal behaviour and they are expected to be correlated.

The Model of Interpersonal Behaviour (Wubbels & Levy, 1993) predicts that the correlations between two adjacent scales are highest, but correlations gradually decrease as the scales move further apart until opposite scales are negatively correlated. This pattern is reflected in Table 3 where the results of the inter-scale correlations from the study generally reflect the circumplex nature of the QTI and thus further confirm the validity of QTI to be used in Indian classroom settings. Based on data given in Table 3, Figure 2 illustrates the circumplex model, as it relates to the Understanding scale.

TABLE 3

Inter Scale Correlations for the Questionnaire on Teacher Interaction (QTI)

	Lea DC	HFr CD	Und CS	SRf SC	Unc SO	Dis OS	Adm OD	Str DO
Leadership (DC)		0.61**	0.70**	0.32**	-0.10*	-0.17**	-0.27**	0.34**
Helping / Friendly			0.59**	0.41**	-0.12**	-0.17**	-0.24**	0.30**
Understanding (CS)				0.24**	-0.16**	-0.21**	-0.31**	0.22**
Student Responsibility / Freedom (SC)					0.30**	0.22**	0.16**	0.26**
Uncertain (SO)						0.54**	0.58**	0.19**
Dissatisfied (OS)							0.58**	0.19**
Admonishing								0.16**
Strict (DO)								

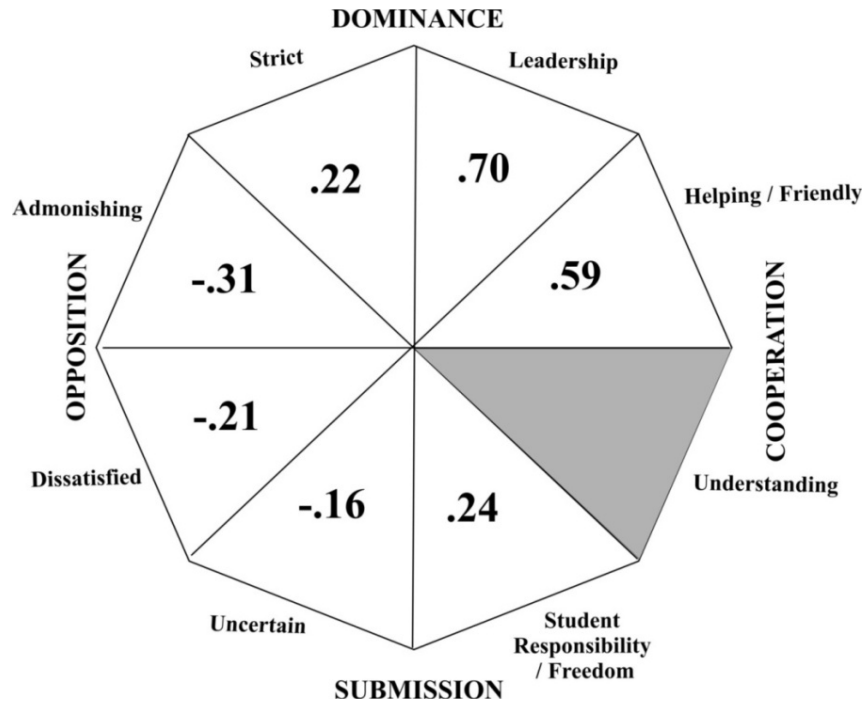**Significant at p<0.001   *Significant at P<0.01
n=705.

Figure 2. Correlation of Understanding Scale with other QTI scales showing the circumplex model.

The Understanding scale is highly correlated to its neighbouring scales, Student Responsibility/Freedom which has a correlation of 0.24 and 0.59 with the Helping/ Friendly scale. The correlation becomes lower with the next scale Uncertain which is negatively correlated with a score of -0.16. As the scales move further apart correlations with Dissatisfied and Admonishing also become negative with scores of -0.21 and -0.31. The maximum negative correlation is with the opposite scale of Admonishing. Generally, the findings in this study support the circumplex model of QTI and hence validate it for use in Indian schools teaching science through the technology-supported classroom.

MEANS AND STANDARD DEVIATIONS ON THE QTI

The data for the descriptive statistics concerning QTI were collected from 705 students in 15 classrooms and the values of means and standard deviations are given in Table 4. The highest mean value is 4.05 for the Leadership scale and the least value is 2.47 for the Admonishing scale. Figure 3 represents the mean scores of the eight scales of the QTI in a graphical manner

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Means and Standard Deviations for the QTI

Scale Name	No. of Items	Mean	S.D
Leadership (DC	6	4.05	0.72
Helping / Friendly (CD)	6	3.63	0.80
Understanding (CS)	6	3.87	0.71
Student Responsibility Freedom (SC)	6	3.10	0.68
Uncertain (SO)	6	2.53	0.79
Dissatisfied (OS)	6	2.72	0.81
Admonishing (OD)	6	2.47	0.84
Strict (DO)	6	3.46	0.66

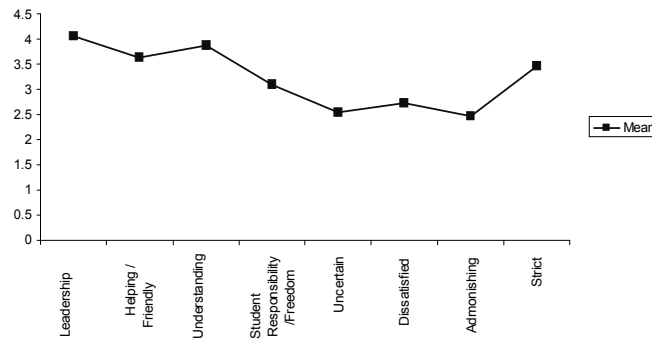Means and Standard Deviations for the QTI.

n = 705

Figure 3. Mean scores on the eight scales of the QTI.

The overall analysis of the above results shows that the students see their teachers as good leaders most of the time and have also rated their teachers in terms of exhibiting helpful and friendly nature, understanding

and giving students freedom and responsibility in the classroom. In fact, the positive factors have been exhibited by the teachers quite often in the classroom. One interesting feature of the analysis is that students perceive their teachers to be strict which is acceptable in India as a teacher is in-charge of a class and gives direction to the students in various academic matters. Also, the negative aspects of the teacher-student interaction have been rated quite low by the students as teachers seldom exhibit admonishing behaviour, are less dissatisfied and less uncertain. This shows that the technology-supported classroom environment may help in creating a healthy teacher-student interpersonal relationship and promote positive behaviour. Figure 4 represents a sector profile depicting students' perception of the teacher-student interpersonal behaviour in the technology-supported science classroom in an Indian school which was developed by plotting the mean scores of the eight scales of the QTI (student questionnaire) in an excel worksheet. The sector profile reveals diagrammatically the degree to which students perceive each behavioural aspect exhibited by the teacher as measured through the QTI.
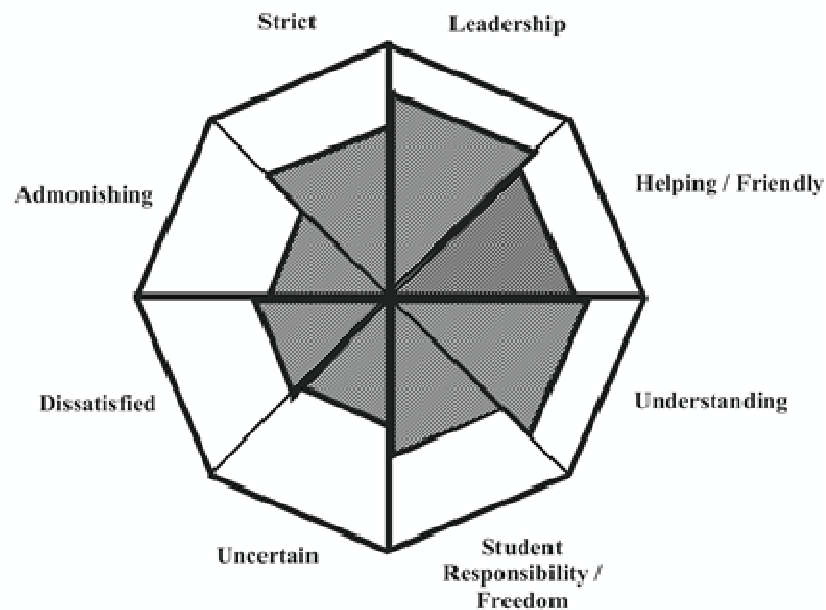

Figure 4. Sector profile diagram of students' perception of their teachers' interpersonal behaviour.

From Table 4 we can see that the standard deviation ranges from 0.66 for the Strict scale to 0.84 for the Admonishing scale. Since the values of the standard deviation are less than 1.00, it suggests that there is no major diversity in students' perceptions.

INVESTIGATION OF THE QTI ASSOCIATIONS WITH STUDENT OUTCOMES

As outlined in the objectives of the present study, it was to be investigated whether there are any associations between students' perceptions of their teacher-student interactions with their attitude towards science, academic efficacy and academic achievement. In order to carry out these investigations, simple and multiple correlation analyses along with the calculation of regression coefficients were conducted between the eight interpersonal behaviour scales of the QTI and three student outcomes of attitude towards science, academic efficacy and academic achievement (the score obtained by the student in the annual examination at the end of the academic year).

ASSOCIATION OF STUDENTS' PERCEPTION OF THEIR TEACHER-STUDENT INTERACTIONS WITH ATTITUDE TOWARDS SCIENCE

Associations between the perceptions of teacher-student interactions measured using the QTI and the attitude of students towards science were explored using simple (r) and multiple correlations (R) followed by the regression analysis between the QTI scales and the Attitude Towards Science scale. The data thus obtained have been presented in Table 5. From the data, it can be deduced that out of the eight scales of QTI only six scales have a significant association with the Attitude towards Science scale. These scales are Leadership, Helping/Friendly and Understanding which have a positive and significant correlation and Uncertain, Dissatisfied and Admonishing which have a negative and significant correlation. The scales with which there is no association are Student Responsibility/ Freedom and Strict. The correlations for the significant scales of the QTI range from -0.02 for the Student Responsibility/ Freedom scale to 0.30 for the Leadership scale.

The multiple correlation (R) between students' perceptions as measured by the different scales of the QTI and the Attitude Towards Science Scale (as seen in Table 5) is 0.34 at the individual level of analysis, which is statistically significant ($p<0.001$). The R^2 value indicates that 12 percent of the variance in the students' attitude towards science can be attributed to the students' perception of teacher-student interactions. Standardized regression values were calculated to provide information about the unique contribution of each QTI scale to the Attitude towards Science scale.

Regression coefficient values (β) indicate (as given in Table 5.4) that two of the eight QTI scales uniquely account for a significant ($p<0.001$, $p<0.01$) amount of variance in attitude towards science, these are Leadership with a value of 0.14 and Admonishing with a value of -0.16. The β value for Admonishing is negatively significant which implies that the admonishing behaviour of the teacher will have a negative influence on the attitude of the students towards science. On the other hand, a high score on Leadership suggests that teachers with good and effective leadership qualities in a class may also affect the development of a positive attitude amongst students in a technology-supported learning environment.

ASSOCIATION OF STUDENTS' PERCEPTION OF THEIR TEACHER-STUDENT INTERACTIONS WITH ACADEMIC EFFICACY

Simple (r) and multiple correlation (R) along with computation of the regression coefficient (β) were used to study the associations between the students' perception of the teacher-student interactions as measured by the QTI and their academic efficacy. Table 5 illustrates the results of the statistical analysis. Computation of data shows that out of the eight scales of QTI only six scales have a significant association with the Academic Efficacy scale. These scales are Leadership, Helping/Friendly, Understanding, Student Responsibility/Freedom and Strict which have a positively significant correlation and Admonishing which has a negatively significant correlation. The scales with which there is no association are Uncertain and Dissatisfied. The correlations for the significant scales of QTI range from -0.08 for the Admonishing scale to 0.23 for the Leadership scale.

The multiple correlation (R) between students' perceptions as measured by the different scales of QTI and the Academic Efficacy Scale (as seen in Table 5) is 0.26 at the individual level of analysis, which is statistically significant ($p<0.001$). The R^2 value indicates that six percent of the variance in students' academic efficacy can be attributed to the students' perception of their teacher-student interactions. Standardized regression values were calculated to provide information about the unique contribution of each QTI scale to the Academic Efficacy scale. Regression coefficient values (β) indicate that two of the eight QTI scales uniquely account for a significant ($p<0.01$, $p<0.05$) amount of variance in academic efficacy, these are Leadership with a value of 0.19 and Student Responsibility/ Freedom with a value of 0.11. The $\hat{a}$ value for these two scales is positively significant which implies that the leadership of the teacher and giving the students some freedom, opportunity and responsibility could go a long way in improving their academic efficacy.

TABLE **5.**

Associations between QTI Scales and three Learner Outcomes i.e. Attitude Towards Science, Academic Efficacy and Academic Achievement in terms of Simple Correlations (r), Multiple Correlation (R) and Standardized Regression Coefficient (β).

Scale Name	Attitude Towards Science		Academic Efficacy		Academic Achievement	
	r	β	r	β	r	β
Leadership	0.30**	0.14**	0.23**	0.19**	0.16**	-0.05
Helping / Friendly	0.20**	0.01	0.18**	0.01	0.16**	-0.03
Understanding	0.25**	0.10	0.17**	-0.02	0.23**	0.20***
Student Responsibility / Freedom	-0.02	-0.05	0.16**	0.11*	0.10*	0.14**
Uncertain	-0.20**	-0.04	-0.00	0.02	-0.21**	-0.12*
Dissatisfied	-0.20**	-0.02	-0.04	-0.02	-0.21**	-0.08
Admonishing	-0.30**	-0.16***	-0.08*	-0.05	-0.24**	-0.11*
Strict	0.04	0.01	0.09*	0.01	-0.00	0.00
Multiple Correlation (R) R^2	R = 0.34*** R^2 = 0.12		R = 0.26*** R^2 = 0.06		R = 0.33*** R^2 = 0.11	

*** Significant at $p<0.001$, ** Significant at $p<0.01$, * Significant at $p<0.05$
n = 705 students

ASSOCIATION OF **S**TUDENTS' **P**ERCEPTION OF THEIR **T**EACHER-**S**TUDENT **I**NTERACTIONS WITH **A**CADEMIC **A**CHIEVEMENT

Simple (*r*) and multiple correlation (*R*) along with computation of the regression coefficient (*β*) were used to study the associations between the students' perceptions of the teacher-student interactions as measured by

the QTI and their academic achievement. Table 5 illustrates the results of the statistical computation. Analysis of data shows that out of the eight scales of the QTI only seven scales have a significant association with the academic achievement scores. These scales are Leadership, Helping/ Friendly, Understanding and Student Responsibility/Freedom, which have a positive correlation and Uncertain, Dissatisfied and Admonishing which have a negative correlation (p<001, p<0.05). The scale with which there is no association is Strict. The correlations for the significant scales of QTI range from -0.21 for the Uncertain and Dissatisfied scales to 0.23 for the Understanding scale.

The multiple correlation (R) between students' perceptions as measured by the different scales of the QTI and the academic achievement scores (as seen in Table 5) is 0.33 at the individual level of analysis, which is statistically significant (p<0.001). The R^2 value indicates that 11 percent of the variance in students' academic achievement can be attributed to the students' perceptions of their teacher-student interactions. Standardized regression values were calculated to provide information about the unique contribution of each QTI scale to the academic achievement scores. Regression coefficient values (β) indicate (see Table 5) that four of the eight QTI scales uniquely account for a significant (p<0.001, p<0.01, p<0.05) amount of variance in academic achievement scores, these are Understanding with a value of 0.20, Student Responsibility/Freedom with a value of 0.14, Uncertain with a value of -0.21 and Admonishing with a value of -0.11. The β value for the two scales is positively significant which implies that the proper understanding of the students' needs and providing them with care along with giving them some freedom, opportunities and responsibility may help in increasing their academic achievement scores. On the other hand, uncertain and admonishing behaviour by the teacher may lead to a decrease in their academic achievement.

1.3 GENDER DIFFERENCES AND PERCEPTIONS OF TEACHER-STUDENT INTERACTION

In the present sample of 705 students taken from 15 classes, there were 379 (53.8%) male students and 326 (46.2%) female students who studied science in a technology-supported environment and interacted with teachers in their class. The means and standard deviations for the two groups were computed followed by a test of significance of difference between means (*t*-test for separate samples), to find out if there were any gender differences on the eight scales of the QTI. The data obtained statistically is presented in Table 6.

T<small>ABLE</small> **6**

Means, Standard Deviations and Significance of Difference between Means for Gender Differences in Students' Perceptions of Teacher-Student Interaction as measured by the QTI Scale.

Scale	Gender	Mean	Mean Difference (M-F)	Standard Deviation	*t*
Leadership	Males	4.02	-0.08	0.75	1.42
	Females	4.10		0.68	
Helping/ Friendly	Males	3.60	-0.10	0.81	1.35
	Females	3.70		0.78	
Understanding	Males	3.80	-0.16	0.71	2.97
	Females	3.96		0.70	
Student Responsibility / Freedom	Males	3.10	-0.01	0.70	0.31
	Females	3.11		0.67	
Uncertain	Males	2.61	0.16	0.78	2.57
	Females	2.45		0.79	
Dissatisfied	Males	2.84	0.26	0.76	4.16
	Females	2.58		0.83	
Admonishing	Males	2.55	0.18	0.83	2.84
	Females	2.37		0.85	

Strict	Males	3.45	-0.03	0.65	0.39
	Females	3.48		0.66	

Males: n = 379; Females: n = 326

The data analysis reveals that there are no gender differences in students' perceptions of their teacher-student interactions in a technology-supported science classroom environment. Thus, both male and female students perceived their teacher-student interactions in a similar manner, thus signifying homogeneity in the group. Figure 5 represents the mean scores of the male and female students on the eight scales of the QTI.
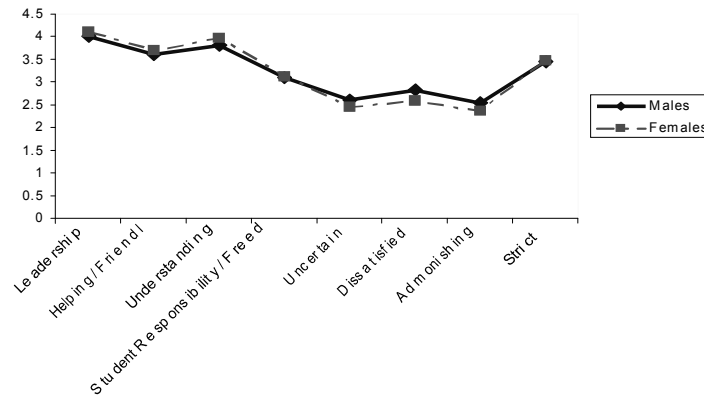

Figure 5. Mean scores of male and female students on the eight scales of the QTI

CONCLUSION

A major contribution of the present study was establishing the reliability and validity of the Questionnaire on Teacher Interaction (QTI) which was used to assess students' perceptions of their teachers' interpersonal behaviour in a technology-supported secondary science classroom in an Indian school situation. Further investigation suggested that positive associations existed between students' perception of their teacher-student interaction and their attitude towards science, academic efficacy and academic achievement in a technology-supported learning environment. Students perceived their teachers to exhibit leadership, helpful and friendly nature, sense of understanding and gave students fair amount of

responsibility and freedom to express themselves in a technology-supported science classroom. They also felt that the teachers were less uncertain, dissatisfied and admonishing in their behaviour. However, a reasonable number of students felt that the teachers were generally strict in the classroom. The study also demonstrated that there were no gender differences in students' perceptions of their teacher-student interactions in a technology-supported science classroom environment. The findings of this research can be broadly applied for improving teachers' interpersonal behaviour as it provides clues through students' perceptions as to what kind of behaviour students like their teachers to exhibit in the classroom which may lead to improvement in the day-to-day classroom learning environment and make learning more interactive and meaningful.

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