Psychosocial learning environments of technology rich science classrooms in India

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1. Introduction

Science teaching at the secondary level can be made more effective with the judicious utilization of multi-media approach involving modern information and communication technologies which are entering the Indian educational system in general and the schools in Jammu region (J&K State) in particular surely but slowly. Technology has played a major role in improving the modern education system at various levels of learning whether it be school, college or university. Not only has the use of technology increased to make the process of teaching and learning in the classroom more effective, learner centered and outcome focused but it has also given an impetus to the teachers to use it as a tool to bridge the gap between traditional learning and modern educational requirements for the overall development of the learner. A look at the use of technology in different settings shows how rapidly various information and communication technologies are being adopted as a catalyst to enhance learning even in Indian School settings which are by and large traditional and slow to innovate. Technology has become the enabler of education in the 21st century and has opened up new vistas in the field of educational research. With the advancement in technology and development of curriculum using ICT-rich material the learner has more flexibility and autonomy to learn at his own pace and time in a highly interactive environment. The present study highlights the impact of technology in education in understanding the learning environments of technology rich science classrooms at the secondary level.

2. Objectives of the Study

The main objectives of this study were: a) to establish the reliability and validity of the modified form of Technology–Rich Outcomes-Focused Learning Environment Inventory (TROFLEI) for use with urban Indian secondary school students; b) to investigate associations of student's perception of a technology-supported learning environment in a science classroom with attitude towards science, academic efficacy and academic achievement; c) to investigate whether gender differences occur in students' perception of their technology-supported learning environment in a science classroom; and d) to investigate whether gender differences occur in attitude towards science, academic efficacy and academic achievement in a technology-supported learning environment.

3. Background and Significance

The use of technology in Education is driven and supported by evidence that new technologies can change schools and improve education (Bracewell et al., 1998; Means & Olson, 1995; Wenglinski; 1998) by major shifts in policy both at national and international levels. In the highly influential synthesis of research *How people learn,* the emphasis on learning with understanding is the hallmark of the new science of learning (Bransford et al., 2000). They summarize research on the benefits of new technologies for enhancing students learning, stressing that technologies do not guarantee effective learning, but that technologies can make it easier to create environments that embed research-based principles of learning. Review of past research gives detailed information regarding the work done by a number of researchers, educators and technologists in studying the role and impact of technology on Education. Research in this area has also been done in India (Gupta, 1985; Singh, Ahluwalia & Verma, 1991; Rangaraj, 1997). However, few researches have been conducted on studying the learning environments of technology-supported science classrooms at the secondary level in general and almost none in India in particular. This research contributes to the ever expanding field of learning environments and is significant for the following reasons: a) for the first time the modified form of TROFLEI has been used in an Indian setting to study the students' perceptions of their technology-supported learning environment in science classrooms at the secondary level in which computer is one of the components used to deliver the contents to the students and b) the TROFLEI would also be used for the first time in India to investigate gender difference and associations between technology-supported learning environments and students' attitude, achievement and academic efficacy.

4. Theoretical Construct

Students spend up to 15,000 hours at school by the time they finish senior high school (Rutter, Maughan, Mortimore, Ouston, & Smith 1979), thus they have a large stake in what happens to them at school and their reactions to and perceptions of their school experiences are significant. Remarkable progress has been made in conceptualising, assessing and investigating the determinants and effects of psychosocial aspects of the learning environments of classrooms and schools (Fraser, 1998). Contemporary research on school environments partly owes inspiration to Lewin's (1936) seminal work in non-educational settings, which recognised that both the environment and its interaction with characteristics of the individual are potent determinants of human behaviour. Since then, the notion of person-environment fit has been elucidated in education by Stern (1970), whereas Walberg (1981) has proposed a model of educational productivity in which the educational environment is one of nine determinants of student outcomes. Research specifically on classroom learning environments took off about 30 years ago with the work of Walberg and Moos. The study of educational environments and their effects has been a major concern of educational researchers, policy makers and practitioners. Many questions have been asked about the relationship between the classroom environment and educational outcomes. Some of these have included, does a classrooms environment affect student learning and attitudes? What types of questionnaires and instruments should a teacher use to measure the environment of a classroom? What are Psycho-Social factors which influence the students learning? The development of various learning environment instruments enabled researchers to explore these problems. As a result learning environments have become a firmly established field of study in educational research (Fraser, 1998).

5. 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 setup with provision of computers, televisions and digital content in general science. In the second stage, the science teachers were trained in the use 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 a learning environment questionnaire (TROFLEI) was administered to assess student's perception of technology rich learning environments which was modified to suite Indian settings and involved the development of a new scale namely Technology Teaching. The data thus collected was tabulated in an excel file and statistically analysed using SPSS.

6. Findings and Results

6.1 Validation of the TROFLEI

The data for the modified TROFLEI was collected from a sample of 705 students in 15 classes who studied science in a technology-supported classroom setting and was analysed for determining the reliability and validity of the TROFLEI questionnaire for use in Indian settings. Three indices for scale reliability and validity were generated for both the Actual and Preferred Forms separately. The Actual Form measured the classroom environment in its current form while the Preferred Form measured perceptions of students' ideal or preferred classroom environments The Cronbach alpha reliability coefficient was used as an index of scale internal consistency indicating the consistency of the test items relative to other test items which are designed to measure the same construct of interest. A coefficient of 0.00 indicates a complete absence of a relationship, whereas 1.00 is the maximum possible coefficient that can be obtained (Fraenkel & Wallen, 2000). Analysis of variance (ANOVA) results were used as evidence of the ability of each scale in the Actual Form to differentiate between the perceptions of students in different classrooms. A discriminant validity index (namely, the mean correlation of a scale with other scales) was used as evidence that each TROFLEI scale measures a separate dimension that is distinct from the other scales in this questionnaire.

The modified form of the TROFLEI used in this study involved the development of a new scale, i.e. Technology Teaching and since this scale is being used for the first time, its inter-correlations with other TROFLEI scales will give an impression of its strong association and 'belongingness' in the instrument. Table 6.1 illustrates the inter-correlations between the nine scales of TROFLEI. It is evident that all the scales are positively correlated with each other and that the inter-correlations are significant ($p<0.001$).This shows that the new scale of Technology Teaching is in harmony with other scales and will contribute to the study of technology-supported learning environments in science classrooms. The new scale has correlation values ranging from 0.32 with the Student Cohesiveness and the Differentiation scales to 0.46 for the Task Orientation scale.

Table 6.1
Inter Scale Correlations for the Modified TROFLEI.

	SC	TS	IN	TO	IV	CO	EQ	DI	TT
Student Cohesiveness (SC)		0.46*	0.51*	0.50*	0.44*	0.52*	0.49*	0.22*	0.32*
Teacher Support (TS)			0.62*	0.45*	0.46*	0.49*	0.51*	0.34*	0.42*
Involvement (IN)				0.49*	0.56*	0.57*	0.49*	0.37*	0.34*
Task Orientation (TO)					0.56*	0.55*	0.56*	0.31*	0.46*
Investigation (IV)						0.58*	0.52*	0.43*	0.45*
Cooperation (CO)							0.59*	0.39*	0.39*
Equity (EQ)								0.32*	0.41*
Differentiation (DI)									0.32*
Technology Teaching (TT)									

* Significant at $p < 0.01$ n = 705

Table 6.2
Internal Consistency Reliability (Cronbach Alpha Coefficient), Discriminant Validity (Mean Correlation with Other Scales) and Ability to Differentiate Between Classrooms (ANOVA Results) for the Modified TROFLEI

Scale Name	No. of Items	Alpha Reliability		Mean Correlation with other scales		ANOVA *eta*^{2}
		Act.	Pref.	Act.	Pref.	
Student Cohesiveness (SC)	8	0.67	0.76	0.43	0.44	0.14*
Teacher Support (TS)	8	0.79	0.75	0.47	0.47	0.23*
Involvement (IN)	8	0.80	0.82	0.49	0.51	0.11*
Task Orientation (TO)	8	0.78	0.83	0.48	0.54	0.14*
Investigation (IV)	8	0.82	0.84	0.50	0.54	0.16*
Cooperation (CO)	8	0.82	0.82	0.51	0.55	0.09*
Equity (EQ)	8	0.85	0.84	0.49	0.52	0.14*
Differentiation (DI)	8	0.68	0.70	0.34	0.34	0.13*
Technology Teaching (TT)	8	0.84	0.86	0.39	0.47	0.21*

* Significant at $p<0.001$ n = 705
Act. Means Actual and Pref. means Preferred
The *eta*^{2} statistics (which is the ratio of 'between' to 'total' sum of squares) represents the proportion of variance explained by class membership.

The results of the three statistical indices are reported in Table 6.2. The scale reliability estimates for the different scales of the TROFLEI using the individual student as the unit of analysis ranged from 0.67 for the Student Cohesiveness scale to 0.85 for the Equity scale in the Actual Form and from 0.70 for the Differentiation scale to 0.86 for the Technology Teaching scale in the Preferred Form of TROFLEI. These indices of reliability are comparable to those in past studies that have used the WIHIC (Aldridge & Fraser, 2000; Fraser & Chionh, 2000) and the TROFLEI (Aldridge, Dorman & Fraser, 2004; Aldridge & Fraser, 2003; Kerr, 2006). The reliability results of the TROFLEI were consistently above 0.50. This suggested that the TROFLEI can be considered a reliable tool (De Vellis, 1991) with Indian school students.

Using the individual as the unit of analysis, the discriminant validity results (mean correlation of a scale with other scales) for the nine scales of the TROFLEI ranged from 0.34 for the Differentiation scale to 0.51 for the Cooperation scale in the Actual form and between 0.34 for the Differentiation scale to 0.55 for the Cooperation scale in the Preferred form (Table 6.2). The analysis of variance (ANOVA) was used to determine the ability of the actual version of each TROFLEI scale to differentiate between the perceptions of students in different classes. The one-way ANOVA for each scale involved class membership as the independent variable and the individual student as the unit of analysis. Table 6.2 reports the ANOVA results showing that all nine of the TROFLEI scales differentiate significantly between classes ($p<0.001$). Thus, students within the same class perceive the environment in a relatively similar manner, while the within-class mean perceptions of the students vary between classes. The eta^2 statistic (an estimate of the strength of association between class membership and the dependent variable) ranges from 0.09 for the Cooperation scale to 0.23 for the Teacher Support scale in the Actual Form of the TROFLEI. Figure 6.1 represents the Cronbach Alpha Reliability scores of the Actual and Preferred Forms of the TROFLEI in a graphical form.

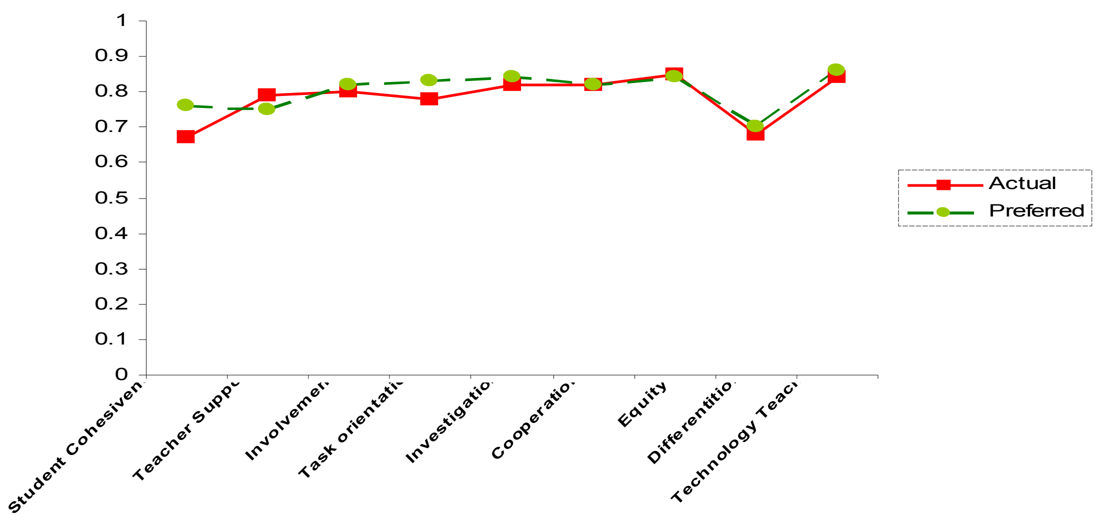

Figure 6.1. Cronbach alpha reliability of the Actual and Preferred Forms of the TROFLEI

In order to further validate the modified TROFLEI questionnaire in the Indian setting, factor analysis was carried out on the data collected. Principal components factor analysis followed by varimax rotation confirmed a refined structure of the Actual and Preferred Forms of the TROFLEI comprising of 72 items in nine scales. Nearly all of the 72 items have a loading of at least 0.35 on their *a priori* scale for the actual version (See Table 6.3). From the data in Table 4.3 it can be seen that item two and eight from The Student Cohesiveness scale, item 13 from the Teacher Support scale and item 23 from the Involvement scale did not load at 0.35 or above on their own or any other scale. The cumulative percentage variance extracted with each factor is also illustrated at the bottom of Table 4.3 and was found to be 44.18%.

The overall loadings confirmed the factor structure of the TROFLEI. In general, the results are similar to the previous cross-validations of the TROFLEI instrument in Australia (Aldridge, Dorman & Fraser, 2004; Aldridge & Fraser 2003). The results confirmed that the modified version of the TROFLEI could be used with confidence in technology-supported science classrooms in Indian settings.

Table 6.3
Factor Loadings for the Modified TROFLEI

Item No.	SC	TS	IN	TO	IV	CO	EQ	DI	TT
1	0.55								
2	-								
3	0.59								
4	0.50								
5	0.56								
6	0.52								
7	0.50								
8	-								
9		0.64							
10		0.66							
11		0.60							
12		0.42							
13		-							
14		0.67							
15		0.56							
16		0.40							
17			0.41						
18			0.56						
19			0.39						
20			0.49						
21			0.56						
22			-						
23			0.39						
24			0.35						
25				0.45					
26				0.42					
27				0.48					
28				0.53					
29				0.57					
30				0.63					
31				0.51					
32				0.51					
33					0.54				
34					0.54				
35					0.54				
36					0.51				
37					0.54				
38		0.36			0.50				
39					0.62				
40					0.46				
41						0.56			
42						0.51			
43						0.58			
44						0.51			
45						0.56			
46						0.59			
47						0.51			
48						0.47			
49				0.37			0.41		
50							0.57		
51							0.56		
52							0.63		
53							0.69		
54							0.63		

55							0.64		
56							0.63		
57								0.53	
58								0.35	
59								0.44	
60								0.66	
61								0.36	
62								0.64	
63								0.69	
64								0.67	
65									0.58
66									0.58
67									0.62
68									0.68
69									0.67
70									0.64
71									0.63
72									0.67
Cumulative % Variance	3.69	8.63	12.34	18.34	23.58	28.69	34.70	38.58	44.18

Factor Loadings smaller than 0.35 have been omitted. n = 705

6.2 Validation of Attitude and Efficacy Scale

To measure students' attitude towards the subject and their academic efficacy data was collected on two scales i.e., the Attitude Towards Science scale and the Academic Efficacy scale. There were in all 16 items with eight items in each scale. The data on these two scales were collected from a sample of 705 students in 15 classes. The internal consistency reliability (Cronbach alpha coefficient) for the two scales was computed with the individual as the unit of analysis. The results have been shown in Table 6.4.

Table 6.4

Internal Consistency Reliability (Cronbach Alpha Coefficient) for the Attitude Towards Science and Academic Efficacy Scale.

Scale Name	No. of Items	Alpha Reliability
Attitude Towards Science	8	0.64
Academic Efficacy	8	0.66

n=705

The scale reliability for the Attitude Towards Science scale is 0.64 and for the Academic Efficacy scale is 0.66. The reliability results of the two scales were consistently above 0.50. This suggested that these scales could be used as reliable tools (De Vellis, 1991) in Indian classroom settings to study the attitude of students and their academic efficacy.

6.3 Means and Standard Deviation on the TROFLEI

Item means and standard deviations were computed to determine the nature of a technology-supported science classroom learning environment using the TROFLEI. The statistical significance of the difference between means (t-test) was also calculated to study whether the differences in the means of the Actual and Preferred Forms of TROFLEI when used in a technology-supported classroom setting were significant. The data obtained are presented in Table 6.5.

For the data in Table 6.5 it can be seen that the mean scores of the different scales of TROFLEI ranged from 3.33 for the Involvement scale to 4.14 for the Technology Teaching scale in the Actual Form which shows that students were generally able to perceive technology-supported science teaching as beneficial for them and technology was being used quite often in the day-to-day teaching of science in the school. If we also look at the mean scores in the Preferred Form of TROFLEI, it can be seen that the mean score ranged from 3.73 for the Differentiation scale to 4.49 for the Technology Teaching scale. This again reiterates the fact that students usually want more of technology-supported science teaching in their classroom. The values of the standard deviations in both the Actual and Preferred Form of the TROFLEI are less than 1, which suggests that there are no major deviations in students' perceptions of the technology-supported learning environment in their science classrooms.

Table 6.5
Mean, Standard Deviation (S.D) and Significance of Difference between Means (t) for the Modified TROFLEI.

Scale Name	No. of Items	Mean		Standard Deviation(S.D)		t
		Act.	Pref.	Act.	Pref.	
Student Cohesiveness	8	3.91	4.26	0.55	0.61	17.22*
Teacher Support	8	3.38	4.00	0.74	0.67	24.84*
Involvement	8	3.33	3.90	0.69	0.69	23.22*
Task Orientation	8	4.08	4.41	0.58	0.60	17.43*
Investigation	8	3.56	4.11	0.71	0.70	21.59*
Cooperation	8	3.75	4.18	0.70	0.67	20.31*
Equity	8	3.78	4.30	0.76	0.66	19.44*
Differentiation	8	3.35	3.73	0.66	0.70	17.54*
Technology Teaching	8	4.14	4.49	0.64	0.59	19.13*

* Significant at $p<0.001$ n = 705

The data for the t-test indicated that there is a significant difference *(p*<0.001*)* between the actual and preferred means for all the scales which shows that students' preferred learning environments should have more student cohesiveness, more support from the teacher than what is being provided at present, more involvement in classroom activities, more task orientation, develop more investigative ability than what students perceive they have at present, more of cooperation in learning with other students in the class, more equity and more technology-based teaching of science in the classroom. Although, all the scales of the TROFLEI show a good response from the students, the main objective is to improve the existing learning environments in the technology-supported science classroom and the information from the students' perceptions of their preferred learning environments gives us vital clues towards the areas that require our immediate focus for further improvement. Figure 6.2 represents the mean scores on the Actual and Preferred Forms of TROFLEI in a graphical form.

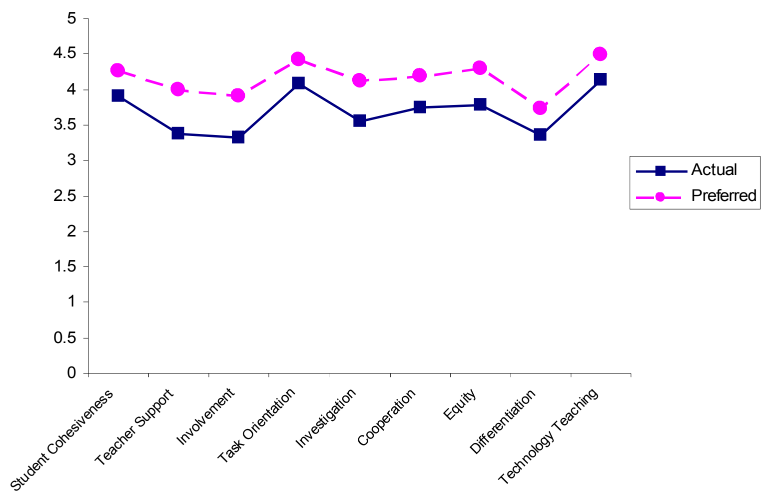

Figure 6.2. Mean scores of the Actual and Preferred Forms of the TROFLEI.

6.4 Mean and Standard Deviation on Attitude and Efficacy Scale

Table 6.6
Mean and Standard Deviation for the Attitude towards Science and Academic Efficacy Scale.

Scale Name	Mean	Standard Deviation
Attitude towards Science	4.0	0.64
Academic Efficacy	3.48	0.57

n = 705

From the data collected for the attitude and efficacy scales, the value of the mean for the Attitude Towards Science is 4.0 and the mean value for Academic Efficacy is 3.48 (see Table 6.6). The high mean score points out towards the fact that generally students exhibited a positive attitude towards science when taught in a technology-supported learning environment and that the mean score on the efficacy scale shows that the students feel that they are successful when studying science in a technology-supported classroom.

6.5 Investigation of the Association between the TROFLEI and Three Learner Outcomes.

6.5.1 Association of Students' Perception of the Technology-Supported Learning Environment with Attitude Towards Science

Students' perception of their technology-supported learning environment and its association with their attitude towards science was explored using simple and multiple correlation analysis, followed by computation of the regression coefficient. The results of these analyses are shown in Table 6.7, which gives a clear picture indicating significant associations between technology-supported learning environments and student outcomes.
The results from Table 6.7 indicate that for simple correlation (r) all the nine scales of TROFLEI are statistically significantly and positively associated with student attitudes towards their class ($p<0.01$, $p<0.05$) at the individual level of analysis. The values of correlation range from 0.09 for the Differentiation scale to 0.42 for the Task Orientation scale. Another important inference that can be drawn is that students' attitude towards science is significantly correlated in a positive direction with the Technology Teaching scale with a value of 0.40, which tells us that the use of technology in teaching science may have a positive effect on student attitudes.

The multiple correlation (R) between students' perceptions as measured by the different scales of the TROFLEI and the Attitude Toward Science scale (see Table 6.7) is 0.50 at the individual level of analysis, which is statistically significant ($p<0.001$). The R^2 value indicates that 23 percent of the variance in the students' attitude towards science can be attributed to the technology-supported learning environment and thus the better the learning environment the more positive are the students' attitudes towards science. Standardized regression values were calculated to provide information about the unique contribution of each learning environment scale to the Attitude Towards Science scale. Regression coefficient values (β) indicate (see Table 6.7) that five of the nine TROFLEI scales uniquely account for a significant ($p<0.001$, $p<0.01$, $p<0.05$) amount of variance in student attitudes towards science, these are Task Orientation, Investigation, Equity, Differentiation and Technology Teaching. The β values for the significantly associated scales ranged from -0.11 for the Differentiation scale to 0.30 for the Task Orientation scale. Although the Differentiation scale has a significant association with the attitude scale, it is negatively associated. This means that the influence of the differentiation environment variable is opposite to student's attitude towards science i.e. the more the differentiation in the classroom by the teacher the less the development of attitude towards the subject. From the point of view of this study, it is pertinent to note that the Technology Teaching scale is positively associated with the attitude scale and has a value of 0.20 which is significant ($p<0.001$). This again shows that the technology-supported learning environment has a healthy relationship with development of a positive attitude towards science, which in fact is the aim of this study

6.5.2 Association of Students Perception of the Technology-Supported Learning Environment 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 their technology-supported learning environments as measured by the TROFLEI and their academic efficacy. Table 6.7 illustrates the results of the statistical analysis. The results from Table 6.7 indicate that for simple correlation (*r*) all the nine scales of TROFLEI are statistically significantly and positively associated with students' academic efficacy ($p<0.01$) at the individual level of analysis. The values of correlation range from 0.32 for the Student Cohesiveness scale to 0.44 for the Task Orientation and Investigation Scales. Another important inference that can be drawn is that Academic Efficacy is significantly correlated in a positive direction with Technology Teaching scale with a value of 0.43 which is highly significant ($p<0.01$). This tells us that the use of technology in teaching science could improve the students' beliefs in their own efficiency and effectiveness in science.

The multiple correlation (*R*) between students' perceptions as measured by the different scales of the TROFLEI and the Academic Efficacy Scale (see Table 6.7) is 0.60 at the individual level of analysis, which is statistically significant ($p<0.001$). The R^2 value indicates that 33 percent of the variance in the students' academic efficacy can be attributed to the technology-supported learning environment. Standardized regression values were calculated to provide information about the unique contribution of each learning environment scale to the Academic Efficacy scale. Regression coefficient values (β) indicate (see Table 6.7) that five of the nine TROFLEI scales uniquely account for a significant ($p<0.001$, $p<0.01$, $p<0.05$) amount of variance in academic efficacy; these are Involvement, Task Orientation, Investigation, Differentiation and Technology Teaching. The β values for the significantly associated scales ranged from 0.11 for the Investigation scale to 0.21 for the Technology Teaching scale, which is the highest value and is significant at $p<0.001$. All the β values are positive. Again from the data it is clear that the technology-supported learning environment in a science classroom has a positive effect on the academic efficacy of the students.

6.5.3 Association of Students Perception of the Technology-Supported Learning Environment with Academic Achievement

The association between the academic achievement of the students and their perception of technology-supported learning environments as measured using TROFLEI was studied using simple correlation (*r*), multiple correlation (*R*) and the regression coefficient (β). The statistical results have been illustrated in Table 6.7

The data illustrated in Table 6.7 indicate that for simple correlation (*r*) eight out of the nine scales of TROFLEI are statistically significantly and positively associated with students' academic achievement ($p<0.01$) at the individual level of analysis. The values of correlation ranged from 0.11 for the Involvement and Cooperation scales to 0.30 for the Technology Teaching scale. Thus academic achievement is significantly correlated in a positive direction with the Technology Teaching scale with a value of 0.30, which implies that a technology-supported science classroom may help improve the academic achievement of the students in terms of their performance in the examination and attainment of knowledge.

The multiple correlation (*R*) between students' perceptions as measured by the different scales of TROFLEI and the Academic Achievement Scale (as seen in Table 6.7) 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' academic achievement can be attributed to the technology-supported learning environment. Standardized regression values were calculated to provide information about the unique contribution of each learning environment scale to the Academic Achievement scale. Regression coefficient values (β) (as given in Table 6.7) indicate that five of the nine TROFLEI scales uniquely account for a significant ($p<0.001$, $p<0.01$, $p<0.05$) amount of variance in academic achievement. These are Task Orientation, Investigation, Cooperation, Differentiation and Technology Teaching. The β values for the significantly associated scales ranged from -0.11 for the Cooperation scale to 0.20 for the Technology Teaching scale, which is the highest value and is significant at $p<0.001$. The data as mentioned in Table 6.7 show that the values of the Cooperation and Differentiation scales are negative which implies that these two scales influence the academic achievement in an opposite direction. This is some what understandable, especially with the Indian classroom settings, as the pressure on achieving in the examination is on the students and they would not like to cooperate with other students in the same classroom academically with the fear of losing their grades. Also, the teachers who differentiate a lot in the classroom may give an idea to the students that the teacher is being partial or biased in his or her approach towards a selected few. These could be the probable reasons for negative correlations on these two scales. It is again evident from the data that the technology-supported learning environment in a science classroom may help in improving the academic achievement of the students as both the correlation and regression coefficients have a positive and significant association with the academic achievement scores.

Table 6.7
Associations between TROFLEI 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 Standardised Regression Coefficient (β).

Scale Name	Attitude Towards Science		Academic Efficacy		Academic Achievement	
	r	*β*	*r*	*β*	*r*	*β*
Student Cohesiveness	0.24**	0.00	0.32**	0.02	0.20**	0.10
Teacher Support	0.26**	0.05	0.40**	0.06	0.14**	0.00
Involvement	0.20**	0.07	0.42**	0.14**	0.11**	-0.04
Task Orientation	0.42**	0.30***	0.44**	0.20***	0.23**	0.12*
Investigation	0.31**	0.10*	0.44**	0.11*	0.20**	0.10*
Cooperation	0.23**	-0.10	0.40**	-0.03	0.11**	-0.11*
Equity	0.34**	0.15**	0.35**	-0.01	0.20**	0.10
Differentiation	0.09*	-0.11**	0.36**	0.14***	-0.01	-0.15***
Technology Teaching	0.40**	0.20***	0.43**	0.21***	0.30**	0.20***
Multiple Correlation (R) R^2	R = 0.50*** $R^2 = 0.23$		R = 0.60*** $R^2 = 0.33$		R = 0.34*** $R^2 = 0.12$	

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

6.6 Investigation of Gender Differences

6.6.1 Gender Differences and Technology-Supported Learning Environment

The association between gender differences and technology-supported learning environments was studied by first dividing the main group of students into two subgroups of male and female.

Means and standard deviations for the two groups were computed followed by a test of significance of difference between means (*t*-test for independent samples), to find out gender difference on the nine scales of TROFLEI. The data obtained statistically has been illustrated in Table 6.8.

From the information given in Table 6.8, it can be seen that out of the nine scales of the TROFLEI only two scales, i.e. Student Cohesiveness with a *t* value of 0.41 and Cooperation with a *t* value of 0.60 are statistically significant ($p<0.01$). In the two scales, which are statistically significant, females have a higher mean score than males. This means that female students show more cohesiveness within their group and help and support one another, also they show more cooperation with one another on learning tasks in a technology-supported science classroom environment. Figure 6.3 depicts the respective means of male and female students on the nine scales of TROFLEI.

Table 6.8
Mean, Standard Deviation and Significance of difference Between Means for Gender differences in Students Perceptions of Learning Environment as Measured by the Modified TROFLEI

Scale	Gender	Mean	Mean Difference (M-F)	Standard Deviation	*t*
Student Cohesiveness	Males	3.90	-0.02	0.53	0.41**
	Females	3.92		0.58	
Teacher Support	Males	3.36	-0.03	0.71	0.43
	Females	3.39		0.77	
Involvement	Males	3.31	-0.05	0.70	0.98
	Females	3.36		0.72	
Task Orientation	Males	4.03	-0.11	0.60	2.55
	Females	4.14		0.57	
Investigation	Males	3.57	0.02	0.70	0.23
	Females	3.55		0.72	
Cooperation	Males	3.74	0.03	0.66	0.60**
	Females	3.77		0.74	
Equity	Males	3.76	-0.05	0.75	0.84
	Females	3.81		0.78	
Differentiation	Males	3.34	-0.01	0.65	0.12
	Females	3.35		0.68	
Technology Teaching	Males	4.06	-0.18	0.66	3.71
	Females	4.24		0.61	

** Significant at $p<0.01$
Males: n = 379; Females: n = 326

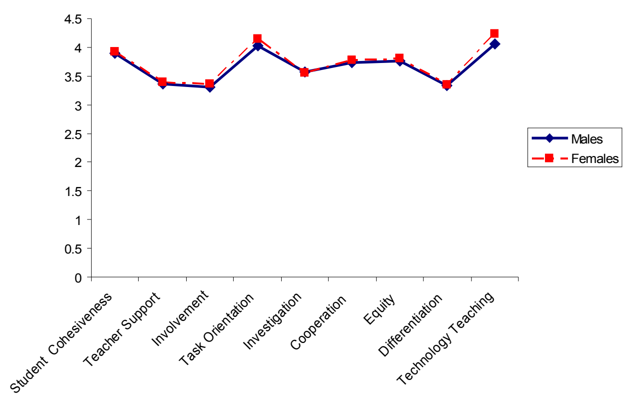

Figure 6.3. Mean scores of male and female students on the nine scales of the TROFLEI.

6.6.2 Gender Difference on Attitude Towards Science, Academic Efficacy and Academic Achievement

Gender differences on attitude towards science, academic efficacy and academic achievement were studied by dividing the whole group into subgroups of male and female students. Means and standard deviations for the two groups were computed followed by a significance of the difference between means (*t*-test), to find out gender differences on the three student outcomes. The data obtained statistically has been illustrated in Table 6.9. From the data analysis it is evident that there are no gender differences between male and female students in their attitude towards science and academic achievement in a technology-supported learning environment. However, the difference between male and female students in academic efficacy is statistically significant with a *t* value of 1.60 ($p<0.01$). Thus, female students feel more motivated and more confident than do male students in a technology-supported learning environment.

Table 6.9

Mean, Standard Deviation and Significance of Difference between Means for Gender Differences in Attitude Towards Science, Academic Efficacy and Academic Achievement

Scale	Gender	Mean	Mean Difference (M-F)	Standard Deviation	t
Attitude Towards Science	Males	3.75	-0.04	0.64	0.83
	Females	3.79		0.63	
Academic Efficacy	Males	3.44	-0.07	0.53	1.60**
	Females	3.51		0.62	
Academic Achievement	Males	61.41	-3.23	21.21	2.01
	Females	64.64		21.38	

** Significant at p<0.01
Males: n = 379; Females: n = 326

7. Conclusion

A major contribution of the present study is the modification and validation of a widely-applicable and distinctive questionnaire (TROFLEI) for assessing students' perceptions of their Actual and Preferred classroom learning environments in a technology-supported secondary science classroom in Jammu, India. This questionnaire has been used for the first time and its reliability and validity was established in an Indian school situation. This research, by examining the learning environment and its impact on student attitudes towards science, academic efficacy and academic achievement, has the potential to provide information to teachers on how technology can be used in creating a healthy learning environment and promoting improved learner outcomes. The findings of this research can be broadly applied to study the learning environments in areas other than science such as mathematics, English, social sciences and regional languages etc. by researchers and practitioners of education.

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