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Impact of Teacher-Student Relationship and Attitude towards Achievement in Chemistry at Higher Secondary Level

P. Susai Raj and A. Edward William Benjamin
Bharathidasan University, Tiruchirappalli, Tamil Nadu

This study investigated the relationship between the teacher-student relationship, the attitudes towards chemistry, and the achievement in chemistry among class eleven students in Cuddalore District, Tamil Nadu, India. A survey methodology was employed, involving 303 conveniently selected participants. Data were collected using three instruments: i) Attitude towards Chemistry Lessons Scale (ATCLS), ii) Student Version of Teacher-Student Relationship Inventory (S-TSRI), and iii) the researcher-developed Standardized Chemistry Achievement Test based on the Tamil Nadu State Board syllabus.Data were quantified according to scale guidelines and analysed using SPSS software to determine correlations between teacher-student relationships, attitudes towards chemistry, and chemistry achievement and the impact of these variables on each other. The results exhibited a moderate to high positive correlation among the variables of this study. Notably, the teacher-student relationship effect on achievement in chemistry was substantially higher thanthe effect on attitude towards chemistry. When comparing students with strong teacher-student relationships to those with conflictual relationships with the teacher, the former group demonstrated higher levels of engagement and superior academic outcomes in chemistry. The researcher postulated that enhanced teacher-student relationships could potentially lead to long-term benefits in students' academic trajectories and careers.

Keywords: Achievement in Chemistry, student-teacher relationship, conflict factor, attitude towards chemistry.

The relational bond between the teacher and students is vital in making the educational journey rich and productive for chemistry learners. The dimensions of these positive interactions in the bonding can significantly influence students' participation, ambition needs, and academic accomplishment in chemistry(Pianta, Hamre, & Allen, 2023). Focusing on these bonds and encouraging those attachments and reducing the conflicts may lead to a near-perfect learning environment, and make students learn the difficult chemical theories with ease, self-assurance, and zeal. Conversely, teacher-student relationships in conflict may lead to indifference, nervousness, anxiety, hatred, or boredom towards chemistry(Poling, Van Loan, Garwood, Zhang, & Riddle, 2022).These dynamics have far-reaching consequences beyond the classroom, influencing students' enduring perspectives on chemistry and subsequent career decisions(Sharma & Kumar, 2023). Instructors who exhibit enthusiasm for the subject, deliver lucid explanations, and provide personalized assistance can spark a genuine curiosity for chemistry and enhance students' attitude towards chemistry(Cheung, 2022; Mercer, Dawes, & Wegerif, 2022). This, in turn, may lead to improved academic performance, greater involvement in chemistry-related pursuits, and an increased likelihood of pursuing advanced studies or careers in the field(Tytler, Haslam, & Prain, 2022; Vilia, Neto, Melo, Candeias, & Franco, 2017).

Theories Supporting Positive Teacher-Student Environments

Self-Determination Theory: It is proposed that the students' internal locus of control expands when their elementary psychological needs are satisfied. Supportive teachers fulfil the need for relatedness, which promotes engagement and academic achievement (Chen & Jang, 2023; Reeve, Ryan, Deci, & Jang, 2022). Attachment Theory: Bowlby (1969) explained how secure relationships foster emotional safety and exploration, which are essential for learning. Learning success is assured when emotional safety is ensured by the teachers (Hamre & Pianta, 2023). Social Cognitive Theory (SCT): It emphasizes that learning occurs through observation and interaction. Teachers modelling supportive behaviours positively impact students' self-efficacy and academic performance (Zimmerman & Schunk, 2023).

Constructivist Learning Theory: Vygotsky and Piaget's constructivist principles suggest that teachers create meaningful interactions to help students actively build their knowledge. A supportive environment facilitates better engagement and conceptual understanding (Mercer et al., 2022). Motivation-Hygiene Theory: Herzberg (1959) suggests that teachers reduce anxiety and foster intrinsic motivation by creating a supportive and encouraging learning environment (Sing & Raj, 2023).

Studies have consistently shown that the nature of the relationship between teachers and students plays a crucial role in shaping learners' academic success and their outlook toward chemistry as a subject. According to Pianta et al. (2023), when teachers cultivate supportive and encouraging connections with their students, it builds a sense of belonging that enhances both engagement and motivation across academic disciplines. Within the context of chemistry education, these positive relationships help to lower students' anxiety levels and encourage active classroom participation two essential factors for mastering complex scientific ideas. When students experience warmth, trust, and constructive feedback from their teachers, they are more confident in tackling difficult topics, which ultimately contributes to stronger academic outcomes.

Several interrelated elements influence students' attitudes toward chemistry, including the teaching methods used, the relevance students perceive in the subject, and the overall quality of teacher–student interaction. Cheung (2022) highlighted that a teacher's accessibility, friendly demeanor, and continuous encouragement are key components in developing favorable attitudes toward chemistry learning. Moreover, instructional practices that connect chemistry concepts to everyday experiences tend to increase students' curiosity, enthusiasm, and intrinsic interest in the subject. Thus, the effectiveness of chemistry education depends not only on content delivery but also on the relational and contextual dimensions of the learning process.

Achievement in chemistry is likewise shaped by cognitive, affective, and behavioural components. Tytler et al. (2022) suggested that students are more likely to perform better when they perceive their teachers as compassionate, empathetic, and genuinely invested in their academic success. Such perceptions encourage students to seek assistance, face academic challenges with greater resilience, and maintain sustained interest in chemistry learning.

The mediating role of teacher–student relationships has also been explored extensively, as these relationships often serve as a crucial link between students' attitudes and their academic outcomes. A longitudinal study by Mistry and Singh (2023) demonstrated that positive teacher–student

interactions significantly influenced students' motivation and achievement in chemistry, highlighting the importance of relational dynamics in promoting academic success.

In the Indian educational context, teacher–student relationships are further influenced by cultural and hierarchical dimensions. Sharma and Kumar (2023) noted that in higher secondary schools, the traditional respect and reverence for teachers, when combined with approachable and nurturing interactions, can uniquely shape students' attitudes and performance in subjects like chemistry. The balance between authority and emotional connection often determines how students internalize their learning experiences and sustain motivation.

The reviewed studies collectively emphasize that nurturing strong teacher–student relationships, along with adopting effective and interactive teaching strategies, plays a vital role in fostering positive attitudes and enhancing achievement in chemistry learning. This line of inquiry holds particular significance within the context of higher secondary education in India, where students' engagement with science subjects often shapes their future academic and career choices. This investigation's objective was to address the following research gaps:

- This investigation would probe into the complex relationships between teacher-student relationships, attitude towards chemistry, and chemistry achievement, which will help in exploring even further the existing review of the literature available.
- This chemistry-specificContext study of the interplay of the selected variables of the study will provide new knowledge.
- The combined effect of the predictors, namely the teacher-student relationships and attitude towards chemistry, on the dependent variable, achievement in chemistry, and the individual effect of the predictors on the dependent variable, definitely would provide new insights.
- The specific factor of conflict in teacher-student relationships,the variable, and its effects would be the novelty of this study.
- The study focusing on the higher secondary level specifically carries its newness.

Objectives

After pinpointing the research gap, the following objectives are formulated for this specific study:

- To find the significant positive correlation existing between variables.
- To understand and estimate the combined impact of the teacher-student relationships and attitude towards chemistry lessons on achievement in chemistry.
- To explore the effect of the sub-scale conflict in teacher-student relationships on other variables.

The subsequent hypothesis was formulated from the objectives of the study.

Method

Sample

A survey method was employed by gathering data from 303 samples, which were conveniently selected from eleventh-standard students from the population of Cuddalore District, Tamil Nadu, India, with the following scales:

Tools

The Attitude towards Chemistry Lessons Scale (ATCLS), developed by Cheung in 2009 with subscales, with high reliability and validity, was used for the study (Cheung, 2009).

Student version of Teacher-Student Relationship Inventory (S-TSRI), an appropriate instrument derived by Ang, Ong, & Li (2020)through factorial analysis with 14 items with 3 factors, which fills the gap in assessing in the Asian context, was used.

A self-developed Chemistry Achievement Test was constructed based on the Tamil Nadu State Board Grade XI syllabus, covering three units: Gaseous State, Basic Concepts of Chemistry, and Chemical Calculations and Fundamentals of Organic Chemistry.

The preliminary version contained 40 multiple-choice items. To ensure psychometric soundness, item analysis was conducted using the upper–lower group method. Difficulty Value (DV) and Discrimination Index (DI) were calculated, and items with DV between 30% and 70% and DI above 40 were retained, resulting in 40 finalized items. The complete results of the item analysis can be found in Table 1.

Table 1 Difficulty Value (DV) and Discrimination Index (DI) of Each Item in the Chemistry Achievement Test (N=200)

Item No.	DV (%)	DI	Item No.	DV (%)	DI
1	45.83	0.5	21	62.5	0.42
2	54.17	0.58	22	58.33	0.5
3	50.0	0.5	23	41.67	0.58
4	33.33	0.42	24	66.67	0.5
5	62.5	0.42	25	45.83	0.58
6	37.5	0.5	26	50.0	0.5
7	54.17	0.58	27	41.67	0.5
8	45.83	0.5	28	50.0	0.58
9	62.5	0.58	29	54.17	0.5
10	58.33	0.5	30	37.5	0.42
11	41.67	0.5	31	45.83	0.58
12	50.0	0.58	32	50.0	0.5
13	62.5	0.58	33	41.67	0.42
14	50.0	0.5	34	58.33	0.5
15	45.83	0.5	35	54.17	0.58
16	37.5	0.5	36	50.0	0.5
17	50.0	0.5	37	62.5	0.58
18	54.17	0.58	38	45.83	0.5
19	58.33	0.5	39	50.0	0.58
20	41.67	0.5	40	54.17	0.5

Note. DV = Difficulty Value; DI = Discrimination Index.

The internal consistency of the test was verified using Cronbach's alpha (α = .89), indicating high reliability. Content validity was established through expert review by three chemistry specialists and two educational measurement experts, who assessed each item's relevance and alignment with the higher secondary chemistry curriculum. Based on their feedback, minor wording revisions were made. The finalized test was therefore deemed reliable and valid for assessing students' achievement in chemistry.

These three tools were then administered to students with their consent in the selected higher secondary schools of the district. The collected data were quantified and scored according to the guidelines provided in the measurement scales. Statistical analysis was performed using SPSS.

Results

Table 2 Correlation Matrix for Study Variables (N = 303)

Variable	1	2	3
Attitude towards Chemistry	—		
Teacher-student Relationship	.515***	—	
Achievement in Chemistry	.542***	.739***	—

Note.p < .001.

Table 2 illustrates the results of the correlation analysis, revealing a significant positive relationship between students' attitude toward chemistry and their

achievement in the subject (r = 0.542, p < .001). Likewise, a strong association was observed between teacher–student relationships and achievement in chemistry (r = 0.739, p < .001), as well as between attitude toward chemistry and teacher–student relationships (r = 0.515, p < .001).

Table 3 Linear Regression results

Model	R	R^2	Adjusted R^2	β
Mo	0.000	0.000	0.000	0.762
M1	0.762	0.581	0.578	

Note. M1 includes Attitude towards Chemistry and the teacher-student relationship

A hierarchical regression analysis results indicated that the addition of the attitude towards Chemistry and teacher-student relationship in Model 1 significantly improved the fit of the model, R^2 = .581, adjusted R^2 = .578, compared to the null model (Model 0), R^2 = .000, adjusted R^2 = .000. The root mean square error (RMSE) decreased from 20.060 in Model 0 to 13.033 in Model 1, resulting in a better fit (β = 0.762, p < .001). The results presented in Table 3 suggest that, predictor's attitude towards chemistry and the teacher-student relationships in Model 1 are significantly correlated to achievement in chemistry.

Table 4 ANOVA

Model		Sum of the squares	df	F
M1	Regression	70561.791	2	207.693
	Residual	50961.179	302	
	Total	121522.97	302	

Note. M includes Attitude towards Chemistry and Teacher–Student Relationship; model significant at p < .001, η^2 = .581.

The regression analysis discovered a noteworthy association between the predictors and chemistry achievement, F (2, 302) = 207.693, p < .001. This large effect size (η^2 = 0.581) indicated that approximately 58.1% of the variance in chemistry achievement is explained by the predictors, specifically the teacher-student relationship and attitude towards chemistry. This suggests that these predictors have a substantial impact on chemistry achievement.

Table 5 Standardized Coefficient Values

Model		Standard Error	Standardized coefficient (β)	T
M_0	Intercept	1.152		52.057
M_1	Intercept	5.174		-8.500
	Attitude towards Chemistry	0.096	0.219	5.022
	Teacher-student relationship	0.149	0.626	14.339

Note. p < .001.

A multiple linear regression analysis demonstrated that both attitude toward chemistry and teacher–student relationship significantly predicted students' achievement in chemistry. The standardized beta coefficients (β) showed that the teacher–student relationship (β=0.626) had a stronger influence on chemistry achievement compared to attitude toward chemistry (β = 0.219). Specifically, a one standard deviation increase in the teacher–student relationship corresponded to a 0.626 standard deviation rise in achievement, whereas a one standard deviation increase in attitude toward chemistry led to a 0.219 standard deviation improvement. These findings indicate that the teacher–student relationship emerged as the more dominant predictor of academic performance in chemistry.

Table 6 Values for achievement in chemistry

	Mean	*SD*	*T*
Attachment with teacher (n=168)	74.375	11.874	23.236
Conflict with the teacher (n=135)	42.089	12.202	

Note. p < .001, d = 1.34.

A significant difference among the mean attachment towards the teacher (M = 74.375) and the mean conflict with the teacher (M = 42.089), t(301) = 23.236, significant at the 0.001 level, with an immense Cohen's d value of 1.34, indicated that students reported substantially higher levels of attachment towards their teachers compared to conflict with their teachers.

Table 7 Achievement in chemistry

	df	F	p	η^2
Attachment – conflict	1	539.916	<.001	0.642
Residual	301			

Note. p < .001.

A one-way ANOVA in Table 7 exposed the effect of the attachment and conflict groups on the achievement in chemistry, F (1, 301) = 538.916, p < 0.001, η^2 = 0.642. This indicates that the attachment and conflict group explained approximately 64.2% of the variance in achievement in Chemistry.

Table 8 The Values for attitude towards chemistry

	Mean	SD	t	Df
Attachment with teacher (n=168)	43.679	9.860	7.418	301
Conflict with teacher (n= 135)	36.459	6.171		

Note: p < .001, d = 0.84.

Table 8 revealed a substantial difference in attitude towards chemistry among learners who experienced attachment with their teacher (M = 43.679, SD = 9.860) and those who experienced conflict with their teacher (M = 36.459, SD = 6.171), t(301) = 7.418 at the 0.001 level of significance. The d value of 0.843 suggested that the attachment with teachers leads to more positive attitudes towards chemistry, whereas conflict leads to negative attitudes.

Table 9 Attitude towards chemistry

	df	F	p	η^2
Attachment – conflict	1	55.025	<.001	0.155
Residual	301			

Note. p < .001.

F (1, 301) = 55.025, p < .001, η^2 = .155 in table 9, indicated that approximately 15.5 of % attitude towards chemistry can be ascribed to the differences in attachment-conflict. Specifically, the results suggest that students experiencing attachment with their teachers have significantly more positive attitudes towards chemistry compared to those experiencing conflict.

The observation regarding the samples that fall in the category of conflict with the teacher and into the category of attachment with the teacher needs to be looked into seriously. The students in the category of 'conflict with the teachers' amount to 135 out of 303, which means nearly 45% of the samples conflict with their chemistry teacher, or in other words, they struggle to get attached to theteacher,leading to lower achievement in chemistry.

Discussion

The findings indicated a positive moderate to high correlation between the variables of this study. Students with strong relationships with teachers tend to perform more than those with conflict relationships, because the attachment with the teacher leads to higher levels of engagement in learning and better outcomes in chemistry. Thus, it was suggested by the researcher to improve teacher-student relationships, which could potentially reap long-term benefits such as career aspirations in achievement in the present scenario.

From previous studies, it could be traced that positive teacher-student relationships had a consistent link with positive attitudes and better performance in various subjects,

including chemistry (Hajovsky, Chesnut, Curtin, & Oyen, 2019; Sointu, Savolainen, Lappalainen, & Lambert, 2016; Vilia et al., 2017). The healthy bonding motivates and finally leads to overall success in chemistry performance. A meta-analysis study revealed an increased correlation largely in the area of student-engaged activities, and a moderate correlation in achievement in the subject(Roorda, Spilt, Oort, & Koomen, 2011). The teacher-student relationships mediated by self-efficacy increased achievement in mathematics (Hajovsky et al., 2019), and providing the needs of the students promoted autonomy, happiness, and competence, which could indirectly affect academic performance (Froiland, Worrell, & Oh, 2019).These studies suggest the role of the teacher-relationships in the achievement of different subjects, which could be attributed to chemistry as well.

Research indicates that on one hand, teacher-student attachment has substantial immense positive effects on the self-efficacy of the teacher, which in turn slightly improves math achievement (Hajovsky et al., 2019) while on the other hand, it decreases problematic behaviour, increases academic success, improved school engagement, and enhanced social status among peers (Poling, Van Loan, Garwood, Zhang, & Riddle, 2022),and many indirect positive effects. These findings suggest that similar outcomes can be obtained in chemistry education. It is also an interesting observation to note that contrary to our hypothesis, some students with neutral teacher-student relationships or conflict with teachers still achieved high scores, and some with good attachment with the teacher still scored low marks, suggesting other influencing factors. This opens a research gap for further study and also gives the following educational implications:

- The high positive correlation among the predictors in this study brings to the limelight the significance of vibrant relational communication between the teachers and the students, and the schools have an obligation to prioritize professional development programs for teachers to develop interpersonal skills and rapport building.
- Address conflict in teacher-student relationships: Given the high impact of conflict on chemistry achievement, it is crucial to implement strategies for conflict resolution and prevention. This may include training teachers in effective communication techniques, emotional intelligence, and classroom management skills.
- Though the results of the investigation of the impact on attitude towards chemistry were moderate, its role cannot be watered down. Making chemistry lessons more attractive, meaningful, and enjoyable will certainly foster positive attitudes.
- The combined effect of teacher-student relationships and attitude towards chemistry on achievement in chemistry suggests that a comprehensive intervention approach addressing both factors at the same time may produce further desired results in improving performance in chemistry.
- The individual scores in the study play a crucial role. Though some students have a good attachment with the teacher, they scored less in chemistry. Educators should aim for individualized, tailor-made, specific, need-based interventions.
- Regular assessments of teacher-student relationships would help to identify areas of concern and allow planning for progress over time.
- Integrate real-world applications: To enhance student attitudes towards

chemistry, incorporate practical applications and real-world examples into lessons, demonstrating the relevance of chemistry in everyday life and future careers.

- Implementing peer mentoring systems may also bring about positive attitudes towards chemistry and provide supplementary support for those who struggle with the subject.
- Engaging parents in the chemistry education of the students can certainly make the teacher-student relationships and attitudes towards the subject stronger.

The novelty of this research is in its focus on the higher secondary level and its emphasis on chemistry education in particular, as chemistry has not received much attention in the past. Most specifically, its novelty was in studying the combined and individual immense impact of the predictors on the achievement in chemistry, dealing with the important conflict factor in teacher-student relationships.

Limitations

While this study provides meaningful insights into how teacher–student relationships and students' attitudes toward chemistry influence academic achievement, several limitations warrant consideration. First, the study employed self-reported measures, which may be subject to social desirability bias and reflect participants' subjective perceptions rather than objective behaviours. Second, the sample was limited to higher secondary students in the Cuddalore District of Tamil Nadu, which constrains the generalizability of the findings to other regions or educational contexts. Third, the use of a cross-sectional design prevents establishing causal inferences among the studied variables. Moreover, contextual influences such as classroom climate, instructional practices, and school resources were not examined, even though these factors may interact with relational and attitudinal dimensions to shape academic outcomes. Finally, as the investigation focused exclusively on chemistry, the observed patterns may differ when applied to other science subjects or disciplines.

Future Recommendations

Future research should adopt longitudinal or experimental designs to better establish causal links among teacher–student interactions, attitudes toward chemistry, and academic achievement over time. Broadening the sample to include students from varied geographical locations and educational systems would strengthen the external validity and applicability of the findings. Incorporating qualitative approaches such as classroom observations, focus groups, or interviews could also provide richer insights into the nuanced dynamics of teacher–student relationships. Moreover, future investigations may examine potential mediating and moderating factors, including self-efficacy, classroom climate, and parental involvement, which could further explain variations in students' academic performance. Finally, intervention-based research focusing on teacher training and professional development initiatives aimed at enhancing relational and motivational practices could yield practical strategies to foster both positive student attitudes and improved achievement in chemistry.

Conclusion

Improving the attitude towards chemistry even depends heavily on positive teacher-student attachments with reduced conflicts, and more attachment seems to be an auspicious tactic for cultivating students' attitudes towards chemistry and making students achieve high grades in chemistry. This is supported by research showing that interventions targeting teacher-student

relationship quality can lead to beneficial student outcomes (Poling et al., 2022). Educators and policymakers should focus on fostering effective teacher-student interactions can improve educational outcomes, particularly in the chemistry subject, where student performance may be challenging (Thero & Senevirathne, 2024).

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P. Susai Raj, Ph.D, Research Scholar, Bharathidasan University, Tiruchirappalli, Tamil Nadu.

A. Edward William Benjamin, PhD, Professor & Head, Bharathidasan University, Tiruchirappalli, Tamil Nadu.