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The role of science teachers professional learning community in fostering students' interest and attitudes in science

Marika Kapanadze [1*], Nino Javakhishvili [1], Lia Dzagania [1], Natela Bagatrishvili [2]

[1] Ilia State University, Tbilisi, GEORGIA
[2] Iakob Gogebashvili Telavi State University, Telavi, GEORGIA

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Abstract
Engaging teachers in teacher professional learning communities (PLCs) is an effective approach to professional development. PLCs influence teaching practices and provide an ideal environment for supporting and motivating teachers to implement changes – adopting transformative pedagogy for content delivery and preparing future citizens for a multicultural society. Teachers' professional development plays a key role for enhancing students' motivation and improving their performance. This paper describes the impact of teachers' participation in PLC on students' interest and attitudes to science in Georgia. It uses a multi-method design approach. The findings reveal that involvement in teacher PLCs foster positive attitudes toward science and science classes and enhances students' interest. Furthermore, teachers from PLC report an innovative and collaborative training experience, which they translated into innovative teaching methods for their students.

Keywords: collaborative learning, students' motivation, professional development

INTRODUCTION

The significance of science education has remained a central concern in contemporary educational research, given its critical role in fostering scientific literacy, preparing students for STEM careers, and addressing global challenges such as sustainability and technological transformation (Chen et al., 2024; Dabran-Zivan & Baram-Tsabari, 2025; Morales-Aguilar et al., 2025; OECD, 2023; Rehman et al., 2025). Much of recent science education research has focused on understanding students' attitudes toward science learning and identifying factors – including gender, age, and classroom environment – that influence science interest and engagement (Lin et al., 2025; Ofek-Geva & Fortus, 2024; Potvin & Hasni, 2014; Wang et al., 2023).

Empirical evidence consistently demonstrates that positive attitudes toward science foster lifelong interest and engagement in science learning (González-Gómez et al., 2022; Malone & Lepper, 2021) while negative attitudes diminish students' motivation to pursue science (Ding et al., 2025). Consequently, cultivating positive attitudes toward science has remained a fundamental objective for science educators worldwide. Research indicates that high-quality teacher professional development plays a critical role in enhancing both students' interest in science and their academic performance (Lynch et al., 2025; van Beek et al., 2014), particularly when such development emphasizes inquiry-based learning and real-world applications of scientific concepts (Gomez, 2025; Vangrieken et al., 2015; Wilson et al., 2025).

Research shows that professional development programs that are collaborative, sustained, and focused on classroom practice lead to improvements in both teacher and student learning outcomes (Wilson et al., 2025). Critically, professional development that connects content knowledge to pedagogical approaches supporting teachers' instructional practice and student learning demonstrates greater effectiveness than professional development focused exclusively on content knowledge (Visscher et al., 2025). Moreover, effective professional development should incorporate practical experiences as powerful tools to establish connections to real, local, and global issues, while reflective spaces allow teachers to explore new

✉ marika_kapanadze@iliauni.edu.ge **(*Correspondence)** ✉ nino.javakhishvili.3@iliauni.edu.ge ✉ lia.dzagania.1@iliauni.edu.ge ✉ bagatrishvilinatia@gmail.com

Contribution to the literature

- The present study contributes one piece of evidence, suggesting that the investment in teacher collaborative learning may yield returns in student motivation and interest.
- Within the context of science education, where declining student engagement and negative attitudes towards science have been widely documented, this finding carries particular significance.
- Professional learning communities (PLCs) offer teachers a structured and sustained space for collaborative reflection, shared practice, and pedagogical development — all of which appear to have a meaningful downstream effect on how students experience and engage with science learning.

methodologies (Merino et al, 2025). This emphasis on equipping teachers with both disciplinary knowledge and evidence-based pedagogical strategies is essential for translating teacher learning into improved classroom practices that foster student interest and engagement in science.

Participation in teacher PLCs represents an increasingly recognized model of effective professional development (Christensen & Jerrim, 2025; Gunning et al., 2020; Mamlok-Naaman, 2018b). This approach prioritizes teachers' lived experiences and practical needs, emphasizing their capacity to contribute meaningfully to professional learning rather than relying exclusively on external experts (Clark et al., 2023; Mamlok-Naaman, 2018b; Vangrieken et al., 2017). PLCs operate on the principle that teachers' professional knowledge is deeply embedded in their daily practice (Christensen & Jerrim, 2025; Hudson, 2024). By engaging teachers in sustained reflective dialogue about their professional knowledge and instructional methods, PLCs enable the adaptation of teaching approaches to better support student learning (Hendrickx et al., 2025).

PLCs differ fundamentally from traditional professional development models. Rather than focusing on individual teacher learning through isolated workshops or top-down training approaches widely criticized for producing minimal change in classroom practice or student outcomes (Amemasor et al., 2025), PLCs prioritize collaborative learning within communities of educators, fostering cultures of collective growth and shared knowledge (Christensen & Jerrim, 2025; Clark et al., 2023; Hudson, 2024). These collaborative structures emphasize ongoing peer learning, collective problem-solving, and shared responsibility for student success (Tam, 2015).

Research demonstrates that PLCs significantly influence teaching practices by creating supportive environments that empower teachers to implement meaningful pedagogical changes. They provide teachers with sustained opportunities to reflect on practice, co-design lessons, explore innovative strategies, and collaboratively analyze student learning (Mamlok-Naaman, 2018a; Potvin et al., 2024). Specifically, PLCs help educators adopt transformative pedagogies, enhance their pedagogical content knowledge (PCK) and disciplinary content knowledge (DCK), and effectively address critical educational challenges (Doğan et al., 2016, Tan & Wei, 2025). Teachers participating in science-focused PLCs have reported numerous benefits, including enhanced access to teaching resources, increased collaboration with colleagues, greater confidence in teaching science, exposure to diverse pedagogical perspectives, and improved capacity to identify and address weaknesses in science programs (Gülhan, 2024; Jones et al., 2000).

Importantly, teacher PLCs have the potential to influence student motivation by enabling teachers to create more engaging and effective science learning environments (Christensen & Jerrim, 2025; Doğan et al., 2016). Through collaborative examination of student work (Dumandan & Paglinawan, 2025; Shim & Thompson, 2025), shared development of instructional materials, and collective refinement of teaching practices (Wilson et al., 2025). PLCs address one of the most persistent challenges in science education: sustaining student interest and engagement in science learning.

The development of PCK and DCK through PLC participation is particularly significant, as strengthening these knowledge domains facilitates the transition from traditional, teacher-centered instruction to inquiry-based, student-centered approaches (Doğan et al., 2016). Empirical studies have documented positive outcomes for both teachers and students resulting from PLC participation. Research by Meesuk et al. (2021) demonstrated that PLCs yielded measurable improvements in teachers' instructional practices and students' academic achievement. Similarly, Copur and Demirel (2022) established a positive relationship between teacher participation in PLCs and student achievement outcomes.

Despite growing evidence supporting the effectiveness of PLCs, most research has been conducted in certain educational contexts, with limited examination of how these collaborative structures function in diverse international settings. Furthermore, while studies have established connections between teacher professional development and improved student outcomes, the specific mechanisms through which PLC participation influences student interest in science remain underexplored.

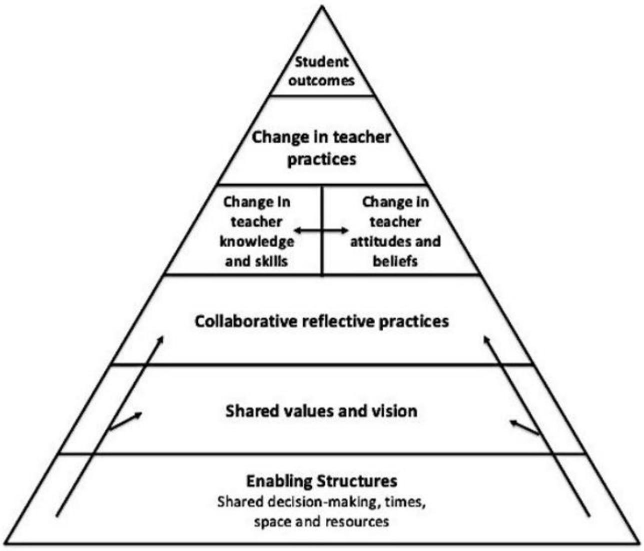

Figure 1. PLC conceptual framework (Hudson, 2024)

Theoretical Framework

The study adopts the theoretical framework proposed by Hudson (2024). This conceptual framework explicates how PLCs generate teacher learning through collaborative reflective practice, resulting in pedagogical transformation and enhanced student outcomes. At the foundational level, effective PLCs require enabling school structures, particularly supportive leadership. When such structures exist, they cultivate both relational trust among teaching colleagues and organic trust derived from collective agreement about the PLC's vision and purpose. Such trust creates an environment conducive to collaborative reflective practice, which strengthens teacher learning. This learning process generates changes in teachers' knowledge, skills, attitudes, and beliefs – elements that are interconnected and mutually reinforcing. These transformations subsequently manifest as changes in instructional practice. Teaching practice and student outcomes exist in an inextricable, mutually influential relationship. Student outcome data are systematically gathered and channeled back into the PLC's collaborative reflective processes, sustaining a commitment to continuous school improvement. Critically, however, student data should serve to enhance collaborative reflective dialogue among teachers rather than becoming an isolated or reified focal point within the PLC (**Figure 1**).

According to the conceptual framework, developed by Hudson (2024), PLC influences teachers in a way that they become more motivated to teach their students in general as well as through using a larger range of innovative and creative teaching approaches to motivate their students. As a result, students better comprehend the study material and improve their outcomes.

The present study aims to test this model – to see whether the changes of teacher practices are connected with the changes of students' interest and attitudes to science and science classes. When students experience situational or individual interest in science, they are more likely to engage in sustained effort, employ deeper learning strategies, and demonstrate higher academic achievement (Renninger & Hidi, 2015). Before proceeding with the study scope, context of Georgia (country) regarding teacher lifelong education opportunities is discussed.

Science teachers' professional development in Georgia

Science teachers in Georgia (south Caucasian country) have an opportunity to develop professionally via two options: one is the state offered trainings via the Teachers Professional Development Center (TPDC) which serves as the official body responsible for in-service teacher training throughout the country and operates under the umbrella of the Ministry of Education of Georgia. The other is the Science Education Research Center SALiS at Ilia State University, Tbilisi (the capital) of Georgia. Thus, some in service science teachers undergo trainings offered by both institutions, while others – only one, offered by the TPDC.

SALiS center was established at the same time as the new teacher professional development programs were initiated. SALiS center supports the development of science education in Georgia through the implementation and advancement of modern teaching methods, conduct of research in this field, and fostering of collaboration at national and international levels.

Activities of science teachers PLC is one of SALiS Center's main efforts. There are more than 400 pre-service and in-service science teachers in SALiS center – educators from both private and public schools across rural and urban regions of Georgia.

Throughout the year, the SALiS Center offers a variety of educational activities for teachers, including workshops, seminars, conferences, and public lectures. These initiatives differ in format and leadership: some are conducted by teachers themselves, while others are led by academic staff or invited researchers from different countries. Participation is completely free, and teachers register based on their interests. All SALiS Center activities aim to disseminate modern practices in science education among Georgian teachers, with many sessions delivered by scientists and educators from various international institutions.

Study Aims and Research Questions

This research is aimed at demonstrating the role of PLC in empowering teachers, who, in turn, become effective in motivating their students. Specifically, it examines the role of SALiS (Science Education Research Center) – collaborative PLC of science teachers in Georgia in equipping teachers with new teaching and learning approaches, who, in turn, manage to increase students' interest in multiple science topics and science

Table 1. Qualitative study sample for PLC teachers

	Number of teachers	Teaching experience (years)	PLC membership (years)	Number of urban schools	Number of rural schools
PLC teachers	9	15-40	12-14	6	3

Table 2. Quantitative study samples

	Number of students	Urban schools	Rural schools	Girls	Boys	Age – 14 years	Age – 15 years
PLC students	1,541	66.7%	33.3 %	54.5%	45.5%	59.9%	40.1%
Students from general sample	2,310	91.9%	8.1%	53.5%	46.5%	46.8%	53.2%

classes, as well as their positive attitudes to science classes, science and technology in general.

At first, we will investigate teachers' experiences with PLC, including their views on how these experiences translate into teachers' motivation and teaching approaches and the second, we will check whether teachers, in turn, succeed in motivating their students. With this aim we will study students' interests in number of concrete science issues, their attitude to science classes and their attitude to science and technology in general. Specifically, we will compare students taught by PLC teachers with students who are taught by teachers without PLC experience.

Additionally, the broader context of TPDC's in-service science teacher professional development programs was explored to complement the study's findings.

Respectively, the research questions for this study are as follows:

(1) *What experiences did teachers have in PLC? How do these experiences widen their teaching practices?*

(2) *Are PLC teacher students' interest in science, positive attitude toward science and technology in general and their science classes in particular higher than those of general sample students?*

METHOD

Based on the type/nature of research questions, a multi-method design employing both quantitative and qualitative data analysis was used in this study. Specifically, the first question about teacher's PLC experiences was addressed via qualitative interviews, while the second question about the outcomes of their students was addressed via quantitate study, specifically, measuring their

(a) interests in science,

(b) attitudes to science classes, including interest to their classes, and

(c) attitude to science and technology in general.

Qualitative data were gathered via focus group with science teachers from the SALiS PLC and with three national science education experts from TPDC.

Invitations to participate in this study were sent to SALiS teachers whose students had taken part in the relevance of science education – second (ROSES) study. This focus group aimed to explore – what experiences teachers have in PLC, how teachers apply SALiS PLC knowledge and evaluate the SALiS role in supporting teachers' professional development. Nine teachers confirmed their willingness to participate. Their teaching experience ranged from 15 to 40 years, while their affiliation with the SALiS spanned between 12 and 14 years. The participants represented a diverse range of schools, including both rural and urban areas, as well as the state and private institutions.

Description of the qualitative study samples is given in **Table 1**.

Qualitative data were analyzed using NVivo 15. Transcripts were coded inductively following Braun and Clarke's (2025) thematic analysis approach.

For the quantitative part, we employed an ex-facto causal-comparative design to be able to demonstrate the role of teachers in fostering interest and positive attitudes to science, introducing science teachers as an independent variable with two levels: general teachers and PLC/SALiS teachers. In the control condition, data from students, who are instructed by science teachers, not involved in any PLC, is collected, while in the experimental condition, data from PLC science teachers' classes are collected. Number of measures were taken to address threat to internal validity, specifically, the students filled out exactly the same surveys in their classroom settings during the same time-frame. Also, assumption was made that other possible confounding variables such as parent education, family socio-economic level, and informal education opportunities are evenly distributed. The composition of the samples can be considered equal considering their gender, while their age and school locations differ (see **Table 2**). To address this difference, we employed these two variables as covariates in our analysis. Description of the quantitative study samples is given in **Table 2**.

The questionnaire from the international research project ROSES was used for the study, because it enables to measure concrete interests of school students in different science issues, as well as their attitudes to science classes and science and technology. ROSES is the

Table 3. Internal consistency indicators of the dependent variables

Scales	PLC students	Students from the general sample
1. Interested in environment and sustainable development	.899	.902
2. Interested in space and physical phenomena	.897	.893
3. Interested in plants, animals, nature	.882	.883
4. Interested in unexplained phenomena	.783	.829
5. Interested in science inventions and discoveries	.872	.877
6. Interested in issues related to sex and reproduction	.804	.777
7. Interested in eating disorders and skin care issues	.798	.776
8. Interested in factors affecting health and healthcare	.811	.764
Overall interest score	.964	.968
Having a positive attitude to science classes	.893	.882
Having a positive attitude to science and technology	.893	.884

second phase of the relevance of science education (ROSE) which was initially conducted from 2004 to 2012 and resulted in development of the questionnaire. ROSES updated questionnaire from ROSE project and now it is used in more than 50 countries. The ROSES questionnaire provides insights into students' interests in learning Science and Technology topics across various contexts at the end of compulsory education. It also examines students' perspectives on science and scientists in society, science education in schools, and overall attitudes to sciences and technology among others.

The ROSES questionnaire is a 4-point Likert-type questionnaire, consisting of 12 sections (A to L) containing 174 items and two open-ended questions. The ROSES questionnaire was translated into the Georgian language, piloted and adapted for the cultural and educational context of Georgian students (Kapanadze et al., 2023). Data collection was done electronically by a Google form, which was prepared and sent to all participant schools.

The preparatory phase for the data analysis was to conduct exploratory factor analysis (EFA) to check whether the items in each of the initial ROSES' sections yield on a scale. For the purposes of the current study, we examined scales of interest, attitude to science classes and attitudes to science and technology. An EFA resulted in 8 different interest scales (see the scales in **Table 3**), with high internal consistency indicators. At the same time, Cronbach's alpha for all 78 items was high and that enabled us to also calculate the overall interest score. Positive attitude to science classes' scale consists of 12 items with high alpha coefficient, and positive attitude to science and technology scale contains 13 items with high internal consistency. The coefficients are presented in **Table 3**.

SPSS was used for quantitative data analysis. EFA, mean scores, standard deviations and MANCOVA were calculated.

RESULTS

Qualitative Data Analysis

Qualitative analysis of the focus group of SALiS teachers' data revealed three thematic categories regarding teachers' perceptions about their participation in SALiS PLC:

- Collaboration and positive environment
- Learning and knowledge sharing
- Strong sense of community

Collaboration and positive environment

The qualitative data revealed a culture of intensive collaboration within the SALiS, characterized by peer-led training sessions, shared problem-solving, and collective resource development. Teachers described conducting workshops for colleagues and collectively developing teaching materials. Teachers reported:

> I deeply appreciate the collaboration within our PLC. Our meetings at SALiS serve as vital spaces for professional growth and collective problem-solving. During these gatherings, we engage in multiple forms of meaningful collaboration: we exchange experiences and insights from our everyday teaching practices, sharing what works well in our classrooms and learning from one another's successes and challenges; we support each other by introducing new knowledge, research findings, and innovative pedagogical approaches that can enhance our teaching effectiveness.
>
> During our meetings at SALiS we engage in critical discussions about the persistent challenges and emerging issues facing science education in our country, from curriculum constraints to student motivation; and most importantly, we work together to develop practical, context-appropriate solutions to overcome these obstacles. This collaborative inquiry enriches our individual

> practice and our shared commitment to advancing science education.

> There's a real culture of collaboration here – everyone is willing to help and share their expertise.

SALiS teachers stressed the importance of positive collaborative environment of the PLC for the collaboration. Teachers shared examples of meetings in which one of them conducted a training session, while the others participated in discussion and developed new ideas for their teaching practice together. In their responses teachers mentioned the role of feedback for their professional development.

> SALiS creates a supportive atmosphere where we feel comfortable sharing our ideas and challenges without judgment. We can experiment with new approaches and learn from both successes and failures. Everyone's voice is valued, whether you're a new teacher or have decades of experience.

> SALiS has created an inspiring environment where theory meets practice. We're not just talking about teaching approaches — we're actually implementing it in our classrooms. The continuous feedback and support from my PLC colleagues have made me a much better teacher.

Learning and knowledge sharing

Teachers learned the new methods of teaching through the variety of meetings within the frames of the SALiS activities and used the gained experience and knowledge in their everyday practice.

> Through SALiS I've developed skills I never would have gained on my own – from designing inquiry lessons to analyzing student misconceptions.

Teachers discussed the importance of the SALiS workshops and conferences for their learning from the beginning, when teachers were not yet familiar with modern teaching and learning methods such as inquiry-based science education (IBSE) or project-based learning (PBL). For many of them, it was their first such experience:

> My first student-centered workshop was at SALiS in 2012, focused on the use of low-cost technology in science lessons. It was a turning point in my pedagogical practice. I work in a rural school without a science laboratory, and this approach demonstrated to all of us how we can engage students without special or expensive equipment.

In their responses teachers mentioned the role of discussion for learning and knowledge sharing after each session they had at SALiS Center. One of the teachers mentioned:

> We often discuss the issue of student motivation and exchange best practices in this regard. Sharing our own examples is very important to us. We learn a lot from each other.

Teachers deliberated the value of EU funded projects, they were participating or later sharing experience of the results. They learned what Inquiry-based learning means, or how to plan projects in the classroom, or implement the low-cost technology approach. And also, the role of these practices is for the students' engagement and interest in science.

> First inquiry-based teaching in my practice was from "PROFILES" project. Students stayed at school till late evening conducting different experiments.

Strong sense of community

A striking theme emerging from the qualitative analysis was the emotional dimension of PLC participation. Teachers repeatedly emphasized feelings of support, belonging, and shared professional identity. This sense of community appeared essential for encouraging teachers' experimentation with new approaches and persistence through implementation challenges.

SALiS PLC teachers always support each other, if necessary:

> If we have any news, we share it with each other and then advice, criticism is also acceptable, because we are colleagues. The main thing is the feeling of support, that friends and colleagues always support me, that you have someone who shares your thoughts. The sense of community means we celebrate each other's successes and learn from each other's setbacks.

> Being a member of the SALiS PLC provides me with valuable professional knowledge. I am part of the big community, which gives me confidence in managing classroom processes and supporting student learning.

> In SALiS everyone's growth contributes to the whole. When one person learns something new, we all benefit.

> We are members of the SALiS community, and when we meet there, we trust each other.

Drawing on our empirical findings, we present the following SALiS professional development model:

- Collaboration and positive environment – collaboration in science teacher PLCs refers to the sustained, purposeful interactions among teachers who work together toward shared goals of improving science instruction and student learning. Teachers supporting each other through shared challenges. Positive environment allows teachers to openly discuss instructional challenges, admit uncertainties in their science content knowledge, and experiment with new approaches without fear of criticism. Regular discussion and constructive criticism are integral components;
- Learning and knowledge sharing – this includes deepening understanding of science content (DCK), developing PCK specific to teaching science topics and learning inquiry-based instructional strategies. Knowledge sharing occurs through multiple channels: presenting successful lessons or approaches to colleagues, sharing resources and materials, and collectively interpreting student learning data. Members conduct training sessions for colleagues, fostering active participation, international experiences (e.g., guests from different countries and festival participation) disseminated through the network;
- Strong sense of community – a strong sense of community in SALiS reflects teachers' perception of belonging to a collective professional identity that extends beyond individual classroom practice. This encompasses shared values and vision regarding science education, collective commitment to improving science learning for all students, and deep interpersonal connections among members.

PLC teachers described their participation in SALiS activities not as episodic training but as ongoing professional engagement. They regularly attended workshops and conferences and participated in international projects. This continuous learning is very different from the training sessions, offered by the Ministry of Education (TPDC), which is compulsory for all the teachers at Georgian state schools. Moreover, network participation appeared to shape teachers' professional identities. Teachers described themselves as members of a learning community, positioned as both learners and knowledge contributors. As a result, they are more focused on student-centered learning and equipped with variety of up-to-date teaching practices.

To interpret the findings of this study, it is essential to examine official educational policy frameworks and the current state of in-service science teacher education programs in Georgia. Knowing the context of in-service teachers' lifelong education is needed to understand the role of SALiS in equipping teachers with advanced teaching strategies.

To validate the study's findings, three science education experts from TPDC were invited to participate in semi-structured interviews. Participants discussed that the TPDC transitioned exclusively to online training formats, eliminating hands-on experimental teaching components. Training programs varied in duration and intensity, with some consisting of brief interventions while others comprised multiple cycles of 2-hour sessions conducted over 3-4 iterations. At the time of data collection, laboratory-based science teaching modules were under development and not offered to teachers yet.

The experts emphasized the critical importance and need for encouraging active learning such as hands-on activities, also systematic feedback mechanisms and extended training frameworks, as articulated by one participant:

> There must be feedback. We don't have information on how teachers apply the knowledge in school, what they've learned. There needs to be evaluation, monitoring. Ongoing collegial supervision is essential.

Experts mentioned that future planning includes the implementation of post-training follow-up sessions designed to assess knowledge transfer and practical application in classroom settings, incorporating structured monitoring protocols.

Quantitative Data Analysis

Hypotheses testing

The following hypotheses were formulated for the research question 2 of the study:

Hypothesis 2a: interest scores, including overall interest score of PLC students will be higher than those of general sample students;

Hypothesis 2b: positive attitude to science classes scores, including interest to their classes score of PLC students will be higher than those of general sample students;

Hypothesis 2c: positive attitude to science and technology scores of PLC students will be higher than those of general sample students;

A MANCOVA was conducted to examine differences between general and PLC samples on all dependent variables, while controlling the school location and age. There was a significant multivariate effect of an independent variable: Pillai's trace = .042, $F(12, 3767) = 13.879$, $p < .001$, $\eta_p^2 = .042$.

The overall interest as well as eight interest scale scores are higher for the students who are taught by PLC teachers – the differences are statistically significant.

Table 4. MANCOVA results

Scales	PLC students		Students from the general sample		F	p	η_p^2
	M	SD	M	SD			
1. Interested in environment and sustainable development	2.8	.713	2.71	.699	23.427	.000	.006
2. Interested in space and physical phenomena	2.95	.585	2.78	.616	65.500	.000	.017
3. Interested in plants, animals, nature	3.05	.608	2.88	.629	79.146	.000	.021
4. Interested in unexplained phenomena	3.27	.672	3.03	.669	53.317	.000	.014
5. Interested in science inventions and discoveries	3.14	.630	2.95	.681	69.206	.000	.018
6. Interested in issues related to sex and reproduction	2.88	.730	2.73	.715	42.838	.000	.011
7. Interested in eating disorders and skin care issues	2.58	.898	2.52	.876	3.905	.048	.001
8. Interested in factors affecting health and healthcare	3.23	.672	3.09	.666	45.026	.000	.012
Overall interest score	2.99	.522	2.83	.539	76.668	.000	.020
Having a positive attitude to science classes	2.92	.756	2.68	.696	74.832	.000	.019
School science is interesting	3.25	.880	2.97	.971	82.511	.000	.021
Having a positive attitude to science and technology	2.86	.563	2.71	.610	45.716	.000	.012

Students taught by PLC teachers have higher scores on positive attitudes, including interest to science classes, than students from the general sample.

Students taught by PLC teachers have higher scores on positive attitudes to science and technology, than students from the general sample (see **Table 4**).

Thus, all three hypotheses were confirmed with relatively small effect sizes.

DISCUSSION

The present study investigates the relationship between science teachers' participation in the SALiS PLC and students' interest in and attitudes toward science in the Georgian educational context. The study results align well with the conceptual framework of Hudson (2024), confirming the hypothesized relationships between PLC professional development and student outcomes.

The organizational structure of SALiS enabled collaborative professional learning. This base layer of Hudson (2024) framework acknowledges that good intentions and professional commitment alone are insufficient – teachers require tangible enabling conditions to engage in meaningful collaborative work.

Shared values and vision in PLCs encompass fundamental beliefs about teaching, learning, and professional responsibility, collective aspirations for what science education should be and what students should experience and achieve. When SALiS teachers regularly share strategies for engaging students, analyze what works and why, and troubleshoot implementation challenges together, they develop shared effective practices. The cumulative effect of such collaboration may manifest in consistently more engaging science instruction, which students experience as increased interest. Our findings regarding collaboration within the SALiS PLC resonates with research on PLCs demonstrating that collective problem-solving and collaborative practice enhance teaching quality (Ronfeldt et al., 2015; Wilson et al., 2025).

Our finding about the emotional dimension of PLC participation aligns with research on collective efficacy – the shared belief that together, educators can overcome challenges and improve student learning (Tan et al., 2025). When teachers feel supported by a community of colleagues, they develop confidence to try ambitious instructional approaches, tolerate initial implementation difficulties, and maintain high expectations for student learning. This enhanced teacher confidence and persistence may translate into more enthusiastic, engaging instruction – changes in teacher practices that students experience as increased interest in science.

SALiS teachers consistently stressed the importance of innovative pedagogical approaches, particularly, IBSE, PBL, and low-cost technology methods, which they learned and became experienced during SALiS professional development meetings. The emphasis on inquiry-based approaches is particularly relevant to student interest outcomes. Research confirms that scientific inquiry – as opposed to cookbook-style hands-on activities – effectively enhances student engagement and motivation (Potvin & Hasni, 2014; Teplá & Distler, 2025).

Our findings reveal statistically significant differences across multiple dimensions of science interest, with students taught by SALiS PLC teachers demonstrating consistently higher interest scores for all eight measured dimensions of science interest compared to students in the general sample.

Particularly noteworthy are the domains showing the most pronounced differences. Students of PLC teachers demonstrated substantially higher interest in "science inventions and discoveries", "plants, animals, and nature", and "space and physical phenomena". These patterns align with the pedagogical emphases reported by SALiS teachers in the qualitative data, particularly their focus on IBSE, real-world applications, and hands-on learning experiences using low-cost technology approaches. This convergence between teacher practices and student interest domains supports the theoretical proposition that pedagogical approaches emphasizing authentic scientific inquiry and real-world relevance enhance student engagement (Gomez, 2025; Potvin & Hasni, 2014; Wilson et al., 2025).

Beyond general science interest, students of SALiS teachers also demonstrated significantly more positive attitudes toward science classes and higher interest in school science specifically. These findings are particularly significant because they reflect students' responses to their actual classroom experiences rather than abstract interest in science topics. This suggests that PLC participation may influence not only what teachers teach but how they teach, creating more engaging classroom environments.

Based on our results, we can conclude that SALiS PLC participation positively influences teachers' pedagogical innovation. Teachers demonstrate increased commitment to teaching alongside broader implementation of creative and innovative strategies, resulting in measurable improvements in students' outcomes. Research in science education shows that students' interest and attitudes toward science are significant contributors to academic outcomes, including engagement, achievement, and long-term STEM participation (Ranellucci & Rosenberg, 2024).

While the present study offers valuable insights into the relationship between PLC participation and student motivation, some challenges emerged, which relate to curriculum limitations and warrant further discussion. Teachers frequently cite time constraints, which are defined and structured by the curriculum, as a significant barrier to fully implementing PLC-based practices. Because the curriculum prescribes both the content to be covered and the time available for delivering it, the structured and often rigid nature of curricular requirements often left teachers with little flexibility to integrate PLC-derived instructional strategies into their teaching.

Taken together, these findings suggest that the positive outcomes observed in this study may be closely tied to the specific conditions under which this PLC operated and may not be readily replicable in contexts with different curricular structures. Future research should therefore extend this line of inquiry to other PLCs operating in diverse educational settings, examining in particular how curricular design shapes the conditions under which PLCs can be effectively implemented.

Limitations of the Study

The research team included both researchers affiliated with the SALiS Center and independent researchers from other institutions. While this combination provided both insider knowledge and external perspective, the involvement of researchers with vested interest in demonstrating PLC effectiveness introduces potential bias. To mitigate this concern, analysis protocols were established in advance, independent researchers participated in all data analysis decisions, and disagreements were resolved through discussion and reference to data. Nevertheless, complete elimination of potential researcher bias cannot be guaranteed, and findings should be interpreted accordingly.

CONCLUSIONS

This study provides evidence that science teachers' participation in PLCs is associated with enhanced student interest and positive attitudes toward science. Students taught by SALiS PLC member teachers demonstrated consistently higher interest across multiple science domains, more positive attitudes toward science classes, and greater interest in school science compared to students in a representative general sample. Qualitative analysis revealed potential mechanisms including enhanced collaborative problem-solving, pedagogical knowledge, emotional support, and sustained professional engagement that may link PLC participation to these student outcomes.

The present study contributes one piece of evidence, suggesting that the investment in teacher collaborative learning may yield returns in student motivation and interest. While definitive conclusions require stronger evidence, the consistency of findings across quantitative and qualitative data provides reasonable grounds for continued attention to and investment in PLCs as one of the effective and efficient approaches to improving science education. Future research with stronger designs and longer time horizons will be essential to move from suggestive associations to confident understanding of how, why, when, and for whom teacher PLCs contribute to the ultimate goal: engaging, inspiring, and educating the next generation of scientifically literate citizens.

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