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STUDENTS' LEARNING APPROACHES AND TEACHING QUALITY IN CHEMISTRY TEACHER TRAINING PROGRAM: A COMPARATIVE PERSPECTIVE OF STUDENTS AND TEACHERS

Abstract. This study comprehensively analyzed the learning approaches of future chemistry teachers and the quality of chemistry teaching, and identified their relationship. The data for the study were collected through an online survey. 179 students from 8 higher education institutions and 29 teachers from 6 higher education institutions in Kazakhstan participated in the research. The data were collected on the basis of a Likert scale and processed using t-test for independent samples, correlation and multiple regression analysis. The results showed that strategic and deep learning approaches are relatively dominant among students, while the surface learning approach is weakly observed. It was also found that teachers rate the quality of lectures and laboratory classes higher than students, which is due to the fact that teachers prioritize the scientific validity and structure of the content, and students pay more attention to learning activity, the ability to participate in classes and the availability of feedback. Correlation and regression analyses showed that the quality of lectures, seminars and especially laboratory classes is positively related to students' deep and strategic learning approaches. The quality of laboratory classes was the strongest predictor of the deep learning approach. The results of the study indicate the need to strengthen the content connection between lectures, seminars, and laboratory classes, and to systematically introduce interactive teaching methods and feedback in the chemistry teacher training program.

Keywords: chemistry teacher training, student learning approaches, quality of education, correlation-regression analysis.

Introduction

The relationship between learning outcomes and effective teaching has been widely studied in higher education. Parpala and Lindblom-Ylänne (2007) and Zakaria et al. (2025) show that learning outcomes depend on both teachers' teaching approaches and students' learning approaches. Trigwell et al. (1999) also found that there is a strong relationship between teaching approaches and students' learning approaches. In particular, while in traditional teacher-centered teaching, students tend to use surface learning approaches, student-centered teaching promotes the development of deep learning approaches.

The ways in which students learn are called learning strategies or learning approaches. Biggs (1978) proposed the presage–process–product (3P) model, suggesting that students' learning approaches are shaped by the interplay between their previous learning experiences, their learning environment, and their learning outcomes. Subsequent research has shown that how students perceive their learning environment influences their learning approaches (Keenan, 2025; Trigwell et al., 1999).

Entwistle et al. (1997) proposed the ASSIST (Approaches and Study Skills Inventory for Students) tool for identifying students' learning approaches, dividing learning approaches into three main categories: deep, surface, and strategic:

The surface learning approach is often based on mechanical memorization of material, and is characterized by a lack of attention to the connections between topics (Duff, 2004).

The strategic learning approach is focused on achieving high results and includes features such as effective time management, systematic organization of learning activities, and adaptation to assessment requirements (Duff, 2007).

The deep learning approach is characterized by students' efforts to understand the meaning of the learning material, connect new knowledge with previous knowledge, and critically analyze it (Duff, 2004).

Studies in the natural sciences have found that students who use deep learning approaches are more likely to develop scientific explanations, ask questions about cause-and-effect relationships, and engage in metacognitive thinking, while students who use surface learning approaches are more likely to describe facts

and perform procedural actions (Chin & Brown, 2000).

In science subjects, especially chemistry, students' learning approaches are often shaped by laboratory work, experimental tasks, and problem-solving. Such learning environments allow students to develop scientific explanations and analyze cause-and-effect relationships rather than simply memorizing information (Chin & Brown, 2000; Hofstein & Lunetta, 2004). Thus, laboratory classes help students to critically examine the material and create a conducive environment for the development of deep learning approaches. However, despite the potential of laboratory learning environments, research shows that chemistry students often use both deep and surface learning approaches, demonstrating their difficulty consistently engaging in deep learning (Keenan, 2025). These difficulties are primarily due to students' insufficient systematic acquisition of learning strategies, their reliance on personal perceptions rather than effectiveness, and a lack of skills in effectively using deep learning approaches. Furthermore, students' tendency to choose simpler and less demanding approaches leads them to use surface or strategic learning approaches even when deep understanding is required.

Students' learning approaches do not automatically change during their studies. Their formation and change largely depend on teaching methods, assessment systems, characteristics of the learning environment, and students' learning load. Therefore, if the learning process is not focused on students' deep understanding, analysis, and connection of knowledge, students may continue to use surface learning approaches (Asikainen & Gijbels, 2017). It has also been found that students who use deep learning strategies often achieve high academic results, while relying on surface learning approaches is often associated with low academic achievement. However, students with average academic performance may use both deep and surface learning approaches (Gabut et al., 2026). Therefore, students learn in different ways (Clark & Mayer, 2003).

Students' learning approaches are not static and can vary depending on the learning environment, teaching methods used, and assessment requirements (Struyven et al., 2005). For example, student-centered interactive teaching methods promote the development of deep learning approaches by increasing students' active participation and developing critical thinking and analysis (Trigwell et al., 1999; Shukla, 2024). However, some studies suggest that problem-based learning promotes the development of deep learning approaches in students, but has little effect on surface learning approaches (Dolmans et al., 2016).

The study of teaching quality, which influences the formation of students' learning approaches, was comprehensively considered in the 20th and 21st centuries. In the 1900s, students were given tests in the subjects they studied and the results showed the quality of education, in the 1930s, the teaching method and the quality of education were linked, in the 1950s-60s, the influence of the teacher on the quality of education was studied, and in the 1980s-90s, the influence of teachers, students and their interactions on the quality of education was studied. However, modern studies focus on factors such as student perception of learning and teacher teaching (Al Kharusi, 2023; Blömeke, 2022; Money, 1992). Students are important stakeholders in the process of evaluating the quality of education, because "who eats the food, their opinion must be taken into account in order to know the taste" (Seldin, 1993). Marsh (1984) concluded that students' evaluation of teaching quality is characterized as follows: (1) multifaceted; (2) reliable and stable; (3) aimed at assessing the performance of the teacher; (4) relatively valid for various indicators of effective teaching; (5) relatively unaffected by variables that are often considered biases; and (6) useful as feedback on teaching for teachers, in course selection for students, and in personnel decisions for administrators.

In assessing the effectiveness of student learning, Stringer and Irwing (1998) used questionnaires to assess the quality of teaching, feedback, workload, course integration, learning motivation, and overall assessment. Wilson et al. (1997) used questionnaires to assess teaching: good teaching, clear goals, workload, assessment, independence, and general skills. The studies of Stringer and Irwing (1998) and Wilson et al. (1997) mainly rely on questionnaires to assess the quality of teaching in social studies and do not take into account laboratory work specific to natural sciences. Laboratory classes are an important component in teaching natural sciences (Agustian, 2024). Studies have shown that the effectiveness of laboratory teaching should be assessed by indicators such as the connection between theory and practice, the development of experimental skills, data analysis, scientific thinking, and the formation of investigative actions (Hofstein & Lunetta, 2004; Abrahams & Millar, 2008). Ogunkola and Archer-Bradshaw (2013) provide a questionnaire for science teachers to assess their teaching practices. The questions in this paper

focus on the teacher's student assessment process.

As chemistry teaching is characterized by laboratory work, research on evaluating teaching quality among students in chemistry teacher training program, as well as the development of questionnaire instruments for this purpose, remains limited. Only the study by Dalgety et al., (2013) investigated students' attitudes towards chemistry, students' knowledge of chemistry, and thoughts about teaching chemistry using a questionnaire. However, the questionnaire questions were mainly aimed at assessing the teacher's influence on the student, his ability to increase interest in knowledge, and build confidence in learning. That is, the questionnaire questions were not intended to assess the actual quality of teaching, the effectiveness of teaching materials, or the level of lesson content.

The Approaches to Studying Inventory (ASI) questionnaire proposed by Entwistle and Ramsden (1983) has been widely used in the study of students' learning approaches. Later, the ASSIST questionnaire was proposed as an improved version of this tool (Entwistle et al., 1997). Another popular tool for determining students' learning approaches is the Study Process Questionnaire (SPQ) proposed by Biggs (1987). Later, this questionnaire was improved and the Revised Study Process Questionnaire (R-SPQ-2F) was proposed to measure students' deep and surface learning approaches (Biggs et al., 2001).

Thus, the results of the literature review indicate that the relationship between students' learning approaches and teaching quality in higher education has been widely studied. However, given the specifics of chemistry teaching, the issue of parallel assessment of the quality of education based on the opinions of students and teachers in lectures, seminars and laboratory classes has not been sufficiently addressed. In addition, the learning approaches of students in chemistry teacher training programs have not been studied in the context of Kazakhstan.

Research questions:

1. What learning approaches do students in the chemistry teacher training program use most?
2. Are there differences between students' and teachers' perceptions of teaching quality?
3. How do students' learning approaches relate to different teaching formats?

Methodology

Based on the methodology proposed in Miskeljin and Arsenijevic (2014), a parallel study was chosen to conduct on the same topics from the perspective of teachers and students. A Likert scale (1–5) was used to collect data (1 – strongly disagree, 5 – strongly agree). The survey consisted of two main parts. The first part was aimed at identifying students' learning approaches and was based on the concept of the ASSIST (Entwistle et al., 1997). The internal reliability of the survey was Cronbach's alpha coefficient ($\alpha = 0.84$). In this part, students' surface, deep and strategic learning approaches were assessed. In the second part, participants were asked about the quality of chemistry teaching: lectures, seminars and laboratory classes.

Questions related to lectures covered aspects such as the content of teaching materials, clarity of information, use of digital technologies and visuals, teacher interaction with students, providing feedback, and increasing student interest in the subject.

The questions for the seminar sessions were aimed at assessing indicators such as the seminar's connection to the lecture content, the use of interactive teaching methods, active student participation, opportunities for discussion and group work, deepening theoretical knowledge, and the development of students' critical and creative thinking skills.

Questions for laboratory classes covered aspects such as the relationship between theory and practice, organization of experimental work, teacher guidance and feedback, compliance with safety requirements, analysis of experimental results, and increasing students' interest in chemistry.

To verify the content validity of the questionnaire, three experts (specialists in the field of chemistry education) evaluated the content of the questions and checked their subject-specific relevance. In addition, formal approval was obtained from the university ethics committee before conducting the study. The internal consistency of the questionnaire was determined by Cronbach's alpha coefficient, which showed a high level of reliability ($\alpha = 0.96$).

The survey was distributed online via the Google Forms platform. In the survey for students, they assessed their own learning approaches and also expressed their opinions on the quality of lectures, seminars, and laboratory classes conducted by teachers.

In the questionnaire for teachers, they assessed students' learning approaches and also assessed the quality of lessons in relation to the teaching format they conduct. Since not all teachers may conduct lectures, seminars, and laboratory classes in the same way, three separate questionnaire links were prepared for teachers: assessment of students' learning approaches + assessment of the quality of lectures; assessment of students' learning approaches + assessment of the quality of seminars; assessment of students' learning approaches + assessment of the quality of laboratory classes. Each teacher received a questionnaire link corresponding to the teaching format which they conduct. Thus, the study provided the opportunity to assess learning approaches and lesson quality in parallel based on the opinions of students and teachers.

Descriptive statistics (mean, standard deviation) were calculated during the analysis of the collected data. Independent samples t-test was used to compare the ratings of students and teachers. Correlation analysis was used to identify relationships between variables, and multiple regression analysis was used to identify factors affecting learning approaches. All statistical analyses were performed using Jamovi version 2.6.44.

Participants. A total of 179 1st-4th year students of the specialty "Chemistry Teacher Training" from 8 higher educational institutions of the Republic of Kazakhstan participated in the study, with a 100% response rate. In addition, teachers conducting lectures, seminars and laboratory classes of the specialty "Chemistry Teacher Training" from 6 higher educational institutions of the Republic of Kazakhstan were also involved in the study. A total of 29 teachers (14 lecturers, 12 teachers conducting laboratory classes and 3 teachers conducting seminars) participated in the survey, providing their answers with a 100% response rate.

The wide range of study participants ensured comparability of the results across higher education institutions and allowed for a comprehensive analysis of the quality of chemistry teacher training.

Results and discussion

Comparative Evaluation of Students' Learning Approaches by Students and Teachers

Using survey data collected from students and teachers, a comparative analysis of the learning approaches of students in the chemistry teacher training program was conducted. The analysis focused on three types of learning approaches: surface, strategic, and deep (Tables 1–3). The means of the two groups were compared, and the statistical significance of differences was determined using a t-test for independent samples.

Table 1.

Surface Learning Approach

Variable	Group	Total number of responses	Mean	SD	T (t-test)	df	p
Surface learning approach	Students	179	2.69	0.71	1.42	206	.156
	Teachers	29	2.47	0.41			

Table 1 presents the comparative results of students' and teachers' assessments of students' use of the surface learning approach. Although there was a difference in the mean values of the surface learning approach between students ($M = 2.69$, $SD = 0.71$) and teachers ($M = 2.47$, $SD = 0.41$), the result of the t-test for independent samples showed that this difference was not statistically significant ($t(206) = 1.42$, $p = .156$). The results indicate that students use the surface learning approach in some situations, but this approach is not the dominant one in their learning activity.

A number of factors may influence the use of the surface learning approach. For example, the large volume of learning materials (students – 3.25, teachers – 3.14) and a lack of complete understanding of the connections between topics (students – 3.07, teachers – 3.07).

In addition, some students noted a lack of useful and interesting information in lessons (students – 2.19, teachers – 1.72) and indicated that they had difficulty determining what information to remember (students – 2.50, teachers – 2.31).

Entwistle et al. (1997) wrote that the characteristics of the learning environment and excessive learning load can affect students' choice of surface learning approach, and our study results also support this view. According to Biggs (1982) theory, if learning tasks are focused more on memorization than on understanding, students are more likely to memorize mechanically. However, the relatively low indicators indicate that the majority of students do not just memorize the learning material, but also try to understand and master it in a meaningful way. However, an important issue here is that the surface learning approach has not been completely eliminated. This situation indicates the need to structure the learning content, clarify important concepts, strengthen the logical connection between topics, and systematically introduce elements of reflection. Asikainen and Gijbels (2017) argued that learning approaches do not change by themselves, and that a purposefully organized learning environment is needed to develop them. Therefore, the persistence of the surface learning approach, even if weak, indicates that some structural or methodological factors in the learning process still need to be improved.

Table 2.
Strategic Learning Approach

Variable	Group	Total number of responses	Mean	SD	T (t-test)	df	p
Strategic learning approach	Students	179	3.75	0.61	1.15	206	.251
	Teachers	29	3.60	0.75			

According to the survey results, students' use of strategic learning approaches in learning chemistry was rated relatively highly by both groups (students – 3.75, teachers – 3.60). The results of the t-test for independent samples showed that there was no statistically significant difference between the assessments of students and teachers ($t(206) = 1.15$, $p = .251$).

Individual indicators showed that not all components of the strategic learning approach were developed to the same level in students. Although students rated themselves as being able to manage their time effectively (students – 3.80), teachers' ratings were relatively low (3.45). This difference reflects the gap between students' self-assessment and external monitoring. Nicol and Macfarlane-Dick (2006) showed that students' self-assessment does not always fully correspond to actual learning activity, and that systematic feedback and reflection are necessary for students to develop self-regulation skills.

It was observed that the steady work throughout the semester (students – 3.46; teachers – 3.34) and systematic preparation for the exam (students – 3.96; teachers – 3.62) were not always maintained consistently. In addition, the relatively high assessment of teachers on the indicators of completing the task when necessary (students – 3.90; teachers – 3.69) and motivation (teachers – 3.79; students – 3.65) indicate that students use strategic elements, but there is a certain instability in steady work throughout the semester, systematic preparation for the exam and the stable realization of their learning potential. Pintrich (2000) explained this situation with the incomplete formation of self-regulation skills in students and instability of motivation. That is, a strategic learning approach requires not only the ability to plan, but also the ability to maintain motivation and continuous support for the learning process. However, Keenan (2025) showed that students' choice of strategic learning approaches is largely driven by the need to adapt to exam requirements and optimize time use.

Table 3.*Deep Learning Approach*

Variable	Group	Total number of responses	Mean	SD	T (t-test)	df	p
Deep learning approach	Students	179	3.68	0.57	0.66	206	.507
	Teachers	29	3.66	0.74			

As shown in Table 3, the level of students' use of deep learning approaches in chemistry learning was estimated approximately equally by students and teachers (students – 3.68, SD = 0.57), (teachers – 3.66, SD = 0.74). And the results of the t-test for independent samples ($t(206) = 0.66$, $p = .507$) showed that there was no difference in the assessments of students and teachers regarding the use of deep learning approaches by students.

The results showed that students' use of a deep learning approach to mastering chemistry was lower than that of a strategic approach, but higher than that of a surface approach. However, individual indicators indicated that deep processing is not always possible. For example, students rated the desire to understand the connections between ideas highly (3.88), while teachers rated it highly (3.66), which indicates that students highly value themselves from an analytical perspective, while teachers do not always notice this ability in them. Similarly, students rated the desire to understand the meaning of a task before completing it (3.93; teachers - 3.88), but the rate of asking questions about lectures and literature was low (students - 3.42; teachers - 3.55), which is evidence of the incomplete formation of skills for connecting new knowledge with previous knowledge and reflection. In addition, the motivation to think deeply about the information received was rated lower in both groups (students - 3.17; teachers - 3.31), which suggests that students do not always find enough time and opportunity to process the material in depth. In general, these results indicate that although elements of deep learning are formed in students, it is not implemented consistently and systematically.

Chin and Brown (2000) showed that students who use the deep learning approach in science subjects tend to make scientific explanations, compare evidence, and find meaningful connections. Our results are similar: students strive to understand the connections between ideas and grasp the meaning of the task. However, the fact that the deep learning approach is lower than the strategic approach and that some indicators remain at an average level indicates that this approach is not fully established. In particular, the decrease in asking questions about lectures and literature and encouraging students to think about the information received for a long time indicates that students' cognitive activity does not always reach a reflective and critical level. An important issue here is the extent to which the learning environment encourages students to process the material in depth. If the learning process is dominated by a lack of time, a large amount of information, or a share of reproductive tasks (Entwistle et al., 1997), students are more inclined to master the learning material functionally than to analyze it meaningfully. Therefore, our results indicate that although elements of deep learning have been formed, further improvement of the learning environment is necessary for them to become a permanent practice.

Comparative Evaluation of Teaching Quality by Students and Teachers

Further, based on the opinions of students and teachers, responses regarding the quality of lectures, seminars, and laboratory classes in the chemistry teacher training program were analyzed (Tables 4–6). The average scores of students and teachers for each training format were compared, and the statistical significance of the difference between them was determined using the t-test for independent samples.

Table 4.
Quality of Lectures

Variable	Group	Total number of responses	Mean	SD	T (t-test)	df	p
Quality of lectures	Students	179	3.81	0.64	-3.27	191	.001
	Teachers	14	4.38	0.44			

As shown in Table 4, the results of the evaluation of the quality of chemistry lectures showed that there was a difference between the opinions of students and teachers. The average student rating was $M = 3.81$ ($SD = 0.64$), while the teachers' rating was $M = 4.38$ ($SD = 0.44$). The results of the t-test for independent samples showed that this difference was statistically significant ($t(191) = -3.27$, $p = .001$).

When comparing individual indicators, significant differences were also observed. In terms of content quality, students rated the quality of lecture materials as 3.80, while teachers rated it as 4.43. Similarly, in terms of content freshness, students rated it as 3.87, while teachers rated it as 4.50.

There were also differences in the methods of delivering the material. For example, students rated the clarity of the materials as 3.84, while teachers rated it as 4.36. In addition, students rated the use of visuals as 3.58, while teachers rated it as 4.00. These indicators indicate that students largely rely on teaching methods to rate the quality of lectures as high.

The student-teacher ratio for audience interaction and feedback was 3.89, while the faculty member's was 4.29. This suggests that students may not be able to participate actively in lectures in all situations. There was also a difference in the indicators of student support and motivation. For example, the indicator of increasing student interest was 3.85 for students, and 4.43 for teachers. In addition, the indicator of providing professional guidance was rated by students as 3.97, and by teachers as 4.43. And the indicator of encouraging independent research in terms of the cognitive impact of the lecture was 3.87 for students, and 4.50 for teachers.

The statistically significant difference between students and teachers in terms of lecture quality is particularly striking. While teachers rated lecture quality highly, students rated it relatively low. While teachers often focus on the accuracy, relevance, and structure of the content, students are more likely to focus on how clear, interesting, and accessible the material is. Ramsden (1992), Biggs (1999) and Deslauriers (2019) showed that the quality of teaching in higher education is determined not only by the quality of the content, but also by how students interact with it. Our study also shows this gap: while teachers rated quality highly in terms of content and professionalism, students rated components such as clarity of concepts, use of visuals, and interaction with the audience lower.

This result suggests that in subjects such as chemistry, which are rich in abstract concepts, it is important to explain the lecture not only by simply conveying information, but also by visualizing concepts, clarifying them with examples, and explaining them through interactive communication with the student. If the lecture is mainly aimed at systematically conveying the content, but also by not using methods that enhance the cognitive participation of the student, it may not be perceived as fully qualitative by the student. Therefore, the identified gap in lecture quality is not only a perception difference, but also an indication of the need to make the traditional form of teaching more student-centered.

Table 5.
Quality of Seminar Sessions

Variable	Group	Total number of responses	Mean	SD	T (t-test)	df	p
Quality of seminar sessions	Students	179	3.83	0.65	0.38	180	.704
	Teachers	3	3.69	0.13			

The results of the evaluation of the quality of the seminar classes showed that students and teachers generally rated this form of training positively. The average student rating was 3.83 (SD = 0.65), and the teacher rating was 3.69 (SD = 0.13). Although there was a slight difference in the mean values, the results of the t-test for independent samples showed that this difference was not statistically significant ($t(180) = 0.38$, $p = .704$).

In the evaluation of the seminar classes, certain differences were observed in the two groups on individual indicators. For example, students highly rated the coverage of the lecture content of the seminar topics (student – 3.93), while teachers rated it relatively low (teacher – 3.33). This indicates that students perceive the seminars as a practical form of learning that consolidates the theory in the lecture.

In terms of organization and teaching methods, the ratings for the interestingness of the seminars (student – 3.82; teacher – 3.67) and the level of stimulation of student activity (student – 3.88; teacher – 4.00) were close to each other. This indicates that the seminars were held in a generally active format, but the relatively low student ratings indicate the need for further improvement of the teaching methods used.

Indicators related to learning outcomes and skills development also showed that seminars contribute to deepening knowledge. For example, the indicators of deepening theoretical knowledge (student – 3.94; teacher – 4.00), increasing scientific interest (student – 3.82; teacher – 4.00), and developing explanatory skills (student – 3.77; teacher – 3.67) indicate the importance of seminars in developing cognitive and academic skills.

Differences were also observed regarding interactivity and lesson format. For example, students rated the use of the discussion format highly (student – 3.77), while teachers rated it low (teacher – 2.67). At the same time, students rated the use of the traditional format relatively highly (student – 3.77; teacher – 2.33), which indicates that interactive and traditional elements are used in the seminars.

In terms of support and professional development, the seminars' indicators of providing personal feedback (student – 3.76; teacher – 4.00), building professional confidence (student – 3.80; teacher – 4.00), and developing creative thinking (student – 3.75; teacher – 4.00) indicate that the seminars contribute to students' academic and professional development.

Although no statistically significant differences in the quality of the seminars were found, the small number of participating teachers ($n = 3$) limited the generalizability of the results. However, the higher student ratings of the discussion format suggest that they perceived the seminar as a space for reflection and exchange of ideas, rather than simply rehearsing content. This is consistent with findings from Prince (2004) and Freeman et al. (2014) that active learning formats enhance student engagement and learning experiences.

At the same time, teachers' perception of seminars in terms of content consistency and structure is explained by the concept of constructive alignment (Biggs, 1999; Kember, 2011). That is, while for students the quality of a seminar is often felt through participation and activity in the lesson, for teachers it is measured by how well it is organized in accordance with the learning objectives. These two different logics help to explain the subtle differences in the perception of the quality of seminar lessons. Therefore, in improving seminars, it is important not only to increase the number of active methods, but also to clearly demonstrate their connection to specific learning outcomes.

Table 6.
Quality of Laboratory Lessons

Variable	Group	Total number of responses	Mean	SD	T (t-test)	df	p
Quality of laboratory lessons	Students	179	3.88	0.64	-2.40	189	.017
	Teachers	12	4.34	0.48			

The results of the evaluation of the quality of laboratory classes showed that there was a difference between the evaluations of students and teachers. The average score of students was 3.88 (SD = 0.64), while the teachers' score was 4.34 (SD = 0.48). The results of the t-test conducted on independent samples showed that this difference was statistically significant ($t(189) = -2.40$, $p = .017$). This indicates that teachers

perceive the quality of laboratory classes more highly than students.

While teachers rated the monitoring of students' consolidation of theoretical knowledge through practical work during laboratory classes highly (4.33), students rated it relatively low (3.94). This suggests that although consolidation of theoretical knowledge through practice is one of the learning goals, its achievement is not always felt equally in students' learning experiences.

In terms of the connection between theory and practice, there was a difference in the indicators of the connection of laboratory work with lecture and seminar topics (teacher - 4.42; student - 3.88) and the clarity of the instructions for preparing for laboratory work (teacher - 4.33; student - 3.87). This indicates that students have a relatively low assessment of the connection between laboratory lessons and lectures and may perceive the level of practical consolidation of theory as insufficient. It also indicates the need to further improve the quality of theoretical material prepared for laboratory work.

In terms of feedback, the indicators of students' ability to ask questions (teacher – 4.42; student – 3.89) and receiving answers to questions (teacher – 4.42; student – 3.91) indicate that teachers believe that there is open communication during the lesson. However, the relatively low scores of students indicate that these opportunities are not equally available to all students and that the level of interaction in laboratory lessons needs to be further strengthened.

In terms of learning outcomes, the indicators of finding answers to theoretical questions (teacher – 4.50; student – 3.80), learning to analyze results and draw conclusions (teacher – 4.50; student – 3.95), checking the correctness of results (teacher – 4.50; student – 3.90), and understanding the relationship between data and results (teacher – 4.50; student – 3.91) indicate that laboratory classes are aimed at developing analytical skills. However, the relatively low scores of students indicate the need for additional methodological support and strengthening the elements of explanation and supervision in this process.

Compliance with safety rules during laboratory classes was highly rated (teacher – 4.50; student – 3.99). In addition, the indicators of increasing interest in chemistry (teacher – 4.50; student – 3.88) and developing professional confidence (teacher – 4.42; student – 3.88) indicate that teachers highly value their influence, while students perceive this influence relatively less.

The study showed that teachers rated the quality of laboratory classes higher than students. This gap suggests that although the structure and purpose of laboratory work are clear to the teacher, students do not always perceive it to the same extent. In particular, lower student ratings on indicators such as the connection between theory and practice, the ability to ask questions, analyze results, draw conclusions, and understand the relationship between data indicate that it is important not only to do the activity in laboratory classes, but also to explain the meaning of that activity.

This finding is consistent with Hofstein and Lunetta (2004) and Abrahams and Millar (2008) who found that the effectiveness of laboratory work is determined not by its mere execution, but by the extent to which it promotes conceptual understanding, analysis, and reflection. If laboratory lessons are focused solely on performing procedures, students may perceive them as technical activities without fully understanding the logic of the work. Our results also showed that students' deep learning approaches are also strengthened when the quality of laboratory lessons is high. This suggests that the laboratory environment in chemistry has not only practical, but also cognitive and metacognitive potential.

Thus, parallel evaluations of lectures, seminars and laboratory classes showed that teachers generally tend to rate the quality of all forms of learning higher than students. This difference suggests that teachers and students perceive the learning process through different lenses: teachers tend to focus on content accuracy, structure, and disciplinary logic, whereas students emphasize clarity of understanding, opportunities for active participation, feedback, and workload. Similar to this result, Ümit Avcı and Fatma Kalelioğlu (2019) showed in their study that students associate the quality of learning with the practical relevance of the content, the activity of teaching methods and the use of student-centered approaches. Therefore, the difference between the assessments of the two parties should be viewed not only as subjectivity, but as an indicator that the quality of learning is a multifaceted and complex phenomenon.

Relationship Between Teaching Quality and Students' Learning Approaches: Correlation and Regression Analysis

Table 7.*Correlation Between Students' Learning Approaches and the Quality of Teaching Formats*

Learning approach	Lecture quality	Seminar quality	Laboratory quality
Deep learning approach	0.573***	0.551***	0.595***
Strategic learning approach	0.615*	0.605*	0.618*
Surface learning approach	-0.021	-0.023	-0.073

The asterisks in the table indicate the statistical significance of the correlation coefficients (* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$).

Correlation analysis showed that deep and strategic learning approaches were positively and statistically significantly related to the quality of all teaching formats (Table 7). The highest relationship was observed between the strategic learning approach and the quality of laboratory lessons. On the other hand, the surface learning approach was not significantly related to the quality of teaching formats. This result indicates that learning approaches are a phenomenon that is formed not only by the intrinsic characteristics of the individual student, but also by the quality of the learning environment. Theobald (2020) showed that teaching approaches and learning approaches are interconnected, and that a student-centered and comprehension-oriented learning environment encourages deep learning approaches. Our study confirms this finding in the context of chemistry teacher training. If lectures, seminars and laboratory lessons are organized in a quality manner, students are also more likely to use meaningful and goal-oriented learning strategies.

Table 8.*Results of Multiple Regression Analysis to Predict Students' Learning Approaches*

Predictors	Surface learning approach B	p	Strategic learning approach B	p	Deep learning approach B	p
Lecture quality	0.062	.716	0.301	.009	0.271	.014
Seminar quality	0.340	.168	0.027	.872	-0.184	.244
Laboratory quality	-0.458	.052	0.311	.049	0.477	.002

Table - 8.1.*Multiple Regression Model Fit Indices (R and R²)*

Model indicators	Surface learning approach	Strategic learning approach	Deep learning approach
R	0.148	0.642	0.613
R ²	0.022	0.412	0.376

Multiple regression analysis allowed us to predict the formation of students' learning approaches through the quality of different teaching formats. The results showed that the quality of lectures, seminars, and laboratory classes affects students' learning approaches to varying degrees.

For the deep learning approach, the model explained 37.6% of the variation in students' learning behavior ($R^2 = 0.376$). In this case, the strongest predictor was the quality of laboratory classes ($B = 0.477$, $p = .002$). In addition, the quality of lectures also had a statistically significant effect on the deep learning approach ($B = 0.271$, $p = .014$), while the effect of seminar classes was not significant ($p = 0.244$).

For the strategic learning approach, the model explained 41.2% of the variation in students' learning behavior ($R^2 = 0.412$). The results showed that lecture quality ($B = 0.301$, $p = .009$) and laboratory quality ($B = 0.311$, $p = .049$) were significant factors influencing the formation of a strategic learning approach. However, the effect of seminar classes was not statistically significant ($p = .872$).

The regression model for the surface learning approach was very weak ($R^2 = 0.022$). This indicates that the surface learning approach of students is not significantly related to the quality of lectures, seminars, and laboratory classes.

The results of the study showed that students' deep and strategic learning approaches are closely related to the quality of teaching formats. Multiple regression analysis allowed us to further explain this relationship. The fact that the quality of laboratory classes is the strongest predictor of deep learning approaches is fully consistent with the nature of the chemistry subject. During laboratory work, the students do not just accept ready-made knowledge; students make observations, interpret results, compare errors, and draw conclusions. Such actions directly correspond to the main characteristics of the deep learning approach - semantic processing, analysis, and linking new knowledge to previous knowledge. Therefore, it is natural that the quality of laboratory classes is seen as a decisive factor in the development of the deep learning approach.

The importance of the quality of lectures and laboratory classes in predicting strategic learning is also a significant result. This means that students' planning, effective use of time, task completion, and striving for high results are closely related to the organization of the learning environment. If the learning forms are meaningful, structured, and understandable, students will also be able to organize their learning activities more systematically. In other words, strategic learning can be viewed as not only a student's personal discipline skills, but also an adaptive response to a well-organized learning environment.

The weak regression model for the surface learning approach showed that this strategy is not directly explained by the quality of lectures, seminars and laboratory classes. This suggests that other factors – for example, low personal motivation, a focus on assessment, lack of time or already established learning skills – may be more important in the emergence of the surface learning approach. Therefore, reducing the surface learning approach should not be limited to improving the quality of classes; it requires a complex set of measures, such as revising assessment requirements, optimizing the learning load and developing students' metacognitive skills.

Overall, the results of the study showed that there is a systematic relationship between the quality of teaching methods and teaching formats in chemistry teacher training programs. In particular, the quality of laboratory classes was found to have a strong influence on the development of students' deep and strategic learning approaches. This finding is consistent with research showing that the outcomes of laboratory training encompass multiple learning domains. In particular, laboratory training contributes to the development of higher-level cognitive skills, including metacognitive and argumentative skills, especially in the context of problem-based learning and research-based experiments (Agustian, 2025). This result suggests that in improving chemistry teacher training programs, laboratory classes should be considered not only as a place for building technical skills, but also as a key pedagogical environment for developing semantic understanding, data analysis, reasoning, and professional thinking. In addition, strengthening the content consistency, interactivity, feedback, and reflection in lectures and seminars will allow students to develop deep and strategic learning approaches more sustainably.

Limitations of the study. This study has several limitations. First, the data are based on self-reported questionnaires from students and teachers, and therefore responses may be biased by the subjective perceptions of the participants. Second, the number of teachers participating in the study was relatively small, especially for seminar classes ($n = 3$), which requires some caution in interpreting the results. Third, the study was conducted in the context of higher education institutions in Kazakhstan, and therefore direct generalizability of the results to other countries may be limited. Future studies, including larger sample sizes and the use of qualitative methods (observation or interviews), could provide a more in-depth understanding of the relationship between teaching methods and teaching quality.

Conclusion

The results of the study revealed that strategic and deep learning approaches are relatively dominant among students studying in the "Chemistry Teacher Training" educational program at the participating higher education institutions, while the surface learning approach is used to a lesser extent.

It was found that students and teachers have different evaluation criteria for assessing the quality of education. Students assessed the quality of education mainly through the clarity of the material, the possibility of active participation, the availability of feedback, and the convenience of the learning load. For them, interesting, interactive lessons and the connection of theory with practice were important. Teachers, on the other hand, assessed the quality of education in terms of the scientific validity of the content, the

consistency of its structure, its compliance with educational objectives, and its subject logic. This difference indicates that the quality of education is not limited only to the content, but is also a multifaceted phenomenon directly related to the student's learning experience.

Correlation and regression analyses demonstrated a clear relationship between students' learning approaches and the quality of teaching formats. Deep and strategic learning approaches showed a statistically significant positive relationship with the quality of lectures, seminars, and especially laboratory classes. The quality of laboratory classes was found to be the strongest predictor of deep learning approaches, while the quality of lectures and laboratory classes played an important role in predicting strategic learning approaches. In contrast, the surface learning approaches were not significantly associated with the quality of teaching formats. This result suggests that laboratory and active learning formats in chemistry teaching are more conducive to students' meaningful understanding of the material, analysis, and purposeful organization of learning activities.

In this regard, in order to improve the quality of teaching in the chemistry teacher training program, it is necessary to pay attention to several areas. First, it is important to strengthen the content connection between lectures, seminars and laboratory classes. Second, it is necessary to expand interactive methods based on discussion, explanation, reasoning and active participation in seminar classes. Third, it is necessary to systematically develop students' skills in analyzing results, interpreting data and drawing reasonable conclusions in laboratory classes. Also, strengthening feedback and reflection in the teaching process, providing structured and understandable material will allow students to consistently develop deep and strategic learning approaches.

Conflicts of Interest Statement.

The authors declare no potential conflicts of interest regarding the research, authorship, or publication of this article.

Author Contributions

All authors contributed equally to the conception, development, analysis, and preparation of the manuscript. All authors have read and approved the final version of the article.

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