

Research Article

Undergraduate and Postgraduate Students' Approaches to Learning Organic Chemistry: Gender and Level-Based Variations

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Abstract

This study explored students' approaches to learning organic chemistry across multiple academic levels to understand how learning orientations evolve as students progress through their programmes. A quantitative cross-sectional survey design was adopted, involving a purposive sample of 36 students comprising 28 males and 8 females. The participants included 17 Level 200 students, 6 Level 300 students, 5 Level 400 students, and 8 postgraduate students. Data were collected using the Revised Two-Factor Study Process Questionnaire (R-SPQ-2F), which measures deep and surface motives and strategies. Descriptive analyses showed that postgraduate students predominantly adopted a deep approach to learning, characterized by strong intrinsic motivation, reflective engagement, and the use of integrative learning strategies. Similarly, Level 400 students demonstrated a greater tendency toward deep motives and strategies compared with students at Levels 200 and 300, who were more inclined to rely on surface motives such as rote memorization and minimal-effort strategies. Despite these observable patterns across levels, inferential statistical analyses revealed no significant differences in learning approaches by academic level or gender. These findings suggest that while progressive exposure to advanced chemistry content may encourage deeper engagement, students across levels continue to rely differently on both deep and surface approaches. The study recommends that chemistry educators and curriculum designers incorporate conceptual change pedagogies, scientific reasoning tasks, modeling activities, interdisciplinary connections, and context-rich instructional strategies to foster deeper, more meaningful, and transferable learning in organic chemistry.

Keywords

Approaches to Learning, Organic Chemistry, Deep Learning, Surface Learning, Conceptual Change, Chemistry Education, Tertiary Science Education, Learning Strategies

1. Background

Globally, educational stakeholders are increasingly concerned with what students are learning and the extent to which educational systems are effectively preparing learners for life

beyond school [1]. In Ghana, a growing recognition of the need to enhance science education at all levels mirrored this concern, particularly at the tertiary level. Several studies have

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highlighted deficiencies in students' educational outcomes, particularly in critical thinking, communication, and problem-solving skills. These shortcomings have been linked to students' approaches to learning, which influence their capacity for critical thinking [2].

Approaches to learning are defined as the intentions, motivations, and cognitive strategies that students adopt in the learning process [3]. These approaches significantly affect both the quality and outcomes of student learning [4, 5]. Broadly, approaches to learning encompass domain-general skills such as curiosity, persistence, planning, and engagement in collaborative learning [6]. Their perceptions of content, context, and academic demands shaped the specific orientation a student adopts [5]. Empirical evidence indicates that learning approaches are significant predictors of academic gains in science [6] and are essential cognitive and behavioral capacities for meaningful engagement in science education [7].

Three principal approaches to learning have been widely identified in the literature: surface, deep, and strategic. Rote memorisation and reproductive learning strategies characterised the surface approach, typically motivated by a desire to avoid failure. It often results in fragmented understanding and a lack of conceptual integration [8-10]. In contrast, a deep approach involves a genuine intention to understand, synthesise, and critically engage with material. Students adopting this approach are intrinsically motivated and seek to relate new knowledge to prior understanding, identify underlying meanings, and comprehend the broader context of their learning [8].

The strategic approach is oriented toward achieving high academic performance. It involves effective time management, goal-directed behaviour, and an acute awareness of assessment requirements [11, 3]. Students using this approach are typically well-organised and methodical in their study practices. Numerous studies have demonstrated a positive relationship between deep and strategic approaches and higher academic achievement, while surface approaches have been consistently linked to lower academic performance [12-14, 3].

1.1. Statement of the Problem

Educational institutions continue to seek strategies to enhance the quality of learning and, by extension, improve student outcomes. Central to this endeavour is a need to understand how students approach their learning in higher education settings [15]. The ability of students to align their learning activities with assessment requirements is a critical factor in achieving academic success [16]. Students' approaches to learning not only influence academic achievement but are also shaped by their learning environments, including social, psychological, and pedagogical contexts [17, 15, 18].

Numerous factors impact student learning, including instructors' teaching approaches [19, 20], the nature of the

academic discipline [21], and the intensity and structure of assessment tasks [22, 3]. Importantly, learning approaches are not inherent traits of students; rather, they are context-dependent and influenced by students' perceptions of the learning environment [23].

In this regard, researchers emphasised the importance of examining learning approaches within specific disciplinary contexts [24, 18]. Such investigations can provide educators with deeper insights into how students navigate learning within particular domains. Furthermore, students may adopt different learning approaches at various times, depending on the characteristics of the learning environment [25, 3]. Consequently, it is essential to explore the approaches to learning adopted by students within the context of organic chemistry, as students' learning strategies often vary by course [8]. Research on gender differences in learning approaches has yielded mixed findings. Several studies report no significant differences between male and female students in using deep or surface approaches. For example, Kember et al. [26] found that all genders adopted similar learning orientations, suggesting that gender may not play a determining role in shaping study strategies. Likewise, Shaari et al. [27] observed no notable gender-related differences in learning approaches among university students.

However, other studies suggest subtle distinctions. Nordin et al. [2] found no gender differences in deep approaches but reported that female students were less likely to adopt surface approaches compared to male students. Some evidence also suggests that females are slightly more inclined toward strategic learning, focusing on organization and time management, whereas males may rely more heavily on surface strategies, such as rote memorization.

Organic chemistry is the branch of science concerned with the study of carbon-containing compounds, including their structures, properties, reactions, and methods of preparation. It encompasses not only hydrocarbons but also carbon compounds containing elements such as oxygen, nitrogen, sulfur, phosphorus, halogens, and silicon [28]. As a discipline, organic chemistry is central to understanding both living systems and a wide range of synthetic and naturally occurring substances essential to modern life.

The field explores how molecular structure determines chemical and physical properties, reactivity, and behavior, with emphasis on chemical bonding, functional groups, and reaction mechanisms. It also involves the synthesis of complex molecules from simpler precursors, a foundational process in developing pharmaceuticals, polymers, and advanced materials [29]. Organic chemistry is a foundational subject for students in chemistry, biology, health sciences, and engineering, underpinning essential concepts such as molecular structure, reaction mechanisms, and synthesis. Mastery of this subject is crucial for scientific literacy, critical thinking, and applying theoretical knowledge to real-world contexts, including medicine and materials science [30, 31].

Despite its importance, organic chemistry is widely per-

ceived as difficult, often leading students to rely on rote memorization rather than developing conceptual understanding. Students commonly struggle with topics such as acid-base chemistry, resonance structures, stereochemistry, and organic synthesis, resulting in misconceptions and poor academic performance [32, 33].

Although approaches to learning have been extensively studied in higher education research globally, the Ghanaian context remains relatively under-explored. Studies of learning approaches within the Ghanaian context are few and often focus on general learning behaviours rather than discipline-specific contexts. This creates a significant limitation, as approaches to learning are known to be sensitive to disciplinary demands, instructional practices, and the cognitive complexity of the subject. Organic chemistry, in particular, is widely recognized as a challenging domain that requires abstract reasoning, representational competence, and conceptual integration; yet, research investigating how Ghanaian undergraduate and postgraduate students approach learning in this subject area is almost nonexistent.

The present study, therefore, seeks to examine the learning approaches of undergraduate and postgraduate students within organic chemistry learning environments, focusing on gender differences and level-based variations.

1.2. Research Questions

- 1) What learning approaches do undergraduate and postgraduate students adopt in the study of organic chemistry?
- 2) What differences exist in the learning approaches of

undergraduate and postgraduate students in organic chemistry?

- 3) What differences exist in learning approaches in terms of gender?

2. Theoretical Framework

Approaches to learning were first conceptualised by Marton and Saljo [34] in a seminal study investigating variations in learning processes among higher education students. They identified two distinct approaches: surface-level processing and deep-level processing. A student's intent to memorise content characterised surface-level processing, often without a thorough understanding of the underlying meaning. In contrast, deep-level processing involves an intention to comprehend the author's reasoning and arguments, engaging actively and reflectively with the learning material.

According to Marton and Saljo [34], surface-level processing is typically associated with limited understanding and poor learning outcomes, whereas deep-level processing fosters conceptual understanding and leads to improved academic performance [35]. Subsequently, Entwistle [36] introduced a third approach called the strategic approach, which is defined by a student's intention to achieve the highest possible academic grades [35]. Students who adopt the strategic approach often anticipate examination questions based on past papers, interpret assessment cues, and manage their time and cognitive resources efficiently. This approach is dynamic, with learners shifting between surface and deep strategies depending on contextual demands [13].

Table 1. *Motives, Intentions, Outcomes, and Processes Associated with Students' Approaches to Learning.*

Approach	Motive	Intention	Outcome	Processes / Behaviors
Surface approach	Avoid failure	To reproduce	Incomplete understanding	Memorising and rote learning for assessments, balancing between working too hard and just enough to pass, Meeting course requirements with minimum effort, studying without reflection or purpose, failing to link concepts with applications/examples, viewing tasks as external impositions - Focusing on discrete tasks without integration
Deep approach	Intrinsic interest in subject matter	To understand	Extensive understanding	Actualising interest and competence, seeking meaning, relating ideas to prior knowledge and daily experiences, comprehending material thoroughly, engaging with content, collaborating with peers, examining logic and using evidence, and committing to personal learning.
Strategic approach	Maximise achievement (best possible grades)	To succeed	High grades	Paying attention to assessment criteria, striving for top grades, organising the learning environment, managing time and effort effectively, using space/resources strategically, practising self-regulation, monitoring progress, and behaving as a "model student."

Adopted from (Faranda et al., 2021).

Again, Biggs' 3P model of learning (Presage-Process-Product) is a key framework within Student

Learning Theory and offers a powerful lens for understanding how students' perceptions of the teaching-learning environ-

ment, their learning strategies, and their academic outcomes interrelate [37]. The model proposes that personal characteristics and contextual factors (presage), together with students' learning strategies (process), shape the quality and nature of learning outcomes (product) [38].

Presage factors refer to the characteristics that students and teachers bring into the learning situation. For teachers, these include disciplinary expertise, prior experiences, pedagogical beliefs, curriculum design decisions, and their perceived level of institutional support. Teachers who possess strong prior knowledge, hold particular values, and feel supported by their institution are better positioned to communicate concepts effectively. For students, presage factors include academic background, prior experiences, values, interests, and demographic characteristics. Students who have previously engaged with sustainability-related activities or feel personally connected to sustainability values are more likely to participate meaningfully and critically in classroom discussions [39].

Process factors refer to how students approach learning, notably through surface or deep learning strategies. A surface approach reflects minimal effort aimed at meeting basic course requirements, whereas a deep approach involves actively engaging with the subject, seeking meaning, identifying relationships between ideas, and developing higher-order thinking skills. Effective sustainability education, in particular, requires deep learning because it demands an understanding of the interconnected environmental, social, and economic dimensions of sustainable development [40, 39]. Product factors correspond to the learning outcomes that emerge from students' approaches to learning. These outcomes range from basic description and explanation to deeper understanding, reflection, and application [39].

3. Methodology

3.1. Design

The study employed a quantitative research approach, utilising a cross-sectional survey design. A cross-sectional design involves the simultaneous measurement of outcomes and explanatory variables within a defined population, allowing for the identification of patterns and associations at a specific point in time [41]. This design is particularly suited for describing generalised relationships between distinct variables and contextual conditions [42].

3.2. Sample

A purposive sampling technique was employed to select 36 chemistry major students across levels 200 (17), 300 (6), 400 (5), and Postgraduate (8), comprising 28 males and 8 females. The Revised Two-Factor Study Process Questionnaire (R-SPQ-2F) was administered to undergraduate students following the completion of an organic chemistry course, and

to postgraduate students after completing an advanced organic chemistry course. The impact of uneven sample sizes depends on the total sample size, effect size, and the statistical methods used. Studies show that moderate imbalances in sample size do not necessarily compromise the validity of Analysis of Variance (ANOVA) or Kruskal-Wallis tests [43, 44].

3.3. Instrument

The Revised Two-Factor Study Process Questionnaire (R-SPQ-2F) was utilized for this study. Originally conceptualized by Biggs et al. [45], the instrument is designed to assess students' approaches to learning based on the theory of learning approaches. The R-SPQ-2F consists of 20 items, which assess two dimensions: deep and surface approaches to learning. Participants respond on a five-point Likert scale ranging from (1) "never or only rarely true of me," through (3) "it is true of me about half the time," to (5) "it is always or almost always true of me." The deep approach subscale includes 10 items, as does the surface approach subscale. For both deep and surface approaches, five items reflect the students' motives for learning, while the remaining five items assess the strategies employed by the students in their study approach. Data analysis was conducted using the scoring system outlined by Biggs et al. [45], where the deep approach score is the sum of all deep motive and strategy scores, and the surface approach score is the sum of all surface motive and strategy scores.

The Revised Two-Factor Study Process Questionnaire effectively distinguishes between dynamic and stable aspects of students' learning, enabling better retention and application of information learned. It is a reliable instrument for assessing student teachers' deep and surface approaches to learning, which can positively affect their academic performance and teaching practice. It is a reliable and culturally sensitive instrument for measuring university students' learning approaches [46-48].

The internal consistency reliability of the R-SPQ-2F was evaluated using Cronbach's alpha. The results showed that the overall 20-item scale demonstrated acceptable internal consistency, $\alpha = .771$. Recent psychometric guidelines indicate that alpha values of .70 to .79 represent acceptable reliability, with values $\geq .80$ considered good [49, 50]. Contemporary methodological reviews further emphasize that $\alpha \geq .70$ remains an appropriate threshold for attitudinal, educational, and psychological scales [51, 52]. Based on these criteria, the obtained alpha coefficient suggests that the R-SPQ-2F exhibits satisfactory reliability for assessing students' approaches to learning in the present sample.

3.4. Data Collection Procedure

Data were collected after students completed either the Organic Chemistry 1 course (undergraduate students) or the Advanced Organic Chemistry course (postgraduate students)

during the first semester of the 2024/2025 academic year. Participants responded to the Revised Two-Factor Study Process Questionnaire (R-SPQ-2F), which was administered online via Google Forms. Before the major study, the instrument was piloted on a sample of undergraduate students to assess its validity and clarity. Ethical considerations were observed throughout the study. Participation was voluntary, and students were informed about the purpose of the study, their right to withdraw, and the confidentiality of their responses. Informed consent was obtained from all participants before data collection. The data collected was anonymized

and securely stored to ensure privacy. The collected data were subsequently coded and analyzed using IBM SPSS Statistics version 27.

3.5. Tests of Normality

Variables that are approximately normally distributed can be analyzed using parametric tests, such as t-tests, ANOVA, or Pearson correlation, which assume normality in the population.

Table 2. Tests of Normality for Exam Scores and Approach to Learning.

Variable	Shapiro-Wilk Statistic	df	p-value
Exams score	0.945	36	0.072
Approach Learning	0.968	36	0.374

The assumption of normality was assessed using the Shapiro-Wilk test. Results indicated that Exam scores [W (36) = 0.945, p = .072] and Approach Learning [W (36) = 0.968, p = .374] were approximately normally distributed, suggesting that both variables do not significantly deviate from normality.

4. Results and Discussion

4.1. Respondents

The sample comprised 36 participants, including 28 males and 8 females, with representation from different academic levels: 17 students from level 200, 5 from level 300, 5 from level 400, and 8 postgraduate students. The distribution of participants by sex and academic level is presented in Table 3.

Table 3. Distribution of Participants by Sex and Level.

Level	Sex	
	Males	Females
Level 200	12	5
Level 300	5	1
Level 400	4	1
Postgraduate	7	1
Total	28	8

4.2. Approach to Learning Organic Chemistry by Course Levels

Descriptive statistics for students' approaches to learning

across academic levels are presented in Table 4. Overall, the results indicate that students increasingly adopted deep approaches as they advanced academically, while surface approaches showed less consistent patterns.

Table 4. Means and Standard Deviations of the Approaches to Learning by Levels.

Study Approach	Level							
	Level 200		Level 300		Level 400		Postgraduate	
	M	SD	M	SD	M	SD	M	SD
Deep Approach	3.12	0.67	3.16	0.95	3.30	0.71	3.91	0.67
Deep Motive	3.05	0.74	3.23	1.01	3.20	0.88	3.87	0.59
Deep Strategy	3.18	0.75	3.10	0.94	3.40	0.55	3.95	0.81
Surface Approach	2.44	0.60	2.31	0.85	2.74	1.03	2.48	0.75
Surface Motive	2.12	0.77	2.16	0.79	2.32	1.21	2.30	1.10
Surface Strategy	2.76	0.61	2.46	0.97	3.16	0.91	2.67	0.48

For the deep approach, mean scores increased steadily from Level 200 ($M = 3.12$, $SD = 0.67$) to postgraduate students ($M = 3.91$, $SD = 0.67$). A similar upward trend was observed for both deep motive (Level 200: $M = 3.05$, $SD = 0.74$; Postgraduate: $M = 3.87$, $SD = 0.59$) and deep strategy (Level 200: $M = 3.18$, $SD = 0.75$; Postgraduate: $M = 3.95$, $SD = 0.81$), suggesting that higher-level students were more intrinsically motivated and relied on more effective learning strategies.

In contrast, the surface approach showed a fluctuating pattern. Level 300 students reported the lowest mean score ($M = 2.31$, $SD = 0.85$), whereas Level 400 students reported the highest ($M = 2.74$, $SD = 1.03$). Postgraduates scored moderately ($M = 2.48$, $SD = 0.75$), reflecting a reduction in surface tendencies compared to Level 400. Similarly, surface motive scores were consistently low across levels (ranging from $M = 2.12$ to 2.32), while surface strategy scores varied, peaking at Level 400 ($M = 3.16$, $SD = 0.91$) before declining among postgraduates ($M = 2.67$, $SD = 0.48$).

The results suggest that as students progress academically, they increasingly adopt deeper learning motives and strategies, while reliance on surface approaches declines, particularly at the postgraduate level. This pattern reflects a developmental shift in how students engage with academic tasks and how they regulate their own learning. The findings align with earlier studies and reinforce the argument that higher levels of study tend to promote more reflective, meaning-oriented engagement with course material.

Desierto et al. [53] reported that most students employed strategies characteristic of a deep learning approach. This

supports the present findings and suggests that deeper engagement is not limited to specific academic contexts but may represent a broader trend among learners as they encounter more complex academic demands. The results from Chirikure et al. [54], which showed moderately high group means across all three learning approaches, further indicate that although students may use a combination of approaches, deep and strategic orientations remain particularly prominent.

Kember et al. [26] found that mean scores for deep motive and deep strategy were higher than those for surface motive and surface strategy. This pattern mirrors the current study and suggests that students at higher academic levels are more likely to prioritize understanding, personal meaning, and critical engagement. Ilhan-Beyaztas [55] also reported higher means for deep and strategic approaches relative to surface approaches. The convergence across studies strengthens the interpretation that academic progression tends to cultivate learning behaviors associated with deeper comprehension, better self-regulation, and more purposeful engagement with academic tasks. These findings indicate that deeper approaches to learning become more dominant as students advance through their academic careers. This shift may be attributed to increased academic maturity, exposure to more complex disciplinary tasks, and institutional or instructional expectations that encourage critical thinking and analytical reasoning.

A one-way analysis of variance (ANOVA) was conducted to examine differences in learning approaches across student levels. The ANOVA results are presented in Table 5.

Table 5. Results of ANOVA of Students' Approaches to Learning by Levels.

	SS		df	MS	F	p	η^2
Deep Approach	Between Groups	3.604	3	1.201	2.278	0.098	.176

	<i>SS</i>		<i>df</i>	<i>MS</i>	<i>F</i>	<i>p</i>	η^2
	Within Groups	16.873	32	0.527			
	Total	20.476	35				
	Between Groups	0.516	3	0.172	0.313	0.816	.028
Surface Approach	Within Groups	17.611	32	0.55			
	Total	18.127	35				
	Between Groups	3.706	3	1.235	2.033	0.129	.160
Deep Motive	Within Groups	19.45	32	0.608			
	Total	23.156	35				
	Between Groups	3.695	3	1.232	2.061	0.125	.162
Deep Strategy	Within Groups	19.118	32	0.597			
	Total	22.812	35				
	Between Groups	0.243	3	0.081	0.096	0.962	.009
Surface Motive	Within Groups	27.037	32	0.845			
	Total	27.28	35				
	Between Groups	1.371	3	0.457	0.941	0.432	.081
Surface Strategy	Within Groups	15.539	32	0.486			
	Total	16.91	35				

Results indicated no statistically significant differences in the deep approach among the levels, $F(3, 32) = 2.28$, $p = .098$. Similarly, there were no significant differences in the surface approach, $F(3, 32) = 0.31$, $p = .816$, or in the deep motive, $F(3, 32) = 2.03$, $p = .129$. Although these differences were non-significant, postgraduate and Level 400 students reported higher mean scores than Level 200 and Level 300 students. This pattern suggests that while the differences were not strong enough to reach statistical significance, there may be a gradual tendency for more advanced students to engage in deeper learning processes.

No statistically significant differences were observed in deep strategy, $F(3, 32) = 2.06$, $p = .125$, surface motive, $F(3, 32) = 0.10$, $p = .962$, or surface strategy, $F(3, 32) = 0.94$, $p = .432$. The consistency of nonsignificant results across all subcomponents indicates a general stability in learning approaches across academic levels. This stability implies that once students adopt certain learning tendencies, these may become relatively enduring regardless of academic progression.

These findings align with those of Shah et al. [56], who reported that health science students predominantly adopted a deep approach to learning irrespective of age. Their study suggests that demographic variables may have limited influence on learning patterns, reinforcing the interpretation that deep learning tendencies are relatively stable. Similarly,

Faranda et al. [18] found that senior-level students primarily employed a strategic approach, followed by a deep approach and then a surface approach. Their results support the idea that although the dominance of approaches may vary, deeper and strategic orientations commonly take precedence over surface approaches even when statistical differences across groups are minimal.

Effect sizes were interpreted using η^2 benchmarks proposed by Cohen [57] and reinforced in recent methodological literature [58, 59]. According to these conventions, η^2 values of .01, .06, and .14 represent small, medium, and large effects, respectively. The results indicated a large effect of course level on Deep Approach ($\eta^2 = .176$), suggesting that approximately 17.6% of the variance in deep learning tendencies is attributable to level of study. Similarly, Deep Motive ($\eta^2 = 0.160$) and Deep Strategy ($\eta^2 = 0.162$) also exhibited large effects, indicating substantial developmental progression in intrinsic motivation and strategic engagement with academic material. In contrast, Surface Approach ($\eta^2 = .028$) and Surface Motive ($\eta^2 = .009$) displayed small to trivial effects, indicating that course level accounts for minimal variation in surface-oriented learning patterns. Surface Strategy showed a medium effect ($\eta^2 = .081$), suggesting modest variation across levels. The pattern of effect sizes indicates that course level exerts a substantive influence on deep learning approaches but a limited influence on surface learning approaches.

4.3. Students' Approach to Learning Organic Chemistry by Gender

Independent-samples *t* tests were conducted to examine gender differences in learning approaches. The results are presented in Table 6.

Table 6. Independent Samples *t*-Test Results.

Approach	Sex	<i>N</i>	<i>M</i>	<i>df</i>	<i>t</i>	<i>p</i>	Cohen's <i>d</i>
Deep Approach	Male	28	3.35	34	0.385	0.807	.155
	Female	8	3.23				
Surface Approach	Male	28	2.50	34	0.440	0.662	.177
	Female	8	2.37				
Deep motive	Male	28	3.33	34	0.641	0.526	.257
	Female	8	3.12				
Deep Strategy	Male	28	3.37	34	0.087	0.931	.035
	Female	8	3.35				
Surface Motive	Male	28	2.24	34	0.539	0.593	.216
	Female	8	2.05				
Surface Strategy	Male	28	2.76	34	0.228	0.821	.091
	Female	8	2.70				

Results indicated no significant difference in the deep approach between males ($M = 3.35$, $SD = 0.76$) and females ($M = 3.23$, $SD = 0.81$), $t(34) = 0.39$, $p = .807$. Similarly, there was no significant difference in the surface approach between males ($M = 3.35$, $SD = 0.73$) and females ($M = 3.23$, $SD = 0.72$), $t(34) = 0.44$, $p = .662$. These results suggest that both male and female students tend to engage with course material in comparable ways at the broader level of deep and surface learning.

Further analysis revealed no significant gender differences in deep motive (males: $M = 3.33$, $SD = 0.84$; females: $M = 3.12$, $SD = 0.73$), $t(34) = 0.64$, $p = .526$, or deep strategy (males: $M = 3.37$, $SD = 0.79$; females: $M = 3.35$, $SD = 0.92$), $t(34) = 0.09$, $p = .931$. Likewise, no significant gender differences were observed in surface motive (males: $M = 2.24$, $SD = 0.89$; females: $M = 2.05$, $SD = 0.91$), $t(34) = 0.54$, $p = .593$, or surface strategy (males: $M = 2.76$, $SD = 0.74$; females: $M = 2.70$, $SD = 0.56$), $t(34) = 0.23$, $p = .821$. The consistent pattern of nonsignificant findings across all subcomponents suggests that gender may not meaningfully shape students' underlying motivations or strategies for learning. This stability implies that learning preferences are likely influenced more by contextual or educational factors than by gender.

These findings are consistent with previous research. Kember et al. [26] reported no significant gender differences in deep or surface approaches, which aligns directly with the patterns observed in the present study. Nordin et al. [2] simi-

larly found no significant differences in deep approaches, although they did identify significant differences in surface approaches. Shaari et al. [27] also concluded that gender does not significantly influence students' approaches to learning. The convergence of evidence across studies suggests that gender contributes minimally to variation in learning approaches. This supports the interpretation that learning orientation is shaped more by academic experiences, instructional practices, and individual dispositions than by demographic characteristics such as gender.

Independent-samples effect sizes were calculated to examine sex differences in students' approaches to learning. The resulting Cohen's *d* values ranged from 0.035 to 0.257, all of which fall within the small effect size range according to contemporary benchmarks [60]. Moreover, no effect approached the medium threshold ($d = 0.50$), suggesting that sex had minimal practical influence on any dimension of the learning approaches measured. Across all six dimensions of approaches to learning, sex does not meaningfully influence either deep or surface approaches, motives, or strategies in this sample. These findings align with contemporary literature showing that learning approaches are more strongly shaped by curriculum, pedagogy, and contextual variables than by sex [61, 62].

5. Conclusion

The findings suggest that postgraduate students tend to adopt a deep approach to learning organic chemistry, characterized by both deep motives and strategies. Similarly, Level 400 students demonstrated a deeper approach to understanding organic chemistry compared to Level 300 and Level 200 students. In contrast, students at Levels 300 and 200 typically relied more on surface approaches, emphasizing surface motives and strategies. Despite these observed trends, statistical analyses revealed no significant differences in learning approaches across academic levels, indicating that both undergraduate and postgraduate students employed a mix of deep and surface learning approaches. Furthermore, no significant gender differences were found in either deep or surface approaches.

These findings highlight the need for chemistry educators to encourage the adoption of deep learning approaches. This can be achieved through the design of well-structured curricula and the implementation of student-centered teaching and assessment strategies that promote meaningful understanding. To move beyond grade-oriented outcomes, assessments should emphasize comprehensive skill development and hands-on learning (Nordin et al., 2013) [2]. Instructional strategies that discourage surface learning, such as essay writing, problem-based learning, inquiry-based learning, reflective practices, and research projects, can be used to enhance students' engagement.

Providing relevant instructional materials and fostering a conducive classroom atmosphere can encourage students to engage with course content meaningfully. Cultivating personal interest in the subject matter is particularly important, as it promotes deeper engagement while reducing reliance on surface-level strategies. Higher education institutions should therefore prioritize the creation of learning environments that foster strategic and deep learning while minimizing superficial learning tendencies.

Strategies to enhance meaningful chemistry education include the use of relevant contexts, tailoring knowledge to students' needs, and valuing students' perspectives. Meaningful learning requires students to actively connect prior knowledge with new content. Consequently, chemistry education should focus on contextualizing lessons, building on students' existing knowledge to enhance engagement and demonstrate relevance, reasoning, and modeling. Such approaches can promote conceptual understanding and address misconceptions through pedagogies focused on conceptual change.

6. Limitations and Future Research

One limitation of this study was the relatively small sample size, which was addressed through the application of statistical methods. Moreover, the sample exhibited an uneven distribution of male and female participants. Future studies should investigate interventions designed to enhance students' en-

gagement and foster meaningful learning in organic chemistry.

Abbreviations

R-SPQ-2F	Revised Two-Factor Study Process Questionnaire
ANOVA	Analysis of Variance

Conflicts of Interest

The authors declare no conflicts of interest.

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