Indonesian Science Education Research (ISER)
Available online
https://jurnal.unimed.ac.id/2012/index.php/iser
e-ISSN: 2715-4653
p-ISSN: 2797-6262

Preservice Science Teachers' Perceptions of Learning Difficulties in Organic Chemistry at an Indonesian University

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Accepted: January 27th, 2026. Published: February 5th, 2026

Abstract

This study examined preservice science teachers' perceptions of learning difficulties in Organic Chemistry and their relationship with achievement in General Chemistry. A quantitative descriptive–correlational design was employed. The participants were 103 undergraduate students enrolled in the Science Education program who were taking an Organic Chemistry course, selected through total sampling. Data were collected using a four-point Likert-scale questionnaire measuring perceived learning difficulties and analyzed using SPSS 23. The results indicated that students' perceptions of learning difficulties were distributed across high and low levels. Among the assessed indicators, problem-solving and analytical skills were perceived as the most challenging. No significant differences were found in perceptions based on gender. Meanwhile, a significant positive correlation was identified between General Chemistry achievement and perceived learning difficulties in Organic Chemistry ($R^2 = 0.91$), indicating a strong association within the study sample. However, this association should be interpreted cautiously due to the correlational design of the study. These findings suggest that students' understanding of foundational chemistry concepts plays a crucial role in shaping their learning experiences in Organic Chemistry and should be strengthened to support more effective instruction.

Keywords: learning difficulties, organic chemistry, students' perception

Introduction

The Organic Chemistry course is included in the main basic course group in the Undergraduate Natural Science Education Program at the Faculty of Mathematics and Natural Sciences, Universitas Negeri Padang. The course introduces carbon compounds and functional groups, reaction mechanisms, isomerism, stereochemistry, and their applications in daily life (Schuessler et al., 2024). Despite its importance, numerous studies have reported that organic chemistry is among the most challenging areas for students to learn (O'Dwyer & Childs, 2017)

Research consistently shows that both students and instructors perceive organic chemistry as difficult compared to other chemistry branches. For example, Ahiakwo & Ene (2021) found that students struggled with topics such as alkyne detection and the molecular structure and characteristics of benzene. Similar studies highlight difficulties related to memorizing numerous

reactions and mechanisms, limited conceptual understanding (e.g., acids–bases, nucleophiles–electrophiles, stereochemistry), and insufficient active learning strategies (Salame, et al., 2020).

In the Indonesian context, difficulties have also been documented. Students experience challenges in understanding geometric and optical isomerism and determining R/S configurations (Purwanto & Anshori, 2021). Difficulties are also linked to the abstract nature of organic acids and bases, which require multiple representations—molecular, symbolic, and mathematical (Assari et al., 2023). Furthermore, issues related to learning resources, such as the lack of contextual materials and limited support for independent learning, have been identified (Rahmawati & Irawati, 2023).

Several factors contribute to the complexity of organic chemistry learning, including: (1) the large volume and complexity of the material, often overwhelming students with many reactions and exceptions; (2) the high demand for spatial reasoning and three-dimensional visualization, particularly in stereochemistry; (3) the cumulative nature of the content, which requires strong foundational knowledge in general chemistry; and (4) the predominance of teacher-centered learning approaches, which has the potential to encourage students to prioritize memorizing rather than understanding concepts in depth (Salame, et al., 2020).

These learning difficulties not only affect academic performance but also influence students' perceptions, motivation, and attitudes toward chemistry. Perceptions are important to analyze because they provide insight into students' learning experiences and the obstacles they encounter. Studies in other fields have shown that perceptions of learning difficulty can influence students' motivation (Sakdiah & Silalahi, 2017), suggesting the need to explore this construct in the context of organic chemistry education.

In the Undergraduate Natural Science Education program at the Faculty of Mathematics and Natural Sciences, Universitas Negeri Padang, the Organic Chemistry course is offered in the fifth semester. Students are required to have successfully completed the General Chemistry course in the second semester as a prerequisite. Since Organic Chemistry builds upon and extends several fundamental concepts introduced in General Chemistry, it is reasonable to assume a relationship between students' perceptions of learning difficulties in Organic Chemistry and their achievement in the General Chemistry course.

Despite the substantial body of research on students' difficulties in organic chemistry, limited studies have examined these difficulties specifically among preservice science teachers, and even fewer have investigated their relationship with foundational chemistry knowledge. Therefore, this study focuses on examining the perception of preservice science teachers regarding learning difficulties in organic chemistry and exploring the associated contributing factors and implications. This study also investigated the relationship between the learning difficulties of preservice science teachers in organic chemistry and their general chemistry scores. The output of this study is expected to play a role in developing more optimal instructional strategies in learning Organic Chemistry, particularly Organic Chemistry for preservice science teachers.

Research Method

This study employed a quantitative descriptive–correlational design. This approach was chosen to objectively describe the perceptions of preservice science teacher students toward their difficulties on organic chemistry course by using the results of a questionnaire. The population in this study was all preservice science teacher students enrolled in the Bachelor of Science Education program, Faculty of Mathematics and Natural Sciences, Padang State University who are taking the organic chemistry course in current time. The research sample consisted of 103 students, determined using total sampling. They were in their fifth semester at the time of the study. Respondent characteristics are presented in Table 1.

The research instrument was a questionnaire that assessed perceptions of learning difficulties compiled based on a synthesis of several perceptual indicators, including conceptual understanding of organic chemistry, problem solving and analysis, mathematics and chemistry prerequisites, learning resources and teaching methods, and evaluation and motivation. The

questionnaire used a 4-point Likert scale: 1 = strongly disagree, 2 = disagree, 3 = agree, and 4 = strongly agree. Before use, the instrument was validated by experts to assess content validity, then tested for empirical validity and reliability. Empirical validity was assessed using the product-moment correlation coefficient, while reliability was assessed using Cronbach's Alpha coefficient to ensure the internal consistency of the statement items. Based on the results of the validity and reliability tests, 14 items were declared valid and reliable out of a total of 20. The results of the reliability analysis (Cronbach's Alpha) was 0,816 with very high reliability. Data were collected through an online questionnaire by respondents between September and October 2025. Each respondent completed the questionnaire independently based on their experiences and perspectives on Organic Chemistry learning. Table 1 presents the characteristics of the respondents.

Table 1. Respondent characteristics

Characteristics	Category	n	%
Gender	Male	12	11.65
	Female	81	88.35
Semester	5^{th}	103	100
Prior Course Completion	General Chemistry	103	100

Quantitative data analysis was performed using SPSS Statistics 23 software. Descriptive analysis was conducted to calculate the mean, standard deviation, and perception categories for each indicator. The output of the descriptive analysis using a Likert scale can be interpreted based on the score range from the minimum to the maximum, then categorized into four perception levels according to intervals (Sugiyono, 2019). Perception categories were determined according to the score intervals shown in Table 2.

Table 2. Interpretation of perception categories

Score Range	Perception Category
3.26 – 4.00	Very positive
2.51 – 3.25	Positive
1.76 – 2.50	Negative
1.00 – 1.75	Very negative

Additionally, to support the interpretation of the results, additional analysis was conducted comparing perceptions based on gender and the correlation between General Chemistry scores and perception. A prerequisite test was performed before hypothesis test. Data normality was examined using the Kolmogorov–Smirnov test for sample sizes greater than 50 and the Shapiro–Wilk test for sample sizes smaller than 50. And to assess homogeneity, the Levene test was utilized. Data that are normally distributed and exhibit homogenous variance were analyzed using parametric tests. Otherwise, non-parametric tests were employed. And to analyze the relationship between General Chemistry scores and perceptions of learning difficulties, the Spearman rho correlation test was used because the data were not normally distributed.

Results and Discussion

1. Distribution of Students' Responses

The analytical results of the responses of preservice science teachers are shown in Figure 1. The data in Figure 1 shows that the majority of students gave positive and negative responses in the same proportion, which is 47%. Only a small portion gave very positive and very negative responses.

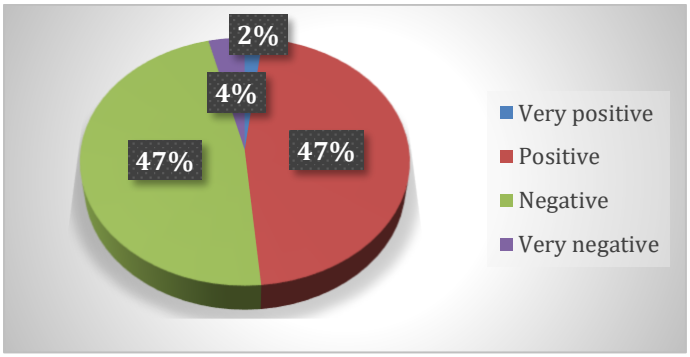

Figure 1. Distribution of Students' Responses Categories

Drawing from the results in Figure 1, it is evident that an equal proportion of respondents expressed positive and negative responses, with each accounting for 47%. This indicates diverse views and the possibility that factors influencing perceptions are not equally felt by all respondents. While the number of extreme responses (very positive or very negative) was very small, indicating that the majority of respondents fell within the "middle" or moderate response zone.

Furthermore, the learning difficulties of prospective science teacher students for each indicator are presented in Figure 2.

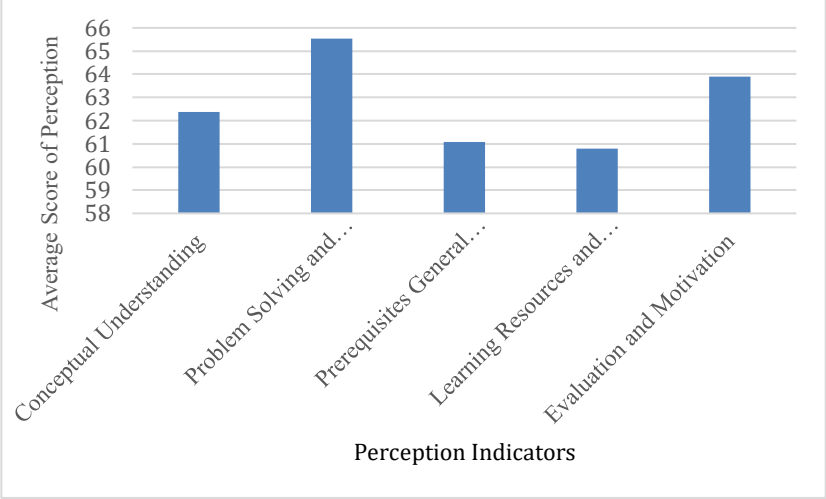

Figure 2. Distribution of Students' Difficulties of Each Indicator

Overall, based on data in Figure 2, the greatest difficulties were found in "problem solving and analysis". It means students tend to struggle when understanding reaction mechanisms or solving problems requiring advanced reasoning. It has been suggested by Grove & Bretz (2012) that there is a need for a shift in emphasis from memorization to conceptual understanding in problem solving in organic chemistry courses. In addition, problem-solving will fail if students do not understand the relationship between concepts (Nakhleh, 1992). Meanwhile, moderate to high difficulties were found in "conceptual understanding" and "evaluation and motivation". Relatively lower difficulties were found in "learning resources and teaching methods". Conventional teaching methods often do not suit students' learning styles, causing difficulties in understanding concepts (Sirhan, 2007).

These findings indicate that strengthening analytical skills, developing problem-solving-based learning strategies, and increasing learning motivation are key priorities for improving the organic chemistry learning process.

2. Perception Based on Gender

The perceptions comparing male and female students are presented in Figure 3. The graph in Figure 3 displays the average comparison of perception scores between male and female preservice science teachers. Figure 3 shows that female students obtained a slightly higher mean perception score than male students, indicating marginally greater perceived learning difficulties among female preservice science teachers. However, this difference in average scores needs to be statistically tested to determine whether it is statistically significant or not.

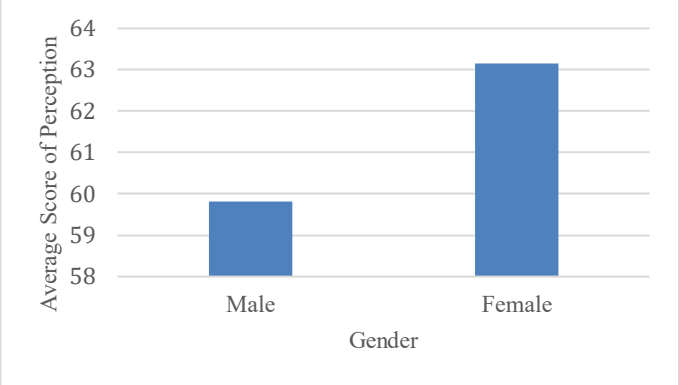

Figure 3. Comparison of Average Responses Based on Gender

To conduct statistical tests, prerequisite tests were carried out in the form of normality tests on the data, the results of which are presented in Table 3. The data in Table 3 shows the results of a normality test using the Shapiro-Wilk test on the perception data of male students. The test results indicate that the Sig. value is 0.562 (> 0.05). While normality test using the Kolmogorov–Smirnov test with Lilliefors Significance Correction on the perception data of female students. The test results indicate that the Sig. value is 0.200 (> 0.05). Based on the decision-making criteria: If Sig. > 0.05, the data is normally distributed, while if Sig. < 0.05, the data is not normally distributed. Therefore, the perception data for male and female students are normally distributed.

Table 3. Perception Normality Test Results Based on Gender

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	**df**	**Sig.**	**Statistic**	**df**	**Sig.**
PercepMale				.945	12	**.562**
PercepFemale	.075	91	**.200***			

*. This is a lower bound of the true significance.
a. Lilliefors Significance Correction

The data analysis was then followed by a homogeneity test using Levene's test, with the results shown in Table 4. The test produced a Sig. value of 0.269 (> 0.05). According to the decision rule, data are considered homogeneous when Sig. > 0.05, it can be concluded that the perception data of both male and female students exhibit homogeneity.

Table 4. Homogeneity Test Results Based on Gender

	Sum of Squares	**df**	**Mean Square**	**F**	**Sig.**
Between Groups	117.217	1	117.217	1.237	**.269**
Within Groups	9572.851	101	94.781		
Total	9690.068	102			

This condition indicates that the data distribution between groups is normal and homogeneous, so a parametric comparison test (independent sample t-test) should be used for two groups (male and female). The results generated from the independent sample t-test are shown in Table 5.

Table 5. Independent Sample T-Test Results Based on Gender

		Levene's Test for Equality of Variances		t-test for Equality of Means		
		F	**Sig.**	**t**	**df**	**Sig. (2-tailed)**
Perception	Equal variances assumed	2.830	.096	-1.112	101	**.269**

The test results indicate that the Sig. value is 0.269 (> 0.05). Therefore, there is no significant difference between male and female students' perceptions. This small difference between male and female perceptions of learning difficulties is statistically not enough to be considered significant.

The results obtained in this study do not show conformity with research that has been conducted, Maspupah & Purnama (2020) which found that females experience greater learning difficulties than males. Although this study focused on mathematics, it can be considered relevant because learning organic chemistry, particularly in the topic of stoichiometry, requires mathematical skills.

3. Correlation between General Chemistry Scores and Perception

As a first step, a normality test was conducted as part of the assumption test. The findings from the Kolmogorov-Smirnov test are shown in Table 6.

Table 6. Normality Test Results of General Chemistry Scores and Perception

	Kolmogorov-Smirnov[a]		
	Statistic	df	Sig.
GenChemScores	.137	103	**.000**
Perception	.075	103	**.172**

a. Lilliefors Significance Correction

The test results showed that the sig. value (0,000) was less than 0,05 for general chemistry scores, indicating that the data were not normally distributed. While sig. value (0,172) was greater than 0,05 for perception, indicating that the data were normally distributed. Therefore, a correlation test was performed using the Spearman test.

The results of the Spearman test between general chemistry scores and students' perceptions are presented in Table 7.

Table 7. Spearman Test Results of General Chemistry Scores and Perception

			Perception	GenChemScores
Spearman's rho	Perception	Correlation Coefficient	1.000	.982**
		Sig. (2-tailed)	.	**.000**
		N	103	103
	GenChemScores	Correlation Coefficient	.982**	1.000
		Sig. (2-tailed)	**.000**	.
		N	103	103

**. Correlation is significant at the 0.01 level (2-tailed).

Referring to the data in Table 6, the Sig. value is shown to be below 0.05, indicating a significant relationship between general chemistry scores and students' perception of their learning difficulties on organic chemistry course. The results of this study are similar to other studies that found that initial general chemistry scores and GPA were highly correlated with organic chemistry scores (Lee & Rix, 2023). Also, there is a significant correlation between general chemistry scores and performance on various types of organic chemistry questions (Austin et al., 2015). Specifically, students with higher general chemistry scores tended to perform better on analysis and mechanisms (high cognitive demand) questions. In other words, general chemistry (and quantitative ability) are important predictors of success in organic chemistry.

The relationship between general chemistry scores and students' perceptions of learning difficulties can be illustrated by the following diagram in Figure 4.

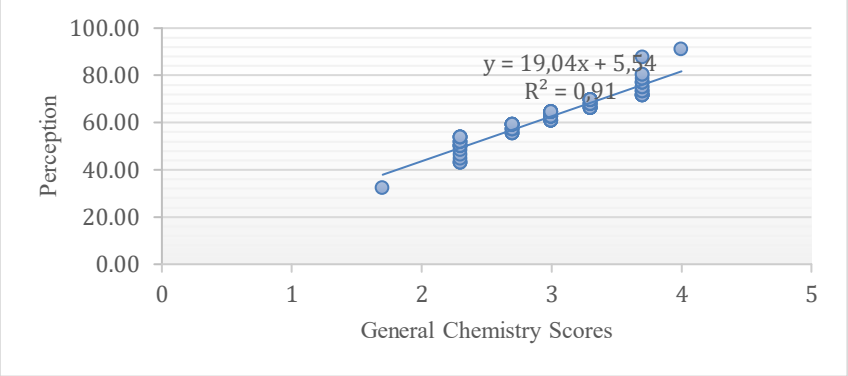

Figure 4. Correlation between General Chemistry Scores and Learning Difficulties Perception

The data points in the graph presented in Figure 4 form an upward trend, indicating that the higher the General Chemistry score, the higher the student's perception of the course. This indicates a positive correlation between the two variables. The resulting regression equation is: $y = 19.04x + 5.54$. The regression equation is mathematically correct. However, its interpretation and validity depend on the fulfillment of regression assumptions and the statistical significance of the estimated coefficients.

The coefficient of determination is: $R^2 = 0.9104$. This means that 91.04% of the variation in student perception can be explained by variations in General Chemistry scores. There is a very strong association between prior achievement in General Chemistry and preservice teachers' perceptions of difficulty in Organic Chemistry. Although the regression model explains a substantial proportion of variance in perceived difficulty ($R^2 = 0.91$), this finding should be interpreted with caution. Given that prior academic achievement may shape students' confidence and expectations, the observed relationship likely reflects reverse causation rather than a direct causal effect of General Chemistry performance on perceptions of Organic Chemistry difficulty.

These results suggest that students with a strong foundation in General Chemistry tend to have more positive perceptions of learning Organic Chemistry. This might be because understanding basic concepts helps students feel more confident and makes it easier to follow subsequent material. On the other hand, students with lower General Chemistry scores tend to have less favorable perceptions, possibly because they experience obstacles in mastering the material.

Students who have performed low grades in foundational courses tend to report more difficult advanced courses, so the observed relationship between perceived difficulty and grades may reflect reverse causation (Botnaru et al., 2021). So, that initial performance influences perceptions. Logically, the experience of failure or low grades in a prior course, in this context, General Chemistry, shapes students' cognitive and affective schemas. For example, they become more anxious, lower their self-expectations, and interpret the new material as more challenging. This may not be solely because the material is intrinsically difficult, but rather because the lens of prior experience alters subjective assessments of difficulty. Consequently, there is a high correlation between perceived difficulty in Organic Chemistry and General Chemistry grades.

The results of this study support a previous study that students find organic chemistry very challenging, and a number of difficulties arise even after they have passed General Chemistry (Salame, et al., 2020). One of the alternative ways that can be done to reduce students' difficulties in understanding organic chemistry includes linking it to real environmental contexts to make it more meaningful and stimulate higher-order thinking skills (Pratama et al., 2023). In addition, using real-world problem scenarios in organic chemistry can help students understand reaction

mechanisms and chemical consequences more deeply (Rahmi et al., 2025). Furthermore, efforts to design and develop learning materials that are appropriate to students' initial abilities are highly recommended.

However, this research cannot yet determine whether the observed relationship represents a causal effect or merely a correlation. Establishing causality would require further investigation using a longitudinal design that measures students' perceptions both before and after instruction, as well as controlling for relevant pre-existing variables that may influence both perception and academic performance. Another limitation of this study is that the sample was drawn from a single institution. Future research should involve larger sample sizes drawn from multiple institutions to enhance the generalizability of the findings.

Conclusion

The results of this study revealed that preservice science teacher students' perceptions of learning difficulties in the organic chemistry course were split between positive and negative levels in equal proportions. Based on difficulty indicators, problem-solving and analysis were the most difficult. Comparisons based on gender indicate that the perceptions of male and female students do not differ significantly. Meanwhile, the relationship between General Chemistry scores and learning difficulties perception, a significant association was observed.

The findings of this study suggest that Organic Chemistry instruction in Indonesian preservice science teacher education programs should place greater emphasis on strengthening prerequisite knowledge from General Chemistry, which is often uneven due to variations in students' secondary school backgrounds. Implementing early diagnostic assessments can help lecturers identify conceptual gaps and provide targeted academic support. Moreover, because perceptions of learning difficulty are shaped by prior learning experiences, instructional practices should address both cognitive and affective aspects, including students' self-efficacy and learning confidence. At the program level, these findings highlight the importance of integrating explicit pedagogical preparation that enables preservice science teachers to recognize common learning difficulties in Organic Chemistry and to design appropriate instructional interventions aligned with the implemented curriculum.

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