

# Self-Efficacy And Attitudes Toward Chemistry Of Pre-Service Chemistry Teachers: Gender And Grades Level Perspective

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**Abstract:** The aim of the study was investigated self-efficacy (SE) and attitudes toward chemistry (ATC) of chemistry teacher candidates based on gender and grades level. The number of samples was 300 of chemistry teacher candidates (200 women and 100 men) determined by clustered random sampling method. Cross-sectional survey and focus group interview was conducted at this study. Chemistry attitudes and experiences questionnaire (CAEQ) was used as a data collecting instrument. The data was analyzed by MANOVA using 0.05 significance quantitatively and by Patton method to process interview result. The results indicated that 1) there were differences between SE and ATC regarding on gender and grades level; 2) ATC and SE level of female chemistry teacher candidates were higher than male; and 3) There were differences of ATC on freshman, sophomore, and junior grade, but the differences did not occur at SE. Furthermore, the result was supported by the survey findings; both male and female of chemistry teacher candidates had similar SE on freshman, sophomore, and junior grade, but it had differences of ATC on freshman, sophomore, and junior grade.

**Index Terms:** self-efficacy, attitude toward chemistry, preservice chemistry teachers, gender and grades level Perspective.

## 1. INTRODUCTION

Benchmarks in the quality of competency of chemistry teacher candidates are not only focused on cognitive achievement but also the development of psychomotor and affective domains. Among the affective domain that has a significant influence on the learning outcomes of chemistry, teacher candidates are the self-efficacy (SE) and attitudes toward chemistry (ATC) of students [1], [2]. Therefore, it is very significant to develop the attitude, self-efficacy, and motivation of students during the learning process so that it has a positive impact on the learning outcomes of prospective chemistry teachers [3], [2]. However, many research showed that the development of attitude and self-efficacy in chemistry learning tends to be neglected, so that, the impact on the low scientific attitude and self-efficacy of students at the primary, secondary, and higher education level [4], [5]. The development of the ability of self-efficacy (SE) and attitudes toward chemistry (ATC) of prospective chemistry teachers is crucial to be implemented because it does not only have a positive impact on academic achievement but also mandatory in future career development. The SE ability has a positive correlation with students' ATC abilities; the higher the SE, the higher the student's ATC, and vice versa [6]. Self-efficacy is students' belief in their ability to complete chemical tasks, whereas scientific attitude is a tendency for individual behavior in solving problems through scientific methods [7], [8]. However, studies on SE and ATC of chemistry teacher candidates are still a few and focused on scientific attitudes of students generally [9], [10], [11]. Therefore, in-depth and focused study in measuring the ability on SE and ATC of prospective chemistry teachers at the university are primarily needed. It could be a benchmark on the success of the learning process. The success learning process can develop the SE and ATC capabilities of prospective chemistry teachers.

It is greatly influenced by the application of innovative learning models and methods so that the learning objectives of chemistry that include the cognitive, affective, and psychomotor domains can be achieved. However, the chemistry learning problems occurred due to the lack of experimental activities and the learning process that is more focused on mastering concepts rather than developing SE and ATC students [12], [13]. Therefore, in order to achieve the maximum learning objectives of chemistry, it is necessary to improve the quality of chemistry learning through the application of methods, strategies, and learning environments by utilizing innovative technologies, so that, the SE and ATC of chemistry teacher candidates can be improved [14], [7], [9]. In addition to the method, strategy, and learning environment factors, many studies interestingly showed that there is a relevance between SE and ATC students based on gender and grades level. It is supported by several studies in many countries such as Xu, Villafane, and Lewis in the United States [14]; Cheung in Hong Kong [2]; Salta and Tzougraki in Greece [15]; and Zeidan and Jayosi in Palestine [16] resulting that the grades level and gender affect the ability of SE and ATC of students. The studies from various countries are more focused on the primary and secondary levels, but these studies have not revealed many factual conditions in higher education. Therefore, it is crucial to research mapping the SE and ATC factual conditions of prospective chemistry teachers in terms of gender and grades level. Based on the above explanation, hopefully, this study may uncover and map the factual conditions of the ATC and SE of chemistry teacher candidates which had not conducted previously. The benefits of this research include 1) map the SE factual conditions of prospective chemistry teachers at the higher education level based on gender and grades level; 2) map the factual ATC conditions of prospective chemistry teachers at the higher education level based on gender and grades level; and 3) the result findings could be a reference in the planning and implementation of learning chemistry to be able developing SE and ATC of chemistry teacher candidates. Besides, this study aimed at determining the differences in SE and ATC of chemistry teacher candidates based on gender and grades level.

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## 2 RESEARCH METHOD

A cross-sectional survey design was chosen as a research design because it can measure the relationship between two or more variables and interpret the situation of the research object [17]. Three hundred prospective chemistry teachers were selected by clustered random sampling method as the study sample (200 women and 100 men) originated from Universitas Mataram. The research sample consisted of juniors (33.3%), sophomore (33.3%), and freshmen (33.3%) regarding on grades level; and 66.7% female and 33.3% male regarding on gender. Ten lecturers and fifty students were involved in focus group interviews through deep interview techniques [18]. The chemistry attitudes and experiences questionnaire (CAEQ) questionnaire developed by Coll, Dalgety, and Salter [19] was implemented in this research. Expert validators conducted instrument validation in the form of construct validity and face validity. Empirical tests were carried out to measure the level of instrument reliability and obtained Cronbach's alpha coefficient of  $\alpha = 0.87 > 0.70$ . Thus the instrument used had met the reliability requirements [20]. In the Focus Group Interview (FGI) activity, 12 questions were developed by researchers as supporting quantitative data obtained from the questionnaire. Each variable was represented by six questions (SE and ATC) so that there were 12 questions involving expert validators who expert in language and content. Arrangement of the number of participants is determined based on the willingness of participants to participate in FGI by disguising their identity. Deep interview technique was chosen to give participants the freedom to express their opinions and to deepen their reasons [18].

## 3 RESULTS AND DISCUSSION

The type of data generated in this study consisted of quantitative and qualitative data. Quantitative data were obtained from the results of the CAEQ questionnaire analyzed by the Manova test to measure the correlation between two or more variables (Bernard, 2000). The MANOVA test was carried out after fulfilling the prerequisite tests, namely the normality test with  $p\text{-value} > 0.05$  (normally distributed data, multicollinearity test obtained  $VIF = 0.40$  (no multicollinearity), and the scatter plot matrix linearity test showed a positive correlation between each pair of variables. Qualitative data were obtained from interviews and analyzed into repetitive patterns concerning the qualitative analysis suggested by Patton (2002). The strengths of the Patton technique can help in identifying the emergence of elements that cannot be anticipated when conducting interviews ((Ismail, & Jarrah; 2019). The qualitative data findings obtained were very instrumental in supporting the quantitative data findings. Based on the results of data analysis, it shows that the Levene's SE and ATC tests obtained  $p > 0.05$  (Table 1). There is no difference in variance consistent with the MANOVA assumption. Therefore, data analysis can be continued with the MANOVA test.

**Table 1.** Levene's test results (Homogeneity test)

	F	df1	df2	Sig.
Self Efficacy	1.569	5	294	.169
Attitudes Toward Chemistry	1.379	5	294	.232
Overall	1.087	5	294	.368

The MANOVA test results showed that there were differences in SE and ATC based on gender and grades level with  $p < 0.05$  (Table 2). It means the null hypothesis is rejected, and the alternative hypothesis is accepted. The results of this study are very relevant to previous studies, which proved that gender differences affect SE [21]. Likewise, student's ATC was also influenced by grades level [22]. Furthermore, to find out the SE and ATC levels of students based on gender and grades level, it was obtained based on the mean value.

**Table 2.** MANOVA test results of SE dan ATC based on Gender and Grades Level

Effect		Sig.
Gender	Pillai's Trace	.000
	Wilks' Lambda	.000
	Hotelling's Trace	.000
	Roy's Largest Root	.000
Grades	Pillai's Trace	.023
	Wilks' Lambda	.023
	Hotelling's Trace	.023
	Roy's Largest Root	.023

Based on the mean obtained, the data showed that there are differences in the SE and ATC levels of prospective chemistry teachers. SE and ATC for female were found to be higher than male (Table 3). The prospective chemistry teachers obtained remarkably result where the level of SE and ATC freshman grade was the highest compared to a sophomore or junior grades (Table 4).

**Table 3.** Mean Value of SE and ATC Based on Gender

Variable Dependent	Gender	Mean
Self-Efficacy	Male	94.295
	Female	95.648
Attitude Toward Chemistry	Male	73.952
	Female	78.524

**Table 4.** Mean Value of SE and ATC Based on Grades Level

Dependent variable	Grades	Mean
Self-Efficacy	Freshman	95.883
	Sophomore	94.724
	Junior	94.308
Attitude Toward Chemistry	Freshman	79.746
	Sophomore	71.209
	Junior	77.759

An interesting fact was obtained based on the research findings that female had higher SE and ATC levels compared to male. The results of this study are perthe previous research proved that women had a higher SE than male [7]. Research conducted by Calik, U "Itay, Kolomucc, and Aytard, also found that male had lower ATC compared to female [23]. The tendency of female to have higher SE and ATC is due to women having stronger motivation, determination, persistence, and unyielding attitude compared to male in doing chemical course tasks [7], [42]. The findings of this study are very relevant to the results of the interviews as follows: According to Ah (lecturer) "Based on ten years of teaching experience, female students are more motivated and more determined in carrying out lecture tasks as well as in practicum in the laboratory so that it gains the higher achievement of learning outcomes compared to male students." Af (male) expressed, "I feel less interested in doing lecture assignments or carrying out practical work because I feel less confident in completing these assignments." Zi (female) stated, "I feel challenged in doing the assignments given by the lecturer,

especially when carrying out experimental activities because it is exciting when carrying out the stages of an experiment to prove the concepts that have been learned through the practicum." To examine thoroughly, the Test of Between-Subjects Effects was conducted to analyze the differences of each factor on the dependent variable. The results showed that there were differences in SE based on gender and ATC based on grades level because p values were  $<0.05$  (Table 5). Conversely, there was no difference in ATC based on gender and SE based on grades level because p values  $> 0.05$  were obtained.

**Table 5.** The Test Results of Between-Subjects Effects SE dan ATC

Effect	Dependent Variable	F	Sig.
Gender	Self-Efficacy	3.929	.048
	Attitude Toward Chemistry	2.663	.104
Grades	Self-Efficacy	2.223	.110
	Attitude Toward Chemistry	10.703	.000

Other exciting research findings also revealed that there were differences in SE based on gender and in ATC based on grades level. In contrast, there was a no difference in ATC based on gender and in SE based on grades level. This result means that student confidence does not increase every semester, even though the learning experience increases every semester. This condition is caused by current chemistry learning practices which tend to be teacher-centered, lack of learning activities that develop independence, attitudes, and skills of students [1], [3], [16], [25]. Previous research also proved that learning methods and strategies through the use of innovative technology have a positive impact on increasing self-efficacy and scientific attitudes [9]. In addition, the ability of SE and ATC of students affects academic achievement because it increases motivation, persistence, and perseverance of students in doing lecture assignments or practicum [7], [21]. Therefore, the planning and implementation of chemistry learning are student-centered so that they can improve the SE, ATC, and mastery of chemical concepts [26]. The survey findings are very relevant to the results of the interview as follows: According to Dh (Junior), "Learning experience in class and practicum in the previous semester is essential to increase my confidence to complete lecture assignments so that my academic achievement had a significant increase." Sh (sophomore) "The lecture assignments in the first year made me more skilled in completing practical work and complete lecture assignments in the following semester." Furthermore, Sz (freshman) revealed, "The learning experience in the laboratory in the early semester made me even more motivated to be more persevering in doing each task which would be very important in doing lecture assignments in the following semester." To strengthen the previous findings, the next step is continued by measuring ATC, SE, and LE more specifically based on grades level. Tukey HSD Multiple Comparisons test results show the difference between SE and ATC based on grades category. Based on the results of the Tukey HSD test, there is no SE difference between freshman, sophomore, and junior grades because p-values  $>0.05$  (Table 6) was obtained. However, there were differences in ATC between freshman, sophomore, and junior grades with p-values  $<0.05$ .

**Table 6.** Multiple Comparisons of SE and ATC Test Results based on Grades

Dependent Variable		Grades	Grades	Sig.
Self Efficacy (SE)	Tukey HSD	Freshman	Sophomore	.249
			Junior	.201
		Sophomore	Freshman	.249
			Junior	.992
		Junior	Freshman	.201
			Sophomore	.992
Attitude Chemistry (ATC)	Tukey HSD	Freshman	Sophomore	.003
			Junior	.010
		Sophomore	Freshman	.003
			Junior	.010
		Junior	Freshman	.003
			Sophomore	.010
Overall	Tukey HSD	Freshman	Sophomore	.000
			Junior	.020
		Sophomore	Freshman	.000
			Junior	.020
		Junior	Freshman	.020
			Sophomore	.020

The research findings show that there is a difference between freshman, sophomore, and junior grade related to ATC. Interestingly, there is no SE difference between freshman, sophomore, and junior grades. These results are very relevant to previous studies that revealed grades level influenced ATC [7], [22]. The following interview results also support the findings based on the survey: According to Sf (junior), "I feel that my learning experience and ability to complete lecture assignments have improved because I have learned from the experience of doing assignments in the previous semester." Be (sophomore) stated, "the provision of independent assignments and practicum activities in the first year made me more motivated and confident to complete lecture assignments in the following semester because as the semester increased, I gained additional experience thereby increasing my academic performance." Sz (Lecturer) "The SE of female and male students are not much different at every grades level, but the ATC of students is increasing in the third year because it is supported by learning experiences in the first and second year." The ability of self-efficacy and chemical scientific attitude of students is positively correlated with the academic performance so that it affects the increase in the academic achievement of prospective chemistry teachers. This condition is very relevant to many research results which prove that SE and ATC greatly influence chemistry learning achievement at the college level [27], [28]. Likewise, the differences between SE and ATC based on gender and grades level are the primary considerations in the planning, implementation, and evaluation of chemistry learning so that it influences the improvement of learning processes and outcomes at the higher education level. Thus it is essential to uncover and map the ability of SE and ATC prospective chemistry teachers as one of the efforts in exploring problems and formulating the best solutions for current chemistry learning practices (21st Century Learning).

#### 4 CONCLUSION

The results of the study revealed exciting facts, including differences in SE and ATC based on gender and grades level. The levels of ATC and SE chemistry teacher candidates were higher in females than males. There were differences in ATC in freshman, sophomore, and junior grades, but there was no SE difference in freshman, sophomore or junior grades. The

interviews also reinforced the survey findings that male and female chemistry teacher candidates had a similar SE between freshman, sophomore, and junior, but there were ATC differences between freshman, sophomore, and junior. Therefore, it is recommended at higher education level to prioritize the development of SE and ATC in the learning process so that it has a positive impact on improving the performance and academic achievement of prospective chemistry teachers. In addition, the findings of this study are expected to contribute to further research in examining the ability of prospective chemistry teachers from aspects of chemical scientific attitudes and skills which are still rarely investigated.

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