MIER Journal of Educational Studies, Trends & Practices
November 2019, Vol. 9, No. 2 pp. 191 - 211

INVESTIGATION OF ATTITUDES TOWARD CHEMISTRY AND LEARNING EXPERIENCES OF PRE-SERVICE CHEMISTRY TEACHERS

Dwi Wahyudiati, Hari Sutrisno and Isana Supiah YL

The objective of this research was to investigate the level of students' attitudes toward Chemistry and Learning Experience (ATCLE). The research sample included 191 students (61 male and 130 female) from three universities; Universitas Negeri Mataram, Universitas Islam Negeri Mataram, and IKIP Mataram, Indonesia. The sample has been selected through cluster random sampling and snowballs random sampling. Mixed method research with a descriptive correlational survey model and a semi-structured interview was employed for the study. The data were collected by Chemistry Attitudes and Experiences Questionnaire (CAEQ) and an interview guide. Results showed no significant correlation in the level of attitude toward chemistry based on gender and grades. The finding also revealed that the attitude of pre-service chemistry teachers based on gender and grade were more positive towards research in chemistry than jobs related to chemistry. However, grades influenced the students learning experience, but there was no influence of gender on students learning experience. It is suggested that teachers need to develop a positive attitude toward chemistry and learning experiences of the students through inquiry-based learning practices.

KEYWORDS: Attitude Toward Chemistry, Chemistry Learning Experiences, Pre-Service Chemistry Teachers

---

Dwi Wahyudiati ✉
Research Scholar, Universitas Negeri Yogyakarta, Yogyakarta, Indonesia
Email: dwiwahyudiati.2017@student.uny.ac.id

Hari Sutrisno
Professor, Universitas Negeri Yogyakarta, Yogyakarta, Indonesia
Email: sutrisnohari@uny.ac.id

Isana Supiah YL
Associate Professor, Universitas Negeri Yogyakarta, Yogyakarta, Indonesia
Email: sutrisnohari@uny.ac.id

INTRODUCTION

Scientific attitude is an important aspect that must be developed so that it becomes a benchmark for the success of learning in higher education. The development of scientific attitudes as an indicator of the development of positive attitudes towards science is the main requirements of the curriculum in schools (Cheung, 2007; Bennet, Rolnick, Green, & White, 2001; Thomas, Koballa, & Crawley, 1985). However, based on the results of the study, the ability of scientific attitudes, understanding of chemical concepts and practicum skills are still relatively low at the college level (Nurhayati & Subroto, 2012; Wahyudiati, 2016; Smith, 2012; Vilafane & Lewis, 2016; Taber, 2001; Calik, Ultay, Kolomuc, & Aytar; 2015). Furthermore, the biggest challenge nowadays is that most students have negative attitudes towards science (Calik, Ozsevgez, Ebenezer, Artun, & Kucuk, 2014; Atwater, Wiggins, & Gardner, 1995). Even there is an interesting finding which shows that students' positive attitudes tend to decline throughout their development in school (Hill, Atwater, & Wiggins, 1995; Simpson, & Oliver, 1985).

According to Dalgety (2003), the indicators of scientific attitude includes attitude towards chemistry, chemical independence, and chemistry learning experience. The development of scientific attitudes is very influential on learning experiences and student learning achievement. According to Osborne, Simon, and Collins (2003), Xu, Villafane, and Lewis (2013), Cukrowska, Staskun, and Schoeman (1999), and Xu and Lewis (2011), students with high scientific attitude abilities have academic abilities higher in science learning. However, based on the results of previous studies, the positive attitudes of students at the primary, secondary and tertiary levels are still relatively low (Stark & Gray, 1999; Weinburgh, 1995). This condition is caused by the practice of science learning which is still focused on increasing cognitive abilities so that scientific attitudes and skills tend to be neglected (Zeidan, & Jayosi, 2015; Hofstein, Ben-Zvi, Samuel, & Tamir; 1977; Ismiani, Syukri, & Wahyudiati, 2017; and Villafane, & Lewis, 2016).

The scientific attitude development of chemistry students in higher education must be carried out so that the learning objectives covering aspects of attitudes, knowledge, and skills can be optimally achieved. However, empirical studies in Indonesia show that chemistry learning in higher education prioritizes mastery of cognitive aspects so it gives negative impact by neglecting their behavior and psychomotor aspects (Rubini, & Liliasari, 2013; Nurhayati, & Subroto, 2012; Irwanto, Saputro, Rohaeti, & Prodjosantoso, 2018a; Wahyudiati, 2010; Irwanto, Rohaeti, & Prodjosantoso, 2018b). Based on the empirical study, it was revealed that learning chemistry in universities in Indonesia is still dominated by lecturer-centered learning practices. It is also

due to lack of practice based on scientific and context-based learning. Therefore, these problems are vital and must be overcome to find the best alternative solutions so that chemistry learning activity can be carried out effectively.

Based on previous research studies, it has been proven that there is relevance of Attitude Toward Chemistry (ATC) with Learning Experiences (LE), and there are differences based on sex and class level. The interesting finding showed that the most significant factor affecting ATC is gender (Cheung, 2007; Calik, Ozsevgez, Ebenezer, Artun, & Kucuk, 2014, George, 2006; Greenfield, 1997; Jones, Howe, & Rua, 2000). Grades also affect the attitudes and learning experiences of chemistry learning (Doherty, & Dawe, 1985; Aiken, 1979; House, 1995; and Menis, 1989). However, various previous studies produced different findings in which there were no significant differences between men and women on their attitudes towards science (Bui & Alfaro, 2011; Dhindsa & Chung, 2003). Furthermore, male students have a more positive attitude towards science than female students (Stables, 1990; Jones, Howe, & Rua 2000; Hacieminoglu, 2015; and Greenfield, 1996). However, research conducted by Villafane and Lewis (2016) gave different facts which showed that women have a more positive attitude towards science than men.

Referring to the previous literature review, there are more studies on the measurement of Attitudes Toward Chemistry and Learning Experiences (ATCLE) at the secondary level than the tertiary level. Moreover, the measurement of ATCLE of pre-service chemistry teachers has not been widely studied (Calik, Ozsevgez, Ebenezer, Artun, & Kucuk, 2014). In fact, to be able to develop a positive attitude towards chemistry at the primary and secondary levels, it is necessary for pre-service chemistry teachers who master the concept and have adequate ATCLE. Therefore, it is very important to conduct a study to map the ability of ATCLE chemistry teacher candidates based on grades and gender, especially in universities in Indonesia. Another strong reason the researcher was interested in conducting ATCLE research based on gender was related to the input of chemistry students in universities which are dominated by female. This fact was obtained based on the results of preliminary observations at 3 universities showing the dominance of women, with a percentage of 20% male and 80% female. These factual conditions are very relevant to the results of previous studies conducted by Cheung (2007) in Hong Kong, Calik, Ozsevgez, Ebenezer, Artun, and Kucuk (2014) in Turkey, Salta and Tzougraki (2004) in Greece, Menis (1989) in The United States, Harvey and Stables (1986) in the United Kingdom, and Villafane and Lewis (2016) in the United States, which proved that the most significant factor influencing

scientific attitudes is gender differences. Various literature studies have mapped scientific attitudes based on gender with studies in various countries. However, this factual condition has never been studied in universities in Indonesia.

Referring to the importance of this research, the researcher strongly believes that the research findings will make a very important contribution to the factual conditions of ATCLE pre-service chemistry teachers in Indonesia. Furthermore, the benefits of this research are; 1) can be a reference for lecturers in planning chemistry learning which is able to develop affective, cognitive, and psychomotor aspects, 2) as a vehicle for linking teaching and research to higher education, 3) the efforts to improve the ability of scientific attitudes will affect the quality of graduates, and finally it can improve the quality of education at the tertiary level. The purpose of this study was to; 1) know the attitudes toward chemistry (ATC) which were typically owned by pre-service chemistry teachers, 2) know the ATC level of chemistry teacher candidates in terms of gender and education level, 3) know the ATC relation based on gender and education level, and 4) know the influence of gender and grades towards learning experiences (LE) of chemistry teacher candidates.

Research Questions

The research questions of this study are:

1. What are the typical attitudes toward chemistry of pre-service chemistry teachers?
2. What is the ATC level of pre-service chemistry teachers based on gender and level of education?
3. Is there a correlation between gender and the level of education towards the ATC of pre-service chemistry teachers?
4. Is there an effect of gender and grades on learning experiences of pre-service chemistry teachers?

Research Hypotheses

The null hypotheses of the research are:

1. There is no correlation between gender and ATC of pre-service chemistry teachers.
2. There is no correlation between grades and ATC of pre-service chemistry teachers.
3. There is no effect of gender towards learning experiences of pre-service

chemistry teachers.

4. There is no effect of grades towards learning experiences of pre-service chemistry teachers.

Research Design

The research design of this study used a mix method research design (Iyankova, Creswell, & Stick, 2009) through a descriptive correlational survey method and continued with the interview stage. The selection of descriptive correlational survey method was suitable for this study because this kind of research is able to measure the pattern of relations between two or more variables (Stangor, 2004; Adegboyega, 2018). The advantage of survey methods is that we can analyse and even interpret the situation of the object of research (Cohen, Manion & Morrison, 2007). The results of the analysis of the survey results was followed by interviews aimed at strengthening the accuracy of survey data so that the accuracy of the data became more reliable.

Sample Of The Study

The sample of this study was obtained from 3 universities; Universitas Mataram, Universitas Islam Negeri Mataram, and IKIP Mataram in the 2018/2019 academic year. The sample included 191 pre-service chemistry teacher students consisting of students from freshman (43.00%), sophomore (30.05%), and junior (26.94%) years as shown in Table 1. A cluster random sampling (Fowler, 2002) technique was used during the survey stage and for interviews a snowball random sampling technique (Creswell, 2009) was utilised.

Table 1

Sample of Demographic Characteristics.

Grade Level	Female	Male	Total
Freshmen	58	25	83
Sophomore	38	20	58
Junior	34	16	50
Total	130	61	191

Tools For Data Collection

The ATC instrument of this study was adopted from the Chemistry Attitudes

and Experiences Questionnaire (CAEQ) instrument developed by Coll, Dalgety, and Salter (2002). This CAEQ questionnaire consists of 3 sub tests; 1) opinions about chemistry and related topics having 15 items, 2) confidence in completing different tasks with 17 items, and 3) experience in chemistry classes with 31 items. However, this study was limited to 2 sub tests; 1) opinions about chemistry and related topics, and 2) experience in chemistry classes. Furthermore, instrument validation was carried out in the form of face validity and construct validity by expert validators from 3 universities namely Universitas Mataram, Universitas Islam Negeri Mataram, and IKIP Mataram. After by the validator stated that the instrument was suitable, it went through empirical test and reliability level. The Cronbach's alpha coefficient of the instrument was $\alpha = 0.90$ and the reliability of the coefficient of the test was above the acceptance limit, namely > 0.70 (Hair, Black, Babin, & Anderson, 2010), so that the instrument was categorized as reliable.

Data Collection And Data Analysis

The research data was obtained by sequential mixed methods (Teddlie, & Tashakkori, 2009). The first stage data was collected by administering the CAEQ questionnaire and followed by interviews. The CAEQ questionnaire was filled by students who were pre-service chemistry teachers from the first, third and fifth semesters in three different universities namely Universitas Mataram, Universitas Islam Negeri Mataram, and IKIP Mataram. The data collection was done through interviews with snowball random sampling techniques. Categorizing the interview sample was based on the previous CAEQ questionnaire score with reference to three categories: high, medium, and low. Analysis of research data was carried out through two stages because there were two types of data obtained, which were quantitative and qualitative data. Quantitative data was obtained from the CAEQ questionnaire with one point for a very negative response and seven points for the most positive response. Learning experiences attitude data were analysed by Two-way ANOVA to measure the causal relationship between one dependent variable and two independent variables (Hair, Black, Babin, Anderson, & Tatham, 2006). The data of attitudes toward chemistry were analysed by regression analysis to measure the correlation between variables. The analysis continued with One-way ANOVA to identify whether there were significant differences between the two independent groups. Next, Pearson Correlation analysis was carried out to calculate the significance of the correlation between attitudes toward chemistry based on grade level and gender. The data analysed has fulfilled the prerequisites with homogeneity values $p = 0.57$ (Bernard, 2000). On the other hand, the data obtained from the interviews were analysed by

qualitative descriptive techniques to complement and strengthen the results of previous quantitative data analysis.

FINDINGS OF THE STUDY

Research Question 1

What are the typical attitudes toward chemistry of pre-service chemistry teachers?

To answer the first research question, mean and standard deviation were computed as given in Table 2. Based on data analysis, the highest average score in chemistry research was 0.980, for chemistry job 0.918, and for chemist 0.919. The data implied a typical ATC attitude which was positive attitude towards chemistry research than chemistry job and chemists.

Table 2

Mean of Attitudes toward Chemistry based on Grade and Gender.

Indicator	Number of Items	Mean	SD
Chemists	1-7	0.919	0.121
Chemistry Research	8-11	0.980	0.072
Chemistry Job	12-15	0.918	0.123

Identification of pre-service chemistry teacher's ATC was not only relied on the mean of highest score but also by Post Hoc test in each dimension based on grades (Table 3). The research result showed that each dimension had significance value between each grade > 0.05, which means that there were no attitude differences among freshman, sophomore, and junior for each dimension, as well as there was no correlation among them.

Table 3

Post Hoc Test of Attitudes toward Chemistry based on Grades.

Dependent Variable	Grades	Grades	*p*
Chemists	Freshman	Sophomore	1.000
		Junior	1.000
	Sophomore	Freshman	1.000
		Junior	1.000
	Junior	Freshman	1.000
		Sophomore	1.000
Chemistry Research	Freshman	Sophomore	0.941
		Junior	1.000
	Sophomore	Freshman	0.941
		Junior	0.378
	Junior	Freshman	1.000
		Sophomore	0.378
Chemistry Job	Freshman	Sophomore	0.319
		Junior	1.000
	Sophomore	Freshman	0.319
		Junior	0.975
	Junior	Freshman	1.000
		Sophomore	0.975
Overall	Freshman	Sophomore	0.948
		Junior	1.000
	Sophomore	Freshman	0.948
		Junior	1.000
	Junior	Freshman	1.000
		Sophomore	1.000

Research Question 2

What is the ATC level of pre-service chemistry teachers based on gender and level of education?

The research result showed that the ATC level of pre-service chemistry level based on gender had no difference (Table 4). However, t-test result for each dimension, especially chemistry job, showed that the attitude of chemistry job implied differences between male and female for the significance value of 0.05 (Table 5).

Table 4

Descriptive Statistics of Students' Scientific Attitude based on Gender.

Indicator	Gender	N	Mean	SD
Chemists	Male	61	0.909	0.125
	Female	130	0.923	0.119
Chemistry Research	Male	61	0.979	0.069
	Female	130	0.981	0.074
Chemistry job	Male	61	0.942	0.115
	Female	130	0.906	0.125
Overall	Male	61	0.937	0.061
	Female	130	0.934	0.062

Table 5

Result of t-test for Equality of Means for Each Indicator based on Gender.

Indicator	Number of Items	t	Sig.(2-tailed)
Chemists	1-7	-0.765	0.445
ChemistryResearch	8-11	-0.112	0.911
ChemistryJob	12-15	1.940	0.054
Overall Attitudes		0.287	0.774

The overall average score of attitudes toward chemistry based on education level showed that the average score of freshmen was higher than both sophomore and juniors (Table 6). It also applied on the significance value of each dimension based on grades where the value of $p > 0.05$ (Table 7), which means that there was no difference of ATC based on grades. However, the average score for each indicator implied that indicator of chemistry research had the higher score on sophomore grade for 0.991 (Table 6) compared to freshman and junior.

Table 6

Descriptive Statistics of Students' Scientific Attitude based on Grades.

Indicator	Grades	N	Mean	SD
Chemists	Freshman	83	0.924	0.114
	Sophomore	58	0.913	0.139
	Junior	50	0.914	0.112
Chemistry Research	Freshman	83	0.979	0.080
	Sophomore	58	0.991	0.046
	Junior	50	0.970	0.082
ChemistryJob	Freshman	83	0.931	0.112
	Sophomore	58	0.897	0.141
	Junior	50	0.920	0.118
Overall	Freshman	83	0.941	0.054
	Sophomore	58	0.929	0.077
	Junior	50	0.931	0.053

Table 7

The Correlation on Attitudes toward Chemistry based on Grades.

Indicator	Number of Items	*F*	*p*
Chemists	1-7	0.166	0.847
Chemistry Research	8-11	1.211	0.300
Chemistry Job	12-15	1.329	0.267
Overall Attitudes		0.651	0.523

Research Question 3

Is there any correlation between gender and the level of education towards the ATC of pre-service chemistry teachers?

Null Hypothesis:

1. There is no correlation between gender and ATC of pre-service chemistry teachers.
2. There is no correlation between grades and ATC of pre-service chemistry teachers.

To test the null hypothesis, the Pearson's Correlation test among variables was applied. Based on the analysis, there is no correlation between grades and gender in attitudes toward chemistry ($p>.05$) (see Table 8).

Table 8

Pearson's Correlation Coefficient for Attitudes toward Chemistry.

Variable		Gender	Grade Levels	Overall Attitudes
Gender	Pearson (r)		-0.021	-0.021
	Sig.		0.771	0.774
Grade Levels	Pearson (r)	-0.021		-0.071
	Sig.	0.771		0.327
Overall Attitudes	Pearson (r)	-0.021	-0.071	
	Sig	0.774	0.327	

Based on statistical test, Pearson's coefficient of correlation value of chemist dimension with chemistry job was .001< .05, which means that there was a positive and significant correlation between two indicators (Table 9). The correlation between other dimensions obtained p > .05 which indicated that there is no positive correlation. It means that dimension of chemist and chemistry job had a positive correlation. On the other hand, there was no correlation between other ATC dimensions. After the Pearson correlation test, Post Hoc test was carried out for each ATC dimension based on grades (Table 10).

Table 9

Coefficient of Correlation in Attitudes toward Chemistry.

Variables		Chemists	Chemistry Research	Chemistry Job
Chemists	Pearson (r)		0.074	-0.238
	Sig.		0.309	0.01
Chemistry Research	Pearson (r)	0.074		-0.072
	Sig.	0.309		0.322
ChemistryJob	Pearson (r)	-0.238	-0.072	
	Sig	0.001	0.322	

Table 10 shows the results of Post Hoc test for each indicator of attitude based on grades. The analysis implies that all indicators had significant value between each grade for > 0.05 (Table 10), which means that there was no difference among the attitude of chemist, chemistry research, and chemistry job for the grades of freshman, sophomore, and junior, as well as there was no correlation among grades.

Table 10

Post Hoc Test in Attitudes toward Chemistry based on Grades.

Variables	Grades	Grades	*p*
Chemists	Freshman	Sophomore	1.000
		Junior	1.000
	Sophomore	Freshman	1.000
		Junior	1.000
	Junior	Freshman	1.000
		Sophomore	1.000
Chemistry Research	Freshman	Sophomore	.941
		Junior	1.000
	Sophomore	Freshman	0.941
		Junior	0.378
	Junior	Freshman	1.000
		Sophomore	0.378
Chemistry Job	Freshman	Sophomore	0.319
		Junior	1.000
	Sophomore	Freshman	0.319
		Junior	0.975
	Junior	Freshman	1.000
		Sophomore	0.975
Overall	Freshman	Sophomore	0.948
		Junior	1.000
	Sophomore	Freshman	0.948
		Junior	1.000
	Junior	Freshman	1.000
		Sophomore	1.00

Research Question 4

Is there a direct effect of gender and grades variable on learning experiences (LE) of pre-service chemistry teachers?

Null Hypothesis:

1. There is no effect of gender towards learning experiences (LE) of pre-service chemistry teachers.

2. There is no effect of grades towards learning experiences (LE) of pre-service chemistry teachers.

Besides the ATC data based on gender and grades, this research also measured the tertiary learning experiences (LE) of pre-service chemistry

teachers. According to the data analysis, the Levene's test had result of p=0.028 > 0.05 (Table 11), which means that there was no difference with F value for 1.393 hence, the null hypothesis was accepted.

Table 11

Result of Levene's Test (Homogeneity Test).

F	*df1*	*df2*	*p*
1.393	5	185	0.228

ANOVA test results showed that there was an effect of grades towards LE with p=0.000 (Table 12). It implied that the null hypothesis was rejected. Conversely, gender was not affected by LE with p=0.204 >0.05 (null hypothesis accepted).

Table 12

Test Result of Subjects Effect in Learning Experience.

Variables	*F*	*p*
Grades	11.418	0.000
Gender	1.623	0.204

The differences existing in learning experiences between gender and grades were shown by the test result of Tukey HSD and Bonferroni. According to the test, there was a difference in learning experience attitude between freshman and sophomore with p=0.000 (Table 13), so as between freshman and junior with p = 0.004 < 0.05.

Table 13

Difference of Learning Experiences based on Grades.

	Grades		**Mean**	*p*
Tukey HSD	Freshman	Sophomore	7.39	0.000
		Junior	5,72	0.004
	Sophomore	Freshman	-7.39	0.000
		Junior	-1.67	0.649
	Junior	Freshman	-5.72	0.004
		Sophomore	1.67	0.649
Bonferroni	Freshman	Sophomore	7.39	0.000
		Junior	5.72	0.004
	Sophomore	Freshman	-7.39	0.000
		Junior	-1.67	1.000
	Junior	Freshman	-5.72	0.004
		Sophomore	1.67	1.000

Discussion And Conclusions

The first aim of the study was to find out the typical ATC owned by pre-service chemistry teacher based on gender and grades. The results of the study revealed that the positive attitudes were shown in the dimensions of chemistry research. This positive attitude was due to the positive impact of the practical activities that have been carried out so that they could develop their ATC abilities. The findings of this study were supported by the research of Cheung (2009), Adesoji, and Raimi (2004), and Calik, UItay, Kolomuc, and Aytar (2015) which revealed the existence of positive attitudes towards chemistry research as a result of positive impact of laboratory assignments. The findings based on the results of the questionnaire was also strengthened by the results of interviews, where Student Al stated that, *"Practical activities are very fun because they develop our problem solving skills"*. Furthermore, according to Student R, *"Practical activities can help train the ability to conduct chemistry research in order to produce important findings for the existence of living things"*. This opinion was supported by the results of Wong and Freser (1996) who illustrated a positive correlation between the enjoyment of students who studied chemistry with chemical laboratory assignments.

The results of this study also measured the typical attitudes of pre-service chemistry teacher based on grades on ATC dimensions. The research findings revealed that there were no differences in attitudes towards chemists, chemistry research, and chemistry jobs based on grades, and there was no correlation among them. This condition was caused by the application of the same learning system at each level so that there was no difference in ATC. It was in accordance with the statement of Student N (junior year) that *"The lecture system applied in the first, second, and third years had no difference because all of them are dominated by the lecturing method"*. Furthermore, Student D (freshman year) argued that *"The lack of application of varied learning methods causes learning to be monotonous and students become passive in understanding ideas"*. Likewise, in the opinion of Student H (sophomore) that *"Learning methods or strategies at each level are more oriented towards understanding concepts"*. These findings were supported by the results of previous studies which revealed that the role of higher education institutions in improving ATC was still not optimal (Calik, UItay, Kolomuc, & Aytar, 2015). In line with this opinion, various studies also revealed that student ATCs declined as they progressed through school years (Georges, 2006; Simpson & Oliver, 1985; Atwater & Wiggins, 1995; Greenfield, 1997).

The research findings revealed that there was no difference in ATC of chemistry teacher candidates in terms of gender and grades. These results

were supported by previous studies which revealed no difference in ATC by gender (Miller, Lietz & Kotte, 2002; Dhindsa & Chung, 2003). However, for the ATC dimension, an interesting finding showed that women had a higher attitude towards chemists and chemistry research. While for the chemistry job attitude, it was found to be higher in men, although the difference was not significant. The tendency of women to have a higher attitude towards chemists and chemistry research was because women preferred research activities in the laboratory more than men (Shannon, 1982). In contrast, men had a higher interest in chemical work with various varied choices to pursue (Calik, Ultay, Kolomuc, & Aytar, 2015). The findings based on the questionnaire were also reinforced by the results of interviews such as the statement given by Student NH (female), *"I am very interested in doing practical activities or chemical research because I can find new things by proving lecture material concepts, which are very useful in everyday life"*. Another opinion expressed by Student RF (male) stated that *"I am very motivated to do chemistry work because I can train my scientific skills and abilities in supporting learning and create a provision to achieve a career in this field in the future"*.

The finding of the ATC level based on grades indicated that sophomore grade had higher grades than other groups' grades. In addition, sophomores showed the highest attitude in chemistry research, but showed a low response to the dimension of chemistry job. This condition was influenced by the implementation of more intense experimental activities carried out in the second year so that they could develop a more positive attitude towards chemistry than in the first year. The same thing was also stated by Cheung (2007), Doherty, and Dawe (1985), and House (1995) who stated that the level of education affects students 'attitudes toward chemistry. Subsequent finding indicated that there was no correlation between gender and grades with ATC. The results of this study were supported by previous research which proves that there is no gender correlation with student attitudes towards science (Bui & Alfaro, 2011; Dhindsa & Chung, 2003). Grades also did not have a positive correlation with attitude toward chemistry of students (Calik, Ultay, Kolomuc, & Aytar, 2015). However, the results of the study indicated that the dimensions of chemists and chemistry jobs had a positive correlation. This condition was influenced by the positive response to chemists. Dieck (1997) also stated that science or chemical education programmes were able to develop positive attitudes towards chemistry jobs. The questionnaire result was supported by the interviews result, where according to Student Zh, *"Carrying out chemical experiments is very interesting because I can find new things like what the previous chemists did so I am sure to choose it as a profession that I will pursue"*. Further, Student Ma stated that,

"Practicing activities is one of my favorite activities because it can help me to prove the phenomena that occurs in the surrounding environments".

In addition to the ATC finding based on gender and grades, this research also measured learning experiences (LE) of pre-service chemistry teachers. The research findings proved that there was an effect of grades on learning experiences, but there was no gender influence. This finding was reinforced by previous research which showed that grades has a significant influence on chemistry learning experiences (Aiken, 1979; House, 1995; Menis, 1989), but is not influenced by gender (Bui, & Alfaro, 2011; Dhindsa, & Chung, 2003). The finding based on the questionnaire was also supported by the results of interviews as follows:

According to Student Nb, *"In the third year, I become more interested in chemistry because the discussion of material was more specific and experiment activities become more enjoyable with the experience of the previous year".*

Student Md argued that, *"In the first year, it was difficult to understand the material and carry out the experiment, but in the second and third years the material studied became more specific, so it was easier to understand, and the practical experience has increased from the previous year".*

Student Za further stated that, *"In the first year, I found difficulty in doing experiments, but in the third year I have been better in understanding the use of tools and materials, as well as do the experimental procedures more carefully so that practicum activities can run smoothly".*

Learning experiences greatly influenced the development of positive attitudes towards chemistry learning. Previous studies have also proven the creation of tertiary inquiry-based learning environments that have a profound influence on improving students' scientific attitudes (Pietzner, 2014; Ayyildiz, & Tarhan, 2012; Hugerat, & Kortam, 2014). Therefore, improving the quality of learning chemistry requires a variety of innovative strategies and improvement in the lecturers' quality (Osborne, Simon, & Collins, 2003; Calik, Ozsevgez, Ebenezer, Artun, & Kucuk, 2014). Further research in this field is still very much needed, especially those aimed at measuring attitudes toward chemistry and learning experiences, from the primary, secondary and tertiary levels.

Referring to the research findings, it can be concluded that: 1) Attitude toward chemistry (ATC) of pre-service chemistry teacher based on gender and grades were more positive for chemistry research than chemistry job and chemists, 2) ATC level for pre-service chemistry teachers by gender and grades had no difference, but there were differences in the dimensions of the

chemistry job, 3) There was no correlation between gender and grades towards ATC, but there was a positive correlation between the dimensions of chemists and chemistry job, 4) The level of education affected learning experiences of pre-service chemistry teachers, but there was no gender influence. It is recommended for higher education institutions and lecturers to develop ATCLE of students from the first year through the development of inquiry-based learning environments. In addition, further research is needed to study ATCLE in universities, in terms of academic majors, lecture programmes, grades, and gender.

REFERENCES

Adesoji, F. A., & Raimi, S. M. (2004). Effects of enhanced laboratory instructional technique on senior secondary students' attitude toward chemistry in Oyo Township, Oyo State, Nigeria. *Journal of Science Education and Technology, 13*(3), 377–385.

Aiken, L. R. (1979). Attitudes toward mathematics and science in Iranian middle schools. *School Science and Mathematics, 79*(3), 229–234.

Atwater, M. M., Wiggins, J., & Gardner, C. M. (1995). A study of urban middle school students with high and low attitudes toward science. *Journal of Research in Science Teaching, 32*(6), 665-677.

Ayyildiz, Y., & Tarhan, L. (2012). The effective concepts on students' understanding of chemical reactions and energy. *Hacettepe Üniversitesi Journal of Education, 1*(42), 72–83.

Bernard, H. R. (2000). *Social research methods: Qualitative and quantitative approaches*. California: Sage Publications, Inc.

Bennett, J., Rollnick, M., Green, G., & White, M. (2001). The development and use of an instrument to assess students' attitude to the study of chemistry. *International Journal of Science Education, 23*(8), 833–845.

Bui N. H., & Alfaro, M. A. (2011). Statistics anxiety and science attitudes: age, gender and ethnicity factors, *College Student Journal, 45*(3), 573–585.

Calik, M., U'Itay, N., Kolomuc, A., & Aytar, A. (2015). A cross-age study of science student teachers' chemistry attitudes. *Chemistry Education Research and Practice, 16*, 228-236.

Çalik, M., O¨zsevgeç, T., Ebenezer, J., Artun, H., & Ku¨çu¨k, Z. (2014). Effects of environmental chemistry elective course via technology embedded scientific inquiry model on some variables, *Journal of Science Education and Technology, 23*(3), 412–430.

Cheung, D. (2009). Students' attitudes toward chemistry lessons: the interaction effect between grade level and gender. *Research in Science Education, 39*, 75–91.

Cheung, D. (2007). Developing an instrument to measure students' attitudes toward chemistry lessons for use in curriculum evaluation. *Paper presented at the 38th annual conference of the Australasian Science Education Research Association*, Fremantle, Australia.

Cohen, L., Manion, L., & Morrison, K. (2007). *Research methods in education.* (6th Edition). London: Routledge.

Coll, R. K., Dalgety, J., & Salter, D. (2002). The development of the chemistry attitudes and experiences questionnaire (CAEQ), *Chemistry Education Research and Practice, 3*(1), 19–32.

Creswell, J. W. (2009). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*. Thousand Oaks, CA: Sage.

Dalgety, J., Coll, K.R., & Jones, A. (2003). Development of chemistry attitudes and experiences questionnaire (CAEQ). *Journal of Research in Science Teaching, 40 (7)*, 649–668.

Dhindsa, H. S., & Chung, G. (1999). *Motivation, anxiety, enjoyment and values associated with chemistry learning among form 5 Bruneian students*. Paper presented at the MERA-ERA joint conference, Malacca, Malaysia.

Dhindsa, H. S. & Chung, G. (2003). Attitudes and achievement of Bruneian science students. *International Journal of Science Education, 25*, 907-922.

Dieck, A., P. (1997). *The effect of a newsletter on children's interest in an attitude toward science.* Retrieved June 26, 2011 from http://wwwlib.umi.com /dissertations/fullcit/1384031.

Doherty, J., & Dawe, J. (1985). The relationship between development maturity and attitude to school science: An exploratory study. *Educational Studies, 11*(2), 93–107.

Fowler, E.J. (2002). *Survey research method 3rd ed*, Thousand Oaks, CA: Sage.

George, R. (2006). A cross-domain analysis of change in students' attitudes toward science and attitudes about the utility of science. *International Journal of Science Education, 28*(6), 571–589.

Greenfield, T. A. (1996). Gender, ethnicity, science achievement and attitudes. *Journal of Research in Science Teaching, 33*, 901-933.

Hacieminoglu, E. (2015). Elementary school students' attitude toward science

and attitude toward science and related variables. *International Journal of Environmental & Science Education, 11*(2), 35-52.

Hair, F.J., Black, C.W., Babin, J.B., & Anderson, E.R. (2010). *Multivariate data analysis (3rd ed)*. New Jersey: Pearson Prentice Hall.

Hair, Jr. J. F., Black, W. C., Babin, B. J., Anderson R. E., & Tatham, R. L. (2006). *Multivariate Data Analysis, 6th Edn*, New Jersey: Prentice-Hall International.

Harvey, T. J., & Stables, A. (1986). Gender differences in attitudes to science for third year pupils: An argument for single-sex teaching groups in mixed schools. *Research in Science and Technological Education,* 4(2), 163–170.

Hill, G., Atwater, M., & Wiggins, J. (1995). Attitudes toward science of urban seventh-grade life science students overtime, and the relationship to future plans, family, teacher, curriculum, and school. *Urban Education, 30*(1), 71-92.

Hofstein, A., Ben-Zvi, R., Samuel, D., & Tamir, P. (1977). Attitudes of Israeli high-school students toward chemistry and physics: A comparative study. *Science Education, 61*(2), 259–268.

House, D.J. (1995), Noncognitive predictors of achievement in introductory college chemistry. *Research in Higher Education, 36*(4), 473–490.

Hugerat, M., & Kortam, N. (2014), Improving higher order thinking skills among freshmen by teaching science through inquiry. *Eurasia Journal of Mathematics, Science and Technology Education, 10*(5), 447–454.

Irwanto, Rohaeti, E., & Prodjosantoso, A.K. (2018a). A survey analysis of pre-service chemistry teachers' critical thinking skills. *MIER Journal of Educational Studies, Trends & Practices, 8*(1), 57–73.

Irwant, Rohaeti, E., & Prodjosantoso, A. K. (2018b). Undergraduate students' science process skills in terms of some variables: A perspective from Indonesia. *Journal of Baltic Science Education, 17(5)*, 751-772.

Iyankova, N. V., Creswell, J. W., & Stick, S. L. (2006). Using mixed methods sequential explanatory design: From theory to practice. *Field Methods, 18*, 3–20.

Jones, G., Howe, A., & Rua, M. (2000). Gender differences in students' experiences, interests, and attitudes towards science and scientists. *Sci. Educ., 84*, 180–192.

Menis, J. (1989). Attitudes towards school, chemistry and science among

upper secondary chemistry students in the United States. *Research in Science & Technological Education, 7*(2), 183–190.

Miller, L., Lietz, P., & Kotte, D. (2002). On decreasing gender differences and attitudinal changes. Factors influencing Australian and English pupils' choice of a career in science. *Psychology, Evolution, and Gender, 4,* 69-92.

Osborne, J., Simon, S., & Collins, S. (2003). Attitudes towards science: A review of the literature and its implications. *International Journal of Science Education, 25*(9), 1049–1079.

Oskamp, S., & Schultz, P.W. (2005). *Attitudes and opinions (3rd ed.)*. Mahwah, NJ: Lawrence Erlbaum Associates.

Pietzner, V. (2014), Computer-based learning in chemistry classes. *Eurasia Journal of Mathematics, Science and Techno- logy Education, 10*(4), 297–311.

Rubini, B., & Liliasari. (2013). Basic natural science for scientific attitude development and values of life. *International Journal of Science and Research,* 2(5). 465-468.

Salta, K., & Tzougraki, C. (2004). Attitudes toward chemistry among 11th grade students in high schools in Greece. *Science Education, 88,* 535–547.

Shannon, A.G., Sleet, R. J., & Stern, W. (1982). School students' attitudes to science subjects. *Australian Science Teachers Journal, 28*(1), 77–82.

Simpson, R. D., & Oliver, S. J. (1990). A summary of major influences on attitude toward and achievement in science among adolescent students. *Science Education, 74*(1), 1-18

Smith, J.C. (2012). Improving the school to university transition: using problem-based learning approach to teach practical skills whilst simultaneously developing students independent study skills. *Chemistry Education Research and Practice, 4(13),* 490-499.

Stables, A. (1990). Differences between pupils from mixed and single-sex schools in their enjoyment of school subjects and in their attitudes to science and to school. *Educational Review, 42*(3), 221–230.

Stark, R., & Gray, D. (1999). Gender preferences in learning science. *International Journal of Science Education, 21*(6), 633–643.

Stangor, C.O. (2004). *Research methods for behavioural sciences.* Boston: Houghton Mifflin Co.

Teddlie, C., & Tashakkori, A. (2009). *Foundations of mixed methods research: Integrating, quantitative, qualitative, approaches in the social and behavioral sciences*. Thousand Oaks, CA: Sage.

Thomas, R., Koballa, Jr., & Crawley, F. (1985). The influence of attitude on science teaching and learning. *School Science and Mathematics, 85*(3), 222-232.

Triandis, H. C. (1971). *Attitude and Attitude Change*. New York: Wiley.

U¨ltay, N., & Çalik M. (2012). A thematic review of studies into the effectiveness of context-based chemistry curricula. *Journal of Science Education and Technology, 26*(6), 686–701.

Villafane, S.M., & Lewis, J.E. (2016). Exploring a measure of science attitude for different groups of students enrolled in introductory college Chemistry. *Chemistry Education Research and Practice, 4(17),* 731-742.

Xu, X., Villafane, S.M., & Lewis, J.E. (2013). College students' attitudes toward chemistry, conceptual knowledge and achievement: structural equation model analysis. *Chemistry Education Research and Practice, 14,* 188–200.

Xu, X., & Lewis, J.E. (2011). Refinement of a chemistry attitude measure for college students, *Journal of Chemistry Education, 88*(5), 561–568.

Wahyudiati, D. (2016). Analisis efektivitas kegiatan praktikum sebagai upaya peningkatan hasil belajar mahaisswa. *Jurnal Tastqif, 14*(2), 143-168.

Weinburgh, M. (1995). Gender differences in student attitudes toward science: a meta-analysis of the literature from 1970 to 1991. *Journal of Research in Science Teaching, 32*, 387-398.

Wong, A. F. L., & Fraser, B.J. (1996). Environment-attitude associations in the chemistry laboratory classroom. *Research in Science and Technological Education, 14*(1), 91–102.

Zeidan, H.A., & Jayosi, R.M. (2014). Science process skills and attitudes toward science among Palestinian secondary school students. *World Journal of Education, 1*(5), 13-24.