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Assessing Vietnamese High School Students' Attitudes toward Chemistry

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ABSTRACT Attitude towards chemistry not only enhances students' chemical perception but is also extremely important because it manifests the interests and emotions towards studying chemistry by students. The main objective of this study is to examine high school students' attitudes toward learning chemistry. The group of 870 high school students (382 males and 488 females) from nine high schools in Vietnam participated in the survey. They completed a 29-item questionnaire about their attitude towards chemistry, chemistry teachers and non-formal chemistry education. The results of this study indicated that there were significant differences in gender and grade level on students' attitude towards learning chemistry. Twelfth grade had a more positive attitude towards chemistry teachers than eleventh grade and tenth grade. There was not a significant multivariate effect for interaction between gender and grade level. All results obtained from this research are necessary for educating and enhancing student's attitude towards science, especially chemistry.

INTRODUCTION

The essential students' characteristics' which influence successful studies are not only motivation and genuine interest but also attitude (Berg 2005; Dalgety and Coll 2005). During the socialisation process, attitude development depends on personal knowledge and personal experience. The component of attitude includes affective, cognitive and behaviour (Petty et al. 2003). In other words, attitude comprises emotions towards a subject, faith, knowledge, and a propensity to act. Olasehinde and Olatoye (2014) described scientific attitudes as attitudes' which could be improved and enhanced. They are also consistent, reasonable and objective responses when confronting challenges based on the ethical rules of science.

Generally, there are numerous studies researching attitudes toward studying science by students, but few studies on attitudes toward learning chemistry have been meticulously investigated in recent years. Chemistry is a significant branch of science associated with the properties and reactions of matter's substances (Bennett and Holman 2002). Chemistry's knowledge assists students in observing, discovering, and understanding natural phenomena involving chemistry and happenings in daily life. Chemistry curricula in many secondary and high schools contain a variety of abstract concepts to enable students to learn both chemistry and other sciences (Taber 2002).

Intelligence is not enough for students to learn chemistry effectively. Students also need to have a positive scientific attitude when they study chemistry. Attitude towards chemistry is extremely important because it manifests the interests and emotions towards studying chemistry by students. Students' interest has a significant role in making a decision about studying science by students (Abulude 2009; Lindahl 2003; Milner et al. 1987). Attitude toward studying chemistry enhances students' chemical perception, which is the ability to identify chemical concepts, understand scientific questions, apply their knowledge about chemistry to elucidate phenomena in daily life, and read simple chemical articles (Shwartz et al. 2006).

The attitudes toward studying the chemistry of students have been thoroughly studied and well documented in numerous scientific researches for a long time. Hofstein et al. (1977) reported that students had more positive feelings and interests in learning chemistry than physics in a comparative study with Israeli stu-

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dents ageing from 16 to 18 years in high school. The researchers also revealed that the positive attitudes toward chemistry of girls were the same as boys. According to the findings in the research conducted in Greece, students who were in high school held neutral attitudes related to the interest in and the obstacles of chemistry courses (Salta and Tzougraki 2004). Besides, the researchers also reported that although students recognised the essentiality of chemistry's knowledge in real-life situations, they did not believe in the importance of chemistry's knowledge for their future career. Nevertheless, the research of Osborne and Dillon (2008) conducted in Europe, surveyed numerous students and indicated that there were differences in interest in science between girls and boys. Shannon et al. (1982) conducted a research in Sydney in Australia, and investigated the attitudes towards science subjects of eleventh-grade students. The authors indicated that female students had more pleasant feelings when learning chemistry than male students. Another study conducted by Hofstein et al. (1977) and Steinkamp and Maehr (1984) had similar findings which indicated that females had a more positive attitude towards learning chemistry compared to males. On the contrary, Menis (1983) surveyed a group of tenth-grade students' attitude towards chemistry courses, and revealed that males expressed a more good feelings and interests in discovering and learning chemistry compared to females. Similarly, Barnes et al. (2005) showed the gender differences in enrolment intentions in a research with 449 participants who were tenth-grade students in Sydney, Australia. Researchers concluded that males expressed more interests in learning chemistry than females.

Besides, it was found that gender differences occurred only in the low-achieving students in their object (Brandriet et al. 2011). Previous achievement in a chemistry course when studying in secondary school influenced students' scientific and emotional attitudes toward learning chemistry when learning in high schools. The result is directly in line with findings of prior research (Brandriet et al. 2011; Narmadha and Chamundeswari 2013; Xu and Lewis 2011) that concluded that there was a positive relationship between attitude and academic achievement. Attitudes have a substantial effect on academic achievement because students who have the right feelings or opinions will be drawn to science' and scientific attitudes play a significant role for students in accomplishing objectives during the study process. Both academic achievements and attitudes towards students' learning could be enhanced by adding more exciting science lessons to education curricula and building various effective learning environments (Ozel et al. 2013). One of the primary factors to build and increase interest in discovering and learning subjects of science is the classroom environment. Experiences in discovering science also influences the change of students' attitude towards subjects which demonstrates the important role of teachers in inspiring students to learn chemistry (Osborne et al. 2003). However, Osborne and Dillon (2008) explored a negative correlation between attitudes towards studying science and academic achievement.

It is essential to develop positive attitudes because of the change of attitudes over time (George 2000). Recent scientific researches reported the ignorance of students in learning chemistry (Hofstein and Mamlok-Naaman 2011). Students showed low interest in learning when participating in the chemistry course (Fahmidani and Rohaeti 2020). This finding is following the finding reported by Cheung (2009), who reported that seven out of ten students interviewed showed no interest in learning chemistry.

The reasons for poor attitude toward chemistry in the learning process could be the fear of failure when studying a chemistry course (Jegede 2007), the complexity of content, the lack of awareness of chemistry's necessity in life, the uninteresting laboratories' which had substandard experiment equipment, few experiential learning activities about the natural science, especially chemistry, along with the low motivated teachers who could not engage and inspire students when studying (Najdi 2013). Many researchers indicate that both nature and academic content of the education curricula are primary reasons for the decrease in interest in science such as physics and chemistry (Eilks et al. 2008; Gilbert 2006; Gräber 2002). Science curricula of science education in many countries are considered to be overloaded with the knowledge' which only focuses on the academic subjects' inner content structure (Gräber 2002). This

frequently results in education curricula containing low levels of orientation towards various problems resulting from real-life situations and social issues (Holbrook 2005). Suppose the scientific knowledge taught in the learning process at school is relevant to students' real-life situations, and they realise the importance of science to society in which students live. In that case, they could create, grow and maintain a positive attitude towards studying chemistry.

In a study about attitudes toward chemistry in Singapore and with the participants who aged from 15 to 16 years old studying in gifted and non-gifted high schools, Lang et al. (2005) suggested that there was a relation between active teacher-student interactions, open-ended chemistry laboratory environments and developed student attitudes toward learning chemistry, especially for the gifted students. Most students expressed their positive attitudes towards learning chemistry because they got experiences in the laboratory. This finding supports the conclusions drawn by Zhang and Lei (2018). The authors reported that if students were given the chances to conduct chemical experiments in the laboratory, they would have a positive scientific attitude towards studying chemistry, but students who only learned at the classroom with teachers did not express a negative attitude towards studying chemistry. Besides, there are few numbers of experimental studies, which showed the influences of interventions on attitudes toward chemistry of students. According to scientific research by Sarantopoulos and Tsaparlis (2004), the finding revealed that applying analogies to the teaching methods assisted educators in developing high school students' attitude towards studying chemistry and increasing their academic achievement.

The attitude towards studying chemistry of students is not a new topic. However, few studies have focused on this subject in Vietnam (Tran-Chi et al. 2019), especially for high school students. To fill this gap, the researchers examine the effects of gender and grade on high school students' attitude concerns, specifically, Attitudes of students towards chemistry (ATC), Attitudes of students towards chemistry teachers (ATCT), and Attitudes of students towards non-formal chemistry education (ATCE). The research starts with reviewing the literature of students' attitudes towards studying chemistry in the secondary section. A basic analytical framework is described, including the research methodology, results and discussion, respectively. Finally, the conclusion is in the last section.

METHODOLOGY

Research Hypotheses

A 3x2 factorial design was used in the present study to investigate the joint influence of two variables, including gender and grade, on the attitudes of high school students toward chemistry. The students' personal information, including gender (male or female) and grade (10, 11, 12) were the independent variables. Three dependent variables were measured, that is, Attitudes of students towards chemistry (ATC), Attitudes of students towards chemistry teachers (ATCT) and Attitudes of students towards non-formal chemistry education (ATCE). The following null hypotheses were examined:

- Ho_1 (main effect): There is no significant difference in gender among the two study groups when they are compared simultaneously on the Attitudes towards chemistry (ATC), Attitudes towards chemistry teachers (ATCT), and Attitudes towards non-formal chemistry education (ATCE).
- Ho_2 (main effect): There is no significant difference in grade among the three study groups when they are compared simultaneously on the Attitudes towards chemistry (ATC), Attitudes towards chemistry teachers (ATCT), and Attitudes towards non-formal chemistry education (ATCE).
- Ho_3 (interaction effect): There is no significant interaction between gender and grade level when students are compared simultaneously on the Attitudes of students towards chemistry (ATC), Attitudes of students towards chemistry teachers (ATCT), and Attitudes of students towards non-formal chemistry education (ATCE).

Participants

Participants were selected randomly from nine high schools in Vietnam. All participants provided informed consent after being intro-

duced about the purpose of the research. The survey instrument was distributed to 900 Vietnamese participants, of which 870 questionnaires returned, for a 96.67 percent return rate, which exceeds the 30.0 percent response rate most researchers require for analysis (Dillman 2000; Huynh et al. 2018). This study's sample was 870 Vietnamese high school students from grade 10 (39.5%) more than grade 11 (27.9%) and grade 12 (32.5%) who were surveyed.

Table 1: An overview of respondents

		n	*%*
Gender	Male	382	43.9
	Female	488	56.1
Grade	Grade 10	344	39.5
	Grade 11	243	27.9
	Grade 12	283	32.5

n = Number of participants; % = Percentage

Measurement

Participants were required to finish the survey questionnaire, that is, the Vietnamese versions of the Attitudes of students towards learning chemistry (ATLC) based on the original Najdi (2013). The role of the teacher in the considering, approaching and applying materials and non-formal educational materials was mentioned. The scale included three subscales, including the Attitudes of students towards chemistry (ATC), Attitudes of students towards chemistry teachers (ATCT) and Attitudes of students towards non-formal chemistry education (ATCE). It was designed to evaluate the attitudes of students towards learning chemistry. Two bilingual researchers, understanding the construct being assessed, translated the 29 items of ATLC into Vietnamese. Vietnamese is the mother tongue language of the first researcher, and the other one is English. Forward and backward translation procedures were used. The sequence of items in the questionnaire was kept intact in the Vietnamese translation of the index. All participants were requested to respond to the questions carefully with answers that best described themselves. Reliability estimates yielded a correlation of .59 for ATC, .56 for ATCT, and .73 for ATCE. A value that is medium but still usually considered sufficient for a questionnaire (Bowling 2014; Taber 2018). Then all the items of the scale were calculated to find out the final score of the scale.

Procedure

Participants and their parents voluntarily agreed to participate and then signed consent forms regarding their rights in the completion of the study. Firstly, the General Information form, including grade, gender and country, was completed by participants. Then, the instructions of ATLC were introduced to participants by researchers. Students were informed that all their answers would be treated as strictly confidential, and the questionnaire did not have a wrong answer. They were asked to respond and complete each question on the basis of their own experience in learning process.

RESULTS

Descriptive Analysis

The participants got the average score on the Attitude Toward Learning Chemistry scale. The mean score for the ATC subscale was 3.01 (SD = 0.48). The mean score on the ATCT subscale was 3.22 (SD = 0.43). The mean score on the ATCE subscale was 3.19 (SD = 0.59). Table 2 presents descriptive statistics of dependent variables, including ATC, ATCT, and ATCE resulting by gender and grade level groups.

Inferential Analysis

The null hypotheses were examined with a two-way multivariate analysis of variance (MANOVA). In order to run MANOVA, the researchers conducted a preliminary assumption check for normality, homogeneity of variance-covariance matrices. MANOVA is robust to violations of homogeneity of variance/covariance matrices if the sizes of groups are nearly equal or the difference of the largest and smallest group is less than about 1.5 times (Leech et al. 2005; Huang et al. 2018). The largest group in this research (n = 210) was about 1.75 times larger than the smallest group (n = 120), and the multivariate homogeneity of variance-covariance matri-

Table 2: Number of participants in each grade by gender groups

Gender	*Grade group*			
	Grade 10	*Grade 11*	*Grade 12*	*Combined*
Male (n)	134	120	128	382
ATC				
M	3.03	3.05	3.06	3.05
SD	.64	.44	.52	.54
ATCT				
M	3.30	3.16	3.32	3.26
SD	0.53	0.45	0.45	.48
ATCE				
M	3.32	3.13	3.28	3.24
SD	.71	.60	.63	.66
Female (n)	*210*	*123*	*155*	*488*
ATC				
M	2.93	3.07	2.99	2.98
SD	.42	.43	0.44	.43
ATCT				
M	3.22	3.13	3.22	3.19
SD	.32	.46	.38	.38
ATCE				
M	3.20	3.12	3.09	3.15
SD	.49	.58	.56	.54

M = Mean, SD = Standard Deviation, n = Number of participants

ces tested with Box's M test revealed that the M value of 140.561 was significant ($p < 0.001$). Therefore, the assumption of homogeneity of covariance matrices was not satisfied. For this reason, a more robust statistic, Pillai's Trace value, was used for reporting the result (Huynh et al. 2018).

Based on the significant effects found from the MANOVA, a separate two-way univariate analysis of variance (ANOVA) for each of the dependent variables was conducted without undue inflation of the experiments Type I error (Grimm and Yarnold 1995). The Levene's Test of Equality of Error Variances tests the assumption of MANOVA and ANOVA that the variances of each variable are equal across the groups. If Levene's test is significant, this means that the assumption has been violated. In this research, the value of Levene's test came out to be significant for all the variables with ATC [$F(5, 864) = 3.734$, $p > 0.05$], ATCT [$F(5, 864) = 3.698$, $p > 0.05$], and ATCE [$F(5, 864) = 3.938$, $p > 0.05$]). Therefore, the assumption that the variances of each variable are equal across the groups was not satisfied.

There was a significant difference between males and females when considered jointly on the variables Attitudes of students towards chemistry (ATC), Attitudes of students towards chemistry teachers (ATCT), and Attitudes of students towards non-formal chemistry education (ATCE), and Pillai's Trace = .01, $F(3, 862) = 2.879$, $p = .035$, partial $\eta 2 = .01$. Therefore, the results suggested that the first hypothesis (Ho1) was rejected. A separate ANOVA was conducted for each dependent variable, with each ANOVA evaluated at an alpha level of 0.017 (that is, 0.05/3). There was a significant difference between males and females on Attitudes of students towards chemistry teachers, $F(1, 864) = 5.831$, $p = .016$, partial $\eta 2 = .007$, with males ($M = 3.26$, $SD = 0.02$) scoring higher than females ($M = 3.19$, $SD = 0.02$), and there was a significant difference between males and females on Attitudes of students towards non-formal chemistry education, $F(1, 864) = 6.148$, $p = .013$, partial $\eta 2 = .007$, with males ($M = 3.24$, $SD = 0.03$) scoring higher than females ($M = 3.14$, $SD = 0.03$). There was not a significant difference between males and females on Attitudes of students towards chemistry, $F(1, 864) = 2.435$, $p = .119$, partial $\chi^2 = .003$.

There was a significant difference between Grades 10, 11 and 12 when considered jointly on the variables Attitudes of students towards chemistry (ATC), Attitudes of students towards chemistry teachers (ATCT) and Attitudes of students towards non-formal chemistry education (ATCE), and Pillai's Trace = .03, $F(6, 1726) = 4.365$, $p < .0001$, partial $\eta 2 = .015$. Hence, the results suggested that the second hypothesis (Ho2) was also rejected. A separate ANOVA was conducted for each dependent variable, with each ANOVA evaluated at an alpha level of 0.017 (that is, 0.05/3). There was a significant difference between Grades 10, 11 and 12 on Attitudes of students towards chemistry teachers, $F(2, 864) = 6.947$, $p = .001$, partial $\eta 2 = .016$, with Grade 12 ($M = 3.27$, $SD = 0.03$) scoring higher than Grade 11 ($M = 3.14$, $SD = 0.03$) and Grade 10 ($M = 3.26$, $SD = 0.02$). There was not a significant difference between Grades 10, 11 and 12 on Attitudes of students towards chemistry, $F(2, 864) = 1.77$, $p = .171$, partial $\eta 2 = .004$ and there was not a significant difference between Grades 10, 11 and 12 on Attitudes of students towards non-

Table 3: Combined univariate ANOVA table

Source	*Dependent variable*	*Type III sum of squares*	*df*	*Mean square*	*F*	*Sig.*	*Partial Eta Squared*
Corrected Model	ATC	2.337[a]	5	.467	2.005	.076	.011
	ATCT	3.605[b]	5	.721	3.966	.001	.022
	ATCE	5.733[c]	5	1.147	3.294	.006	.019
Intercept	ATC	7657.142	1	7657.142	32858.849	.000	.974
	ATCT	8704.437	1	8704.437	47881.729	.000	.982
	ATCE	8522.625	1	8522.625	24485.661	.000	.966
Gender	ATC	.567	1	.567	2.435	.119	.003
	ATCT	1.060	1	1.060	5.831	.016	.007
	ATCE	2.140	1	2.140	6.148	.013	.007
Grade	ATC	.825	2	.413	1.770	.171	.004
	ATCT	2.526	2	1.263	6.947	.001	.016
	ATCE	2.632	2	1.316	3.781	.023	.009
Gender * Grade	ATC	.515	2	.258	1.106	.331	.003
	ATCT	.183	2	.091	.503	.605	.001
	ATCE	1.091	2	.545	1.567	.209	.004
Error	ATC	201.339	864	.233			
	ATCT	157.067	864	.182			
	ATCE	300.729	864	.348			
Total	ATC	8099.815	870				
	ATCT	9201.800	870				
	ATCE	9153.290	870				
Corrected Total	ATC	203.676	869				
	ATCT	160.672	869				
	ATCE	306.462	869				

a. R Squared = .011 (Adjusted R Squared = .006)
b. R Squared = .022 (Adjusted R Squared = .017)
c. R Squared = .019 (Adjusted R Squared = .013)

formal chemistry education, F (2, 864) = 3.781, p = .023, partial $\eta 2$ = .009.

The results revealed that there was not a significant multivariate effect for interaction between gender and grade level when considered jointly on the variables Attitudes of students towards chemistry (ATC), Attitudes of students towards chemistry teachers (ATCT) and Attitudes of students towards non-formal chemistry education (ATCE), and Pillai's Trace = .006, F (6, 1726) = .809, p = .563, partial $\eta 2$ = .003. Thus, the result suggested that the third hypothesis (Ho3) was not rejected (accepted).

DISCUSSION

The present study investigated the attitudes towards discovering and learning chemistry of high school students. The findings indicated that gender and grade groups of students had significant effects on the attitudes towards learning chemistry, attitudes towards chemistry teachers and attitudes towards non-formal chemistry education. However, this research showed no significant interaction between gender and grade groups of high school students when compared simultaneously on the Attitude Toward Learning Chemistry subscales.

The finding indicates the significant effects of gender on the Attitudes of students towards chemistry teachers and non-formal chemistry education scores among males and females. Except for Attitudes of students towards chemistry, males seemed to score higher than females on the two other subscales of the Attitude Toward Learning Chemistry. The finding is directly in line with previous findings of Menis (1983) and Barnes et al. (2005), which reported that male students showed a more pleasant feelings and positive thinkings about discovering and learning chemistry than female students. However, Hofstein et al. (1977), Shannon et al. (1982) and Steinkamp and Maehr (1984) concluded that males had a less positive attitude towards learning chemistry compared to females. Besides, several studies revealed that the positive atti-

tudes toward chemistry of females were the same as males (Hofstein et al. 1977), and both male and female high school students held neutral attitudes related to the obstacles of and eagernesss to be involved in chemistry courses (Salta and Tzougraki 2004). The findings indicate the significant effects of grade on the attitudes of students towards chemistry teachers with twelfth-grade students score higher than eleventh grade and tenth grade. However, the attitudes of tenth, eleventh and twelfth-grade students towards chemistry and non-formal chemistry education were not significantly different.

Contrary to the findings, Menis (1989) concluded that Grade 12 students expressed a more pleasant feelings about and interests in learning chemistry than eleventh-grade students. Nevertheless, Hofstein et al. (1976) examined tenth, eleventh and twelfth-grade high school student for attitudes toward experiences in the chemistry laboratory. They demonstrated that grade 12 students had less favourable attitudes toward the experiences and activities in chemistry laboratory than their grade 10 and 11 counterparts.

The high scores of high school students on the Attitudes of students towards chemistry teachers and non-formal chemistry education subscale showed the influences of teachers, chemistry laboratories and scientific experiments on the students' attitudes towards learning chemistry. Most of them expressed their interest and positive attitude towards chemistry because they got experiences in the laboratory. This supports previous research conducted by Charen (1966), Smith et al. (1968), Ben-Zvi et al. (1976) and Zhang and Lei (2018), which revealed that students who were given the chances to study and conduct experiments in the chemistry laboratory had a positive scientific attitude towards studying chemistry, but students who only learned at the classroom with teachers did not express a negative attitude towards studying chemistry. Lang et al. (2005) also suggested that there was a relation between open-ended chemistry laboratory environments, active teacher-student interactions and developed attitudes of students toward learning chemistry. Moreover, Najdi (2013) indicated that the uninteresting laboratories, along with the low motivated teachers who could not engage and inspire students when studying were the reasons of the poor attitude of students toward chemistry in the learning process. Besides, the fear of failure when studying a chemistry course (Jegede 2007), the complexity of content, the academic content of the education curriculum, the lack of awareness of the chemistry's necessity in life and few experiential learning activities related to natural science, especially chemistry were the reasons for low attitude toward chemistry of high school students.

The limitations of the present studies naturally include the sampling process and the self-reported instrument. Besides, the research investigated the attitude of high school students towards chemistry with a questionnaire, including three subscales, which could bias the results and cross-sectional research. This approach does not assist the researchers in concluding the correlation between research variables. These limitations could be addressed by future studies and empathy for children further examined.

CONCLUSION

Attitude towards chemistry not only enhances students' chemical perception but also be extremely important because it manifests the interests and emotions towards studying chemistry of students. More generally, these primary findings are consistent with research showing the influences of gender and grade on the attitude of students towards chemistry. All results obtained from this research are necessary for educating and enhancing students' attitude towards science, especially chemistry. Future research should consider the interaction between gender and grade or potential effects of non-formal chemistry education such as laboratory environments, teacher-student interactions, the nature and academic content of the education curricula, awareness of chemistry's necessity and experiential learning activities about science on students' attitude towards learning chemistry carefully.

RECOMMENDATIONS

All the results achieved after the research are important to increase the understanding of attitudes towards chemistry among Vietnamese high school students. The research is being done

with the expectation that it will encourage similar research in order to fill the gap between teaching chemistry and its required practices in the department of chemistry at high schools in Vietnam.

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