

High School Students' Attitude Towards Their Learning Geometry

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The study explores secondary school students' attitude towards learning geometry. In this current study, the researchers adopted quantitative and descriptive survey methods. A total of 138 high school freshmen from Xinchuang School District in New Taipei City, Taiwan voluntarily participated in the study. The research was done qualitatively by using a questionnaire that comprised of 32 Likert-type questions which were adopted from Utley Geometry Attitude Scales. This study explores high school students' attitudes toward their learning of geometry and investigates the difference in attitude of students towards learning geometry by gender. 138 secondary students were administered with a questionnaire to find out their attitudes towards geometry. The students answered questions regarding their personal confidence in learning geometry, enjoyment in studying geometry and perceived usefulness of learning geometry. The results show that the high school students' attitude towards geometry is slightly negative below medium. However, the high school students' attitudes toward the usefulness of geometry are slightly positive and many of them believe that geometry is a valuable and necessary topic which could help them in their future careers and education. The study reveals that there exist significant differences in attitude towards confidence in learning seometry.

Keywords: attitudes, geometry, high school students, learning

Introduction

The National Council of Teachers of Mathematics (NCTM, 2000) has highlighted the importance of geometry in school mathematics, "Geometry and spatial sense are fundamental components of mathematics learning. They offer ways to interpret and reflect on our physical environment." In Taiwan, geometry has been adopted into mathematics curriculum since elementary education because of the contributing development of students' critical thinking and problem-solving activities. This plays an important role in everyday life helping students realize the world around them and appreciate the worth of their world. Geddes and Fortunato (1993) found the lack of understanding in learning geometry. Students that have greater confidence in their geometric skills and are aware of its usefulness, have a more positive perception of the topic (Forgasiz, 2005; Tsao, 2017). Attitude is often considered to play an important role in students' geometry achievement; it affects students'

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achievement in mathematics (Farooq & Shah, 2008). Specifically, Utley (2004) defined attitudes towards geometry as set of beliefs focusing on geometry that predisposes a person to respond in a certain way. If students have a positive attitude towards geometry they are expected to like geometry, participate in the classroom activities and to be high achievers in geometry (Bindak, 2004; Tsao, 2018).

Many students perform poorly in geometry and find the subject very difficult and uninteresting. Students face different types of problems in learning geometry. In Taiwan, geometry is taught as a topic within mathematics in secondary education. Considerable research has reported that a large number of the students fail to develop an adequate understanding of geometry concepts, geometry reasoning, and geometry problem solving skills as they are expected to learn and encounter difficulties, and performed poorly in geometry (Noraini, 1999; Mason, 2003). However, the results of studies carried out by different researchers in different parts of the world show that students encounter a lot of difficulties while learning geometry. Some studies reported a significant difference in geometry ability between students of different gender (Benbow & Stanley, 1983), while others indicate that the difference was insignificant (Fennema & Carpenter, 1981). Researchers have found that a few gender differences manifest themselves already in elementary school geometry (Hyde, Fennema, & Lamon, 1990). Baharvand (2001) discovered males perform better than females on geometry problems and that in many cases; recent research has revealed that there is no significant relationships in that secondary school students both boys and girls students and have almost the same attitude towards geometry (Kundu, 2018).

Moreover, research conducted in a study on secondary school students' attitudes towards their learning geometry, reflected that the majority of the students in Bindura Urban did not like solving geometrical problems. It also appeared that geometry is not a difficult topic to either male or female students and that most students did not like solving geometry (Sunzuma, Masocha, & Zezekwa, 2013). In addition, female students reported having less confidence in their mathematical abilities than their male counterparts (Hanson, 1992). Although much effort has been made to conduct studies on the beliefs and attitudes towards mathematics, relatively less research has been done on these topics towards geometry. Studies examining the question of attitude towards geometry are rather limited. Therefore, this study will contribute to fill in the gap in this area.

In the study reported briefly here, a survey was administered to high school students to better understand how students' attitudes toward learning geometry differ by gender. This research would help teachers and mathematics educators to explicitly address specific aspects of dispositional issues for teaching geometry, which could have the potential to support their learning of geometry. Further, it describes how this can provide an opportunity to incorporate curriculum changes that could provide high school students with an opportunity to gain positive attitudes toward geometry. Three research questions will be answered in the study:

1. What are the attitudes toward geometry of high school students in New Taipei city? In particular, how are high school students' scores on each of the three attitudinal components measured: confidence of learning geometry, usefulness of studying geometry, and the enjoyment of studying geometry?

2. What are the relationships among the three measures of attitude towards geometry for high school students?

3. Is there a significant difference between male and female high school student' attitude towards studying geometry?

Methodology

Participants

A total of 138 high school freshmen from Xinchuang School District in New Taipei City, Taiwan voluntarily participated in the study. Of the sample, 75 were male and 63 were female. Participants were administered a questionnaire to find out their attitudes towards geometry. The students answered questions regarding their personal confidence to learn geometry, perceived usefulness of studying geometry and the enjoyment of studying geometry.

Instrument and Procedure

The Utley Geometry Attitude Scales (UGAS) was developed after extensive review of a variety of existing instruments used to measure attitudes toward mathematics (Utley, 2004) and was designed to measure the attitudes of undergraduate college students toward geometry. The UGAS was translated into a Chinese version by researchers. The UGAS, which consists of 32 items, was constructed by making use of Likert's methods of summation to get a five point judgment on each item. Against each statement, five alternative responses, namely, "Strongly Agree", "Agree", "Neutral", "Disagree", and "Strongly Disagree" were given. Weights of 5, 4, 3, 2, and 1 were given for favorable statements and the scoring system is reversed for unfavorable statements. A high score represents more indicative of an overall higher attitude toward geometry. The questions are divided into three factors, namely, "confidence", "enjoyment", and "usefulness". Some questions are positively worded and some are negatively worded. A measure of internal consistency was calculated for the UGAS and each of its sub-category. Cronbach's Alpha coefficient of the confidence of learning geometry sub-category, the enjoyment of studying geometry sub-category, and usefulness of studying geometry sub-category were 0.93, 0.90, and 0.91, respectively. Table 1 shows three sub-categories with items of the UGAS.

Table 1

Sub-category	Statements			
	have a lot of confidence when it comes to studying geometry.			
Confidence of learning geometry	Geometry problems often scare me.*			
Enjoyment of learning geometry	Geometry is an interesting subject to study.			
	Working out geometry problems does not appeal to me. [*]			
Usefulness of study of geometry	I often see geometry in everyday things.			
	I will not need geometry for my future.*			

Note: ^{*}Item negatively worded.

UGAS included three sub-categories as confidence of learning geometry (12 items, e.g., "I have a lot of confidence when it comes to studying geometry."), usefulness of studying geometry (10 items, e.g., "I often see geometry in everyday things."), and the enjoyment of studying geometry (10 items, e.g., "Geometry is an interesting subject to study."). Higher scores on the UGAS indicate more favorable attitudes toward geometry.

Results and Discussion

Information gained from the UGAS can provide mathematics educators and teachers with a useful means

of assessing students' attitudes toward geometry. By examining the overall responses of students, educators can gain a general sense of students' attitude and then by examining scores on the individual sub-category, they can gain an understanding of their students' specific attitudes toward confidence to learn geometry, usefulness in studying geometry, and enjoyment to learn geometry.

Table 2 displays the mean scores and standard deviations on the UGAS by sub-categories for the 138 participants. The UGAS sub-category data on the mean scores of the confidence to learn geometry category, the enjoyment of studying geometry category, and usefulness of studying geometry category were 2.78, 2.80, and 3.04, respectively. The participants had a mean composite survey score of 2.87 on the five-point Likert-scale, the mean composite score that reflected attitudes was just below the neutral position. Unfortunately, many high school students in the study did not exhibit positive attitudes toward learning geometry.

Table 2

Table 3

Means of Sub-category and Standard Deviation of UGAS (N = 138)

Sub-category	Quantity	Mean (M)	Standard Deviation (SD)		
Confidence of learning geometry	12	2.78	0.88		
Enjoyment of learning geometry	10	2.80	0.79		
Usefulness of studying geometry	10	3.04	0.78		

Note. Negatively items have been scored reversely.

High school students' confidence in their ability to learn geometry had a mean score of 2.78, which was slightly below the neutral position. Table 3 displays mean scores of UGAS sub-category item by item. Nine of the items had mean scores below the neutral position of 3.0, and three items had mean scores above 3.0. Examples of items with a favorable attitude, from the confidence level form, were "I am sure that I can learn geometry concepts", "I am confident that if I work long enough on a geometry problem, I will be able to solve it", and "I can usually make sense of geometry concepts." The mean scores for the three items were 3.46, 3.41, and 3.35, respectively.

An answer of disagree on nine negatively stated comments indicated a favorable attitude. Examples of this include "I often have trouble solving geometry problems", "I lack confidence in my ability to solve geometry problems", and "For some reason even though I study, geometry seems unusually hard for me." Three of these items appear to indicate low self-confidence. The lowest-scoring item for confidence, "When I can't figure out a geometry problem, I feel as though I am lost and can't find my way out." had a mean rating of 2.04.

Mean of Kesponses of UGAS Sub-Category tiem by them $(N = 158)$													
Confidence of In learning geometry N	Item No.	1	5	8	9	11	13	18	21	22	27	29	32
	Mean	3.46	2.59	2.68	2.04	2.59	2.69	2.61	2.83	3.41	2.23	3.30	2.93
Enjoyment of It learning geometry M	Item No.	3	4	6	7	14	15	16	23	25	30		
	Mean	2.73	3.10	2.63	2.84	2.92	1.78	2.57	2.98	3.21	3.18		
Usefulness of Its studying geometry M	Item No.	2	10	12	17	19	20	24	26	28	31		
	Mean	3.09	2.83	3.12	2.81	3.58	3.14	2.79	2.96	2.96	3.14		

Mean of Responses of UGAS Sub-Category item by Item (N = 138)

Note. Negatively items have been scored reversely.

The result confirms that the lack of confidence in mathematics is related to the actions of students (Tsao, 2018; Forgasiz, 2005). If students have greater confidence about their geometric skills and are aware of its usefulness, they will have a more positive perception of the topic. Unfortunately, high school students in the study did not exhibit confidence in their ability to learn geometry.

The UGAS sub-category data on the mean scores of enjoyment geometry scale were 2.80 and 7 of the 10 enjoyment items had mean scores less than the neutral position of 3.0, reflecting negative attitudes concerning liking and enjoying geometry. The highest-scoring item for enjoyment, "I just try to get my homework done for geometry class in order to get a grade", had a mean rating of 3.21. This item reflected an attitude slightly above the neutral position, indicating that these high school students did not particularly enjoy solving geometry problems, but they are concerned about the grade. The lower-scoring items for enjoyment were "Working out geometry problems does not appeal to me" and "Geometry is an interesting subject to study." The mean scores for these two items were 1.78 and 2.57, respectively. This indicates a negative attitude; participants did not especially enjoy geometry. This further supports the result that most students did not like solving geometry (Sunzuma et al., 2013; Tsao, 2017) and discovered that students' geometry achievement was found to be affected by students who did not like solving geometry problems (Tsao, 2017).

The mean score of the usefulness of geometry learning sub-category was 3.04. This represents attitudes that are somewhat neutral, indicating that they had only slightly positive attitude scores about usefulness of geometry learning currently and in relationship to their future education, vocation, or other activities. Examples of these included "I believe that I will need geometry for my future," "Geometry is a practical subject to study," and "I will need a firm understanding of geometry in my future work." The mean scores for the items were 3.08, 3.17, and 2.79, respectively. The views expressed by high school students are similar with Bindak (2004) who realized geometrical knowledge as essential not only for living effectively in the society, but also for making useful contributions to the development of one's environment. This agreed with Mogari's (1999) study that defined geometry as a particularly powerful and concentrated example of the functioning of human intelligence. This represents that they had only slightly positive attitude scores about usefulness of geometry currently and in relationship to their future education, vocation, or other activities.

Table 4 displays Pearson correlation coefficient among the sub-categories of UGAS. Pearson correlations were calculated among the three sub-categories, which have been presented in Table 4. The correlations among the three sub-categories were all statistically significant (p < 0.01). A significant relationship appears to be between usefulness of studying geometry, enjoyment of learning geometry, and confidence of learning geometry in high school students. The result confirm the findings of Tsao (2017) and Forgasiz (2005) in that students had greater confidence about their geometric skills and were aware of its usefulness; they had a more positive perception of the topic.

Table 4

Pearson Correlation Coefficient Among the Sub-category of UGAS

55	0 0 7	9	
	Usefulness of studying	Confidence of learning	Enjoyment of learning
	geometry	geometry	geometry
Usefulness of studying geometry	1.000	-	-
Confidence of learning geometry	0.429*	1.000	-
Enjoyment of learning geometry	0.574^{*}	0.800^{*}	1.000

Note. **p* < 0.01.

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Similarly, if students have positive attitudes toward geometry, they are expected to like geometry, participate in the classroom activities, and be high achievers in geometry (Bindak, 2004; Tsao, 2017). The findings of this present research supports Tsao's (2017) investigations that pre-service teachers' geometry achievement was found to be affected by pre-service teachers who did not like solving geometry problems. Attitudes play an important role in students' geometry achievement.

The *t*-test was conducted to determine differences between female and male high school students' mean sub-category of UGAS scores. Table 5 summarizes the *t*-test results between the mean sub-category of UGAS in female high school students and male high school students. Results of the study revealed that there were no significant differences between female and male high school students' attitude regarding enjoyment of learning geometry (t = 1.67, p > 0.05) and usefulness of studying geometry (t = 1.66, p > 0.05). The mean of the confidence of learning geometry attitude score for female and male students of secondary school is found to be 35.85 (SD = 11.21) and 30.41 (SD = 8.96), respectively. However, there was a significant difference between female and male high school students' attitude regarding geometry (t = 3.31, p < 0.05). For confidence of learning geometry, male high school students had stronger confidence of learning geometry in comparison to female high school students. It seems female high school students lack confidence in their abilities to learn geometry.

Table 5Results of T-tests and Descriptive Statistics of Sub-category by Gender

Outcome		Male		Female			
	М	SD	Ν	М	SD	Ν	
Confidence of learning geometry	35.85	11.21	75	30.41	8.96	63	3.11*
Enjoyment of learning geometry	29.00	8.19	75	26.75	7.55	63	1.67
Usefulness of studying geometry	31.43	7.46	75	29.21	8.26	63	1.66

Note. * p < 0.05.

Conclusion

The UGAS sub-category data on the mean scores of the confidence of learning geometry scale, the enjoyment of studying geometry scale, and usefulness of studying geometry scale were 2.78, 2.80, and 3.04, respectively. The participants had a mean composite survey score of 2.87 on the five-point Likert-scale, the mean composite score that reflected attitudes was below the neutral position. Unfortunately, results of the present study demonstrate that many high school students in the study did not exhibit positive attitudes toward learning geometry. High school students seem to value geometry and view it as important, but they did not enjoy geometry or feel self-confident about geometry. This should be a concern for teachers and mathematics educators, because geometry is one of the most important branches of mathematics. Hands-on, active involvement in learning and doing mathematics is important for students to see the usefulness of the geometry and gain confidence in their ability (Tsao, 2018). As mathematics educators, we suggest the need to develop and evaluate strategies directed at improving students' attitudes toward geometry subjects which would include: more real-world and open-ended problems in curriculum and relating geometry lessons to real life situations in order to reduce abstract nature of the content; creating learning opportunities that integrate differences in pre-existing knowledge; and a variation in teaching methods, enhancing cooperation, and communication in the

classroom. Our goal is to help students become more knowledgeable, to assist them in developing positive attitudes and gain confidence in geometry.

There also appears to be a significant relationship (p < 0.05) between gender and confidence of learning geometry in high school students. It seems female high school students had a lack of confidence in their abilities to learn geometry. Gender differences in secondary mathematics are a prominent issue that has been the focus of many studies. The reported differences in attitudes in learning geometry between female students and male students are a contentious issue. Teachers should foster girls' self-confidence to learn mathematics, maintain high expectations for girls and encourage them to solve problems on their own. It could promote for girls in mathematics participation and achievement (Leder, 1992).

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