# Pre-Service Classroom Teachers' Attitudes toward Graphs and Their Ability to Read and Interpret Them

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## Abstract

*The aim of this study is to investigate the impact of the following factors on pre-service classroom teachers' attitudes toward graphs and their ability to read and interpret them: (1) high school stream (scientific, literary, information technology, others); (2) academic level at university (freshman, sophomore, junior, senior) and; (3) the number of science and mathematics courses they had taken at the University.Data were collected using two questionnaires: the attitude toward graphs which was developed by Mumba et al. (2009), and the ability to read and interpret them, which was developed by the researchers. The study sample consisted of 122 female students who were enrolled in the classroom teacher major at the University of Petra in Jordan. The results showed that: (1) pre-service teachers' attitudes toward graphs on the overall scale were moderate; and the pre-service teachers valued graphs, expressed moderate interest in graphs, and moderate cognitive competence for graphing, although they did not make enough effort concerning graphs (2) the attitudes of classroom teachers toward graphs became more positive as they advanced in their level of academic year (freshman, sophomore, junior, senior) as well as by the increase in the number of science and mathematics courses they have attended at the University; (3) level of pre-service classroom teachers' ability to read graphs was below the educationally accepted level. In addition, the ability to read graphs seems to increase as students advance further in their academic level.*

**Keywords:** read and interpret graphs, pre-service classroom teacher, attitudes

## *1. Introduction*

The challenges of the 21st century oblige us to pay more attention to the skills that should be possessed by both students and teachers. Knowledge has become more specific, and is accelerating quickly. Communication and information technology has caused great transformation in the learning process; thus, studying core subjects is not enough anymore. It has now become critical to focus on helping students acquire social and cognitive skills that enable them to deal with the problems they face. These skills include: communication, critical thinking, creative thinking, problem solving, decision making, applying knowledge to new situations, analyzing information, and the ability to comprehend new ideas (Glazer, 2011).Works and publications on the literacy of the 21st century reassure us of what has been said above, asserting that —'21st Century Literacy'—includes "strong academic skills, thinking, reasoning, teamwork skills, and proficiency in using technology" (Ledward& Hirata, 2011).

## *2. Theoretical Framework*

The ability to work with data, such as: analyzing information, making inferences from data, finding trends, and using data to support claims are considered to be one of the main skills that students need to be literate in today's information age, and to equip them with everything needed for the world beyond the classroom, due to the growing use of visual representation of data in the form of graphs and tables in different aspects of life (Glazer, 2011). Therefore, reading, writing, and arithmetic are no longer sufficient; it has now become crucial to develop students' skills to read and communicate meaning with spoken, written and visual texts, which requires us to foster an individual's ability to comprehend different types of graphics, including illustrations, diagrams, maps, graphs, and tables (Norman, 2012; Malamitsa et al., 2008).

It is important to note that students' ability to read abstract scientific images requires many different skills than those needed to simply read ordinary images in daily life. In fact various scientific sources, whether traditional textbooks or modern sources, include a large amount of graphics, whether they are photographs and images, or diagrams and graphs, which are highly abstract and demand certain skills (Lowe, 2000).Winn (1987) divided graphics into three categories: graphs, charts, and diagrams (Slough et al., 2010), Vekiri (2002) added a fourth category so that the four types of graphics became: diagrams, maps, graphs (line, bar, and pie), and charts. Graphs work to illustrate simple relationship between the variables with at least one variable being continuous, while charts present the relationships between variables. The diagram differs from the previous two categories in terms of its function, the degree of complexity and its visual nature. In addition to the above, diagrams represent the process as a whole and include a lot of details, whereas charts and graphs illustrate simple relationship between variables (Slough et al., 2010).Graphical representation is used in school textbooks for a variety of functions, which include decoration, representation, organization, explanation, transformation and extension (Norman, 2012). Graphs are considered to be a key element in the content of textbooks at the elementary level in different subjects such as mathematics, and/or natural and social sciences; as graphs are used to represent detailed results in brief, and in representing complex relationships between variables. Graphs have the ability to deliver information in a way that it is easy to interpret, and aid us in perceiving trends clearly (as compared to tables). Additionally, they are easy and quick to read compared to the same data presented in prose (Kali, 2006), and play an essential role in clarifying scientific concepts to children and making them more concrete. Furthermore, a large number of test questions in the fields of science and mathematics include graphs which contain the necessary information that enable students to answer certain questions (Coleman et al., 2011). In addition to the above, graphs may provide further information not available in the written text (Norman, 2012).

Constructing and interpreting graphs is considered a vital part of learning and teaching science through inquiry (Bowen &Roth, 2005), especially that science teaching objectives have drifted away from the traditional approach in the past few years, which aims to prepare scientists and engineers to provide all students with scientific literacy. Scientific literacy aims to create an educated individual who can successfully comprehend the scientific concepts and the fundamental ways of reading scientific information in the form of texts and images (Rybarczyk, 2011). Thus, the ability to understand and construct graphs has become one of the essentials every scientific literate student must possess; and it is crucial to develop these skills in students at every level (elementary to tertiary). It is important to begin developing students' ability to read and interpret graphs, as well as construct them, beginning with the elementary level, and allowing students to become involved in concrete experiences during science classes and help them transform these concrete experiences into graphs (Keller, 2008).Graphs are used in a wide range in science textbooks – as they are employed as tools of communication in science curriculum, and have become an obligatory skill for students as well as teachers. Teachers require these skills in order to comprehend and deal with different types of graphs and pictures (Kilic et al., 2012), and students require them at all educational levels to be capable of efficiently reading and interpreting them, as they play a great role in the process of inquiry, and are considered to be important tools to analysis and represent quantitative relationships (Glazer, 2011). When students possess the ability to read and interpret graphs, they are expected gain other related skills that help them in studying science (as graphs are considered a main component of critical thinking activities taught in science and mathematics (Keller, 2008), as well as developing the ability to make scientific arguments, decision-making, and problem solving skills (Grueber, 2011).

Science curriculum have emphasized the importance of developing students' ability to interpret and construct graphs, as well as making predictions, and deduction from graphs; as they are seen as essential tools in enabling students in understanding scientific and mathematical concepts (Tairab& Al-Naqbi, 2004). Science and mathematics curriculum in Jordan have paid great attention to graphs, tables, and illustrations; this is quite clear in the school books, as these books contained a large amount of graphical representations.Despite the importance of graphs in the field of teaching science, this aspect of learning is ignored by teachers in different academic levels; either because teachers simply assume that graphs are self-explanatory, or because they may believe that graphs have been added to science textbooks to make the material easy to comprehend (Lowe, 2000), or because a number of teachers do not possess the skills necessary to read and interpret graphs (Kilic et al., 2012); or for reasons that are affective in nature, which are related to their feelings, beliefs, and attitudes toward the graphs. That is because the majority of teacher preparation programs aim to train teachers at universities focus on the cognitive domain and pay less attention to the affective domain (Yoo, 2010;Estrada et al., 2011); although attitudes are considered to be a key concept in analyzing human behavior.

Attitudes are defined as "a learned state that creates a disposition to respond in particular ways to particular objects", and the response toward things, events, people, and ideas is either negative or positive (Sears and Sorensen, 2000). Additionally, the literature review shows that teachers' attitudes toward a certain subject affect their teaching practices (Cho et al., 2003); as positive attitudes among teachers lead to better learning and better teaching. Attitudes also affect the individual's will to learn a certain course or subject (Mumba et al., 2009; Estrada et al., 2011). If a person, for instance, believes that graphs are difficult, and that he or she will not be able to succeed in learning them, he or she will generate hatred toward graphs, which will result in certain behaviors, such as not attending science classes, or not doing homework that includes graphs. Based on the previous, it could be said that a teacher's willingness to learn more about graphs and later teaching them to students may depend on his or her attitudes toward them.

## *3. Review of the Literature*

Despite the importance of graphs in teaching and learning science and mathematics, quite a few studies assert that pre-service teachers lack the skills necessary for reading and interpreting graphs (Bowen & Roth, 2005). Alacaci et al. (2011) show that teachers have a small amount of knowledge on how to deal with scatterplots. A number of studies argue that, although pre-service program educators are exerting efforts, the programs, nevertheless, do not prepare prospective teachers in a way sufficient to be able to teach students these skills later on (Szyjka et al., 2011). In a related study, Coleman et al. (2011) assert that elementary school teachers use graphs in teaching science, but do not give students the opportunity to create graphs, nor the chance to interpret them. Cook's (2011), however, shows that the teacher's choice of graphics and their use in teaching is affected by the course material, student characteristics, and available resources. Szyjka et al. (2011) argue that the abilities of pre-service teachers in logical and mathematical thinking have a great impact on their performance with respect to line graphs.In addition, Dyke and White (2004) argue that mathematics pre-service teachers have little willingness to use graphs as they require higher abstract thinking skills and are difficult to construct and interpret. Likewise, a number of studies found that students think of graphs as images instead of symbolic representations of data (Tairab& Al-Naqbi, 2004).

In Jordan, at the local level, a number of studies tackled the students' abilities to read, interpret, and create graphs; while other studies focused on how widely images, graphs, and tables are used by teachers in science classes. Dajani (2005) focused on 10th grade students' ability to read graphs and illustrations, and the amount of interest teachers have in developing these skills in their students in Jordan. The study shows that students do not find it difficult to read graphs and illustrations, but finds it difficult to read tables. The findings further indicate that teachers use a large quantity of images and graphs found in the school books during science classes. On the other hand, Al-Zoabi (2007) argues that physics major students at Al-Hussein bin Talal University have an accepted ability to read graphs; and that their skills develop as they move on to their senior and junior years. Although many studies in Jordan tackled students' ability to read and interpret graphs, there are only few studies conducted on pre-service classroom teacher to explore their attitudes toward graphs, or on their ability to read and interpret them.

Considering the critical value of graphs as an important communication tool that could contribute to developing students' ability to learn scientific concept and develop their critical thinking skills, and considering the importance of attitudes toward graphs on the teachers' classroom behavior and willingness to learn, the researchers (being university lecturers) have noticed a weakness in students' ability to read and interpret graphs, notably in those in the classroom teacher major. In fact a large number of pre-service classroom teacher registered at University of Petra have graduated from the literary or information technology streams in high-school, and have not attended any science courses during high school level, thus finding it hard to comprehend scientific concepts or read and interpret graphs. This can be enhanced using the results of the TIMSS in 2011 that was conducted on 8th grade students, which included Jordan along with 56 other countries. The TIMSS science assessments included a set of questions containing graphs which the students were asked to read and interpret. The results show that the mean score of Jordanian students was 449, which is below the international mean (500). Jordan came in the 28th place among those countries on a worldwide level (Provasnik et al., 2012).Considering the rarity of Jordanian studies on teacher' attitudes toward graphs or their ability to read and interpret them, especially at pre-service teacher program at university level, as far as the researchers are aware of - as most local studies focused on elementary school students' ability to read graphs, images, and other forms of visual illustrations - it is necessary to conduct further research in this field, especially at university level.

In light of what has been presented, the subject of this study is the clear lack of graph reading and interpreting skills among students in the major of classroom teacher. Thus, this research will attempt to explore the attitudes of pre-service classroom teachers at University of Petra toward graphs, their ability to read them, and how it is affected by their high school stream and their academic level at university (freshman, sophomore, junior, senior), as well as the effect of the number of science and mathematics courses they have taken at the University.

### 3.1 Study Objective and Questions

This study aims to explore pre-service classroom teachers' attitudes toward graphs at University of Petra, and their relation to the ability to read and interpret graphs, and the impact of the following factors: high school stream, academic level at university (freshman, sophomore, junior, senior, and the number of science and mathematics courses they have taken at university. Specifically, the study sought to answer the following questions:

1. What are the attitudes of pre-service classroom teachers at University of Petra toward graphs?
2. Do the attitudes of pre-service classroom teachers at University of Petra differ according to the students' academic year level, high school stream, or the number of mathematics and science courses they have taken at the University?
3. How capable are pre-service classroom teachers at University of Petra of reading and interpreting graphs?
4. Does level of ability in reading and interpreting graphs in pre-service teachers at University of Petra differ in accordance with the academic year/level (freshman, sophomore, junior, senior), high school stream (scientific, literary, information technology, others), or/and the number of science and mathematics courses they have successfully completed?

### 3.2 Operational Definitions

**Attitudes toward graphs**: a group of a pre-service teacher's responses, whether in accepting or rejecting, approaching or avoiding, reading and interpreting of graphs. This is measured by the student's scores in the following 6 aspects: effort, value, cognitive competence, affect, difficulty and interest) of the scale used in this study.

**Ability to read and interpret graphs**: it is the process of translating, analyzing, and interpreting any information delivered by graphs, and connecting this information together to reach at useful scientific conclusions. This is obtained by the student's scores in a test specifically designed to measure their abilities in reading and interpreting graphs.

### 3.3 Study Limitations

This study is limited to students who major in classroom teacher at University of Petra. It is also limited to reading and interpreting graphs, and does not include tables, illustrations, or charts. Additionally, the findings of this study are limited by the characteristics of the two scales used.

### 3.4 Significance of the Study

The significance of the study lies in that its findings show how efficient pre-service teacher (of the first three elementary grades) preparation programs are enhancing the students' attitudes toward graphs and their ability to read and interpret them, as well as how the teaching staff and study plans could develop students' attitudes toward graphs and how to read and interpret them. Additionally, the results of this study are expected to be of importance to those involved in teacher education programs.

## *4. Methodology*

### 4.1 Sample of the Study

The study sample consisted of 122 female students who are enrolled in the classroom teacher major at the University of Petra in Jordan, and account for 50% of the total sample population. A questionnaire was administered to students in the first semester of the academic year 2013/2014. The high school streams of this sample were as follows: 11 students completed science stream; 49 literary stream, 52 information technology stream and 10 completed other streams. Participants in this sample have been categorized into 4 groups based on their academic level/year at university, as follows: 29 freshman (24%); 42 sophomore (34%); 37 junior (30%); and 14 senior (12%).

### 4.2 Tools of Data Collection

Data were collected using two questionnaires, the first measures the pre-service classroom teachers' attitude toward graphs, while the second measures pre-service teachers' ability to read and interpret them.The first questionnaire consisted of two sections; the first include filling in demographic data, including high school stream, academic level, and the number of mathematics and science courses attended at theUniversity, while the second section consisted of a questionnaire measuring pre-service teachers’ attitudes toward graphs. This scale had originally been designed by (Dauphinee et al., 1997) to measure students’ attitudes toward mathematical statistics, and was later developed by (Mumba et al., 2009) to be used in measuring pre-service teachers’ attitudes toward graphs. The scale has been translated to Arabic in order to be used on university students. The attitude questionnaire included 38 items to measure six aspects of attitudes: effort, value, cognitive competence, affect, difficulty and interest. The questionnaire consists of six aspects: the first aspect “effort” refers to the effort that the individual exert to learn about graphs. The second aspect “value” refers to individual appreciation of the benefit and importanceof graphs to the professional and personal growth. The third aspect “affect” refers to the positive and negative feeling of the individual toward graphs. The fourth aspect “cognitive competence” refers to the individual’s perception about possession of the required knowledge and skills needed. The fifth aspect “interest” refers to the extent the individual is attracted to the graphs. The last aspect “difficulty” refers to the difficulties that the individual faces when dealing with graphs. The first aspect consisted of 6 items; the second of 9; the third of 7; the fourth of 7; the fifth of 5; and the sixth of 4. One point was given to each item on a five-level Likert Scale; each item ranging from one to five levels, where 1 implies 'strongly disagree' and 5 implies 'strongly agree'.

The second questionnaire consisted of a test to measure the pre-service teachers' ability to read and interpret graphs. The researchers have set this questionnaire up by first listing all science and mathematics subjects that classroom student teachers could attend in the pre-service teacher program at the university, followed by suggesting a variety of multiple choice questions (25 items), each including 4 choices of which only one is correct. Each item contains a graph, and was designed to measure pre-service teachers’ abilities to read or interpret it. Later, the test was reviewed by a group of university staff members to decide how adequate the scale is in measuring the students’ abilities in reading and interpreting graphs, as well as content validity, and scientific and linguistic accuracy. The arbitrators have agreed that the accepted level of classroom student teachers on this test should be above the score of 50%. The final version of the test was composed of 16 multiple-choice items that cover subjects the student have studied during high school or at university in science and mathematics courses. The items of the test included the following graph types: pie, line and bar graphs. 6 of the items were designed to measure the students’ ability to read graphs and 10 to measure the students’ ability to interpret them. The final score in the test was measured by giving the student one point for each correct answer and no point for incorrect answers.

#### 4.2.1 Reliability

The reliability coefficients of the attitudes toward graphs questionnaire and the graph test has been calculated using a sample of 48 students who were not part of the sample of this study using Cronbach's Internal Consistency Alpha. The reliability value for the attitude questionnaire toward graphs as a whole was (0.91). The reliability values for the six attitude aspects ranged from high to low: 0.82 affect, 0.78 value, 0.67(cognitive competency), 0.66 effort, 0.59 interest, 0.54 difficulty. Even though the reliability coefficients of some aspects was low (the difficulty (0.54) and interest (0.59) aspects), the majority of correlation values of other aspects were relatively high, which implies internal consistency of the overall questionnaire. The reliability value for the graph skill questionnaire was (0.74). These values are good indicators of the reliability of the scales used in this study.

## *5. Results*

To answer the first question: “What are the attitudes of pre-serviceclassroom teachers at the University of Petra toward graphs?” the researchers have calculated the means, standard deviation, and percentage of the pre-service classroom teachers' scores on all six aspects (effort, value, cognitive competence, affect, difficulty, interest) of the attitudes toward graph scale, and for the overall scale. The results are shown in Table (1).

**Table1: Means, Standard Deviation, and Percentage of Classroom Pre-ServiceTeacher Scores on Each Aspect of the Attitudes toward Graph Scale**

| attitude aspects | mean | S.D | % |
|---|---|---|---|
| effort | 2.61 | 0.46 | 52% |
| value | 3.42 | 0.66 | 68% |
| cognitive competence | 3.27 | 0.72 | 65% |
| affect | 3.19 | 0.63 | 64% |
| difficulty | 3.16 | 0.57 | 63% |
| interest | 3.37 | 0.57 | 67% |
| attitude (total) | 3.09 | 0.40 | 62% |

Table (1) shows that the mean of the pre-service teacher scores on the attitudes toward graphs scale as a whole was 3.09 with a percentage of 62%, whereas the means of pre-service teachers' attitudes toward graphs on the overall scale were moderate. The mean scores in the six aspects of the attitudes toward graph scale ranged between 2.61 and 3.42, and the percentage ranged between 52% and 68%. The results in the table show that value aspect of attitudes toward the graphs received the highest mean score (3.42), followed by interest (3.37), cognitive competence (3.27), affect (3.19), and difficulty (3.16). On the other hand, effort received the lowest mean score (2.61) among pre-service teachers.

This points out that the pre-service classroom teachers' attitudes toward the graphs regarding the efforts that must be exerted in the field of graphs was negative, the results indicate that pre-service teachers valued graphs, expressed moderate interest in graphs, and moderate cognitive competence for graphing, but they do not make enough effort concerning graphs. To examine the second question in this study: "Do the attitudes of pre-service teachers at University of Petra differ according to their academic year/level, high school stream, or the number of mathematics and science courses they have taken at the University?" the researchers have first calculated the mean and standard deviation of the pre-service classroom teachers' scores in the different aspects of attitudes toward graph scale, and on the overall scale according to their academic year level (freshman, sophomore, junior, senior). ANOVA test was used to find out whether any statistically significant differences exist among the means of pre-service teacher's scores attributed to academic year/level. Results are shown in Table (2).

**Table 2: Means and Standard Deviation for the Sample Scores on the Attitudes toward Graphs Scale According to Students' Academic Year/Level**

| | The academic year/level (freshman, sophomore, junior, senior) | | | | | |
|---|---|---|---|---|---|---|
| attitude aspects | freshman N=29 M (SD ) | sophomore N=42 M (SD) | Junior N=37 M (SD) | senior N=14 M (SD) | F(3,118) | Sig |
| effort | 2.44 (0.50) | 2.60 (0.37) | 2.68 (0.45) | 2.80 (0.56) | 2.545 | 0.059 |
| value | 3.22 (0.65) | 3.35 (0.58) | 3.46 (0.68) | 3.97 (0.59) | 4.756 | 0.004 |
| cognitive competence | 3.29 (1.20) | 3.24 (0.41) | 3.17 (0.48) | 3.54 (0.56) | 0.914 | 0.436 |
| affect | 3.17 (0.63) | 3.06 (0.50) | 3.19 (0.72) | 3.59 (0.59) | 2.597 | 0.056 |
| difficulty | 3.27 (0.62) | 3.06 (0.57) | 3.12 (0.55) | 3.37 (0.45) | 1.501 | 0.218 |
| interest | 3.37 (0.54) | 3.24 (0.50) | 3.45 (0.56) | 3.50 (0.79) | 1.271 | 0.288 |
| attitude (total) | 3.05 (0.39) | 3.01 (0.33) | 3.10 (0.42) | 3.37 (0.42) | 3.145 | 0.028 |

It can be noted from Table (2) that the mean scores of pre-service teachers on the attitudes toward graphs scale as a whole were higher among senior students (3.37), followed by juniors (3.10), and then by freshmen (3.05); whereas means of sophomores were the lowest (3.01). Additionally, mean scores of seniors on all aspects of the subscale toward graphs were the highest compared to the means of students from other academic years/levels. It is clear from Table (2) that statistically significant differences exist among the means of the participants in the sample based on their academic year/level on the attitudes toward graphs scale as a whole, and on one aspect of the scale, which was the highest on the value aspect and in seniors.

The researchers have calculated post-hoc comparisons between students' mean scores of all four academic levels on the attitudes toward graphs scale using Scheffe's test; the results indicate statistically significant differences with a level of significance of ($\alpha$= 0.005) among means of freshmen and seniors, where seniors scored higher; and among sophomores and seniors with a level of significance of ($\alpha$= 0.02) where seniors scored higher on the value aspect. This implies that students' attitudes become more positive as they advance in their academic level. Second: to investigate the effect of high school stream on students' attitudes toward graphs, the researchers have calculated means and standard deviation of students' scores on all six aspects and on the overall scale on the high school stream variable (scientific, literary, information technology, others). Furthermore, ANOVA test was used to investigate whether there were any significant differences among the sample participants' mean scores based on which high school stream they graduated from. Table (3) illustrates these results.

**Table 3: Means, Standard Deviation and F-Values for the Sample Scores on the Attitudes toward Graphs Scale According to High School Stream Variable**

| | High school stream (scientific, literary, information technology, others) | | | | | |
|---|---|---|---|---|---|---|
| attitude aspects | Scientific N=11 M (SD) | Literary N=49 M (SD) | Information Technology N=52 M (SD) | Others N=10 M (SD) | F(3,118) | Sig |
| effort | 2.68 (0.36) | 2.72 (0.50) | 2.51 (0.42) | 2.52 (0.45) | 2.061 | 0.109 |
| value | 3.75 (0.78) | 3.34 (0.77) | 3.43 (0.50) | 3.44 (0.60) | 1.147 | 0.333 |
| cognitive competence | 3.44 (0.48) | 3.29 (0.97) | 3.23 (0.50) | 3.16 (0.28) | 0.369 | 0.776 |
| affect | 3.61 (0.77) | 3.13 (0.70) | 3.18 (0.52) | 3.03 (0.45) | 2.081 | 0.106 |
| difficulty | 3.31 (0.63) | 3.14 (0.50) | 3.21 (0.59) | 2.86 (0.68) | 1.350 | 0.262 |
| interest | 3.45 (0.64) | 3.36 (0.64) | 3.35 (0.50) | 3.35 (0.49) | 0.102 | 0.958 |
| attitude (total) | 3.29 (0.50) | 3.08 (0.47) | 3.06 (0.30) | 3.00 (0.25) | 1.237 | 0.300 |

Results shown in Table (3) point toward observed differences in pre-service teachers' attitudes toward graphs onthe overall scale according to high school stream variable; the highest means on the overall test were those of participants who had graduated from the scientific stream, which reached up to (3.29), then by the means of those who graduated from the literary stream (3.08), then by those who had graduated from the information technology stream (3.06). As for the six aspects or subscales, it is clear that the participants who graduated from the scientific stream had the highest mean scores on all aspects of the scale except on the effort subscale. ANOVA test showed no statistically significant differences on the high school stream variable among the mean scores of the participants in the sample both on the overall attitudes toward graphs scale, and on its six aspects. Third: To investigate the impact of the number of science and mathematics courses attended by the student at University of Petra on pre-service teachers' attitudes toward graphs, the researchers have calculated means and standard deviation of pre-service teachers' scores on all six aspects of the attitudes toward graphs scale, and on the scale as a whole, on that variable. It can be seen in Table (4) that the researchers have also used the ANOVA test to explore whether there were any significant differences among the participants' mean scores on the variable of the number of science and mathematics courses they have taken at the university.

**Table 4: Means, Standard Deviation, and F-Values of the Participants' Scores on the Attitudes toward Graphs Scale on the Variable of the Number of Science and Mathematics Courses they have Successfully Completed**

| | Number of science and mathematics courses they have successfully completed | | | | | |
|---|---|---|---|---|---|---|
| attitude aspects | 0 N=38 M (SD ) | 1 N=41 M (SD) | 2 N=21 M (SD) | 3 N=22 M (SD) | F | Sig |
| effort | 2.34 (0.39 ) | 2.60 (0.42) | 2.73 (0.36) | 2.98 (0.43) | 12.35 | 0.000 |
| value | 3.25 (0.64) | 3.31 (0.56) | 3.44 (0.73) | 3.92 (0.57) | 6.150 | 0.001 |
| cognitive competence | 3.13 (0.45) | 3.21 (1.04) | 3.26 (0.46) | 3.62 (0.39) | 2.401 | 0.071 |
| affect | 3.14 (0.59) | 3.13 (0.68) | 3.13 (0.59) | 3.45 (0.58) | 1.579 | 0.198 |
| difficulty | 3.14 (0.58) | 3.12 (0.58) | 3.13 (0.60) | 3.33 (0.49) | 0.744 | 0.528 |
| interest | 3.31 (0.49) | 3.27 (0.63) | 3.40 (0.61) | 3.61 (0.49) | 1.996 | 0.118 |
| attitude (total) | 2.97 (0.34) | 3.03 (0.40) | 3.10 (0.40) | 3.38 (0.36) | 5.886 | 0.001 |

Results in Table (4) indicate that mean scores on the attitudes toward graphs scale as a whole increased as the number of science and/or mathematics courses taken by the pre-service teacher at university increased; whereas the mean scores on the overall scale of pre-service teachers who had not taken any science or mathematics courses were the lowest (as low as 2.97), while pre-service teachers who had taken three science and/or mathematics courses had the highest mean scores (3.38). On the other hand, students who had taken three science and/or mathematics courses have higher means on all six aspects of the scale. This helps the researchers argue that attending a higher number of science and/or mathematics courses contain graphs affects students’ attitudes toward them positively.Table (4) demonstrates statistically significant differences among mean scores of the sample participants on the variable of the number of science and/or mathematics courses they had attended at university on the overall attitudes toward graphs scale, and on two of its subscales (effort and value), in favor of students who have attended the largest number of courses (a maximum of three).

The researchers have calculated the post-hoc comparisons among students' mean scores on all four levels of the attitudes toward graphs scale using Scheffe’s method. The results confirm the existence of statistically significant differences on the overall scale with a level of significance ($\alpha = 0.002$) among students who have attended three courses in mathematics and/or science and those who have not attended any courses; as well as among students who had taken three courses and those who have taken only one course with a significance level of ($\alpha = 0.009$). Furthermore, the results indicate significant differences on two aspects of the scale (effort and value) in favor of those students who had attended a higher number of courses.To answer the third question: “How capable are pre-service classroom teachers at University of Petra in reading and interpreting graphs?” the researchers have calculated the mean, standard deviation, and percentage of pre-service teachers' scores on the reading and interpreting graphs test.Table (5) shows the results.

**Table 5: Means, Standard Deviation, and Percentage of Pre-Service Teachers’ Scores on the Ability to read and Interpret Graphs Test**

| read and interpret graphs test | No. of items | M | SD | Percentage |
|---|---|---|---|---|
| reading graphs test | 6 | 2.85 | 1.53 | 48% |
| interpreting graphs test | 10 | 3.78 | 1.64 | 38% |
| overall test | 16 | 6.63 | 2.54 | 41% |

Results presented in Table (5) indicate that the percentage of students’ scores on the reading or interpreting graphs test were less than 50%, which is the limit adopted by the arbitrators to judge the students' ability to read and interpret graphs. Differences between the students' scores and the accepted level -which is 50% - on the scale ranged between (2% -12%). This indicates that there is a clear weakness in the ability of pre-service teachers' in reading and interpreting graphs in science and mathematics. To answer the fourth question: “Does level of ability in reading and interpreting graphs in pre-service teachers at University of Petra differ in accordance with the academic year/level (freshman, sophomore, junior, senior), high school stream (scientific, literary, information technology, others), or/and the number of science and mathematics courses they have successfully completed? The researchers havetaken the followingmeasures:

First: To investigate the effect of academic level/year, they have calculated the means and standard deviation of pre-service teachers’ scores according to their university year/level on the ability to read and interpret graphs test; moreover, the researchers have used the ANOVA – analysis of variance test to investigate whether there were any statistically significant differences among the participants’ mean scores based on their academic year/level. These results are shown in Table (6).Results shown in Table (6) indicate that the mean values of the ability to read and interpret graphs test as a whole increase as students advance in their academic year; as the mean of seniors reached (7.79), with a percentage of 49%, followed by that of juniors with a mean of (6.65) and a percentage of 42%, followed by sophomores with a mean of (6.57) and a percentage of 41%; while freshmen have the lowest mean value (6.14) with a percentage of only 38%. Table (6) also shows how the same pattern is repeated when it comes to students’ abilities to read graphs, as the mean values increase with the students’ advancement in their academic year; as sophomores, juniors, and seniors have mean scores above 50%, while freshmen scored a rather low mean value (of only 36%). As for students’ ability to interpret graphs, it appears that seniors have the highest mean scores (4.43) with a percentage of 44%; followed by freshmen with a mean of (3.97) and a percentage of 40%.

**Table 6: Means and Standard Deviation of Pre-Service Teachers' Scores According to their University Year/Level on the Ability to Read and Interpret Graphs Test**

| | the academic year/level (freshman, sophomore, junior, senior) | | | | | | |
|---|---|---|---|---|---|---|---|
| read and interpret graphs test | No. of items | Freshman N=29 M (SD ) % | Sophomore N=42 M (SD) % | Junior N=37 M (SD) % | Senior N=14 M (SD) % | F | Sig |
| reading graphs test | 6 | 2.1 (1.58) 36 | 3.00(1.40) 50 | 3.03(1.61) 51 | 3.36 (1.22) 56 | 2.852 | 0.04 |
| interpreting graphs test | 10 | 3.9 (1.80) 40 | 3.57(1.47) 36 | 3.62 (1.64) 36 | 4.43(1.79) 44 | 1.195 | 0.315 |
| overall test | 16 | 6.1 (2.59) 38 | 6.5 (2.41) 41 | 6.65 (2.52) 42 | 7.79 (2.75)49 | 1.353 | 0.261 |

It is clear from the table that statistically significant differences exist among the mean scores of the participants in their ability to read graphs; and in favor of seniors. Post comparisons in the students mean scores for all four academic years on the ability to read and interpret graphs were administered using Scheffe's Test; the findings show that no statistically significant differences exist.

Second: To study the effect of stream students have graduated from high school on their ability to read and interpret graphs, the researchers have calculated means, standard deviations, and percentages of pre-service teacher scores on the high school stream variable. Researchers have used analysis of variance test-ANOVA to investigate whether there were any statistically significant differences among the mean scores of sample of pre-service teachers on this variable. The results are shown in Table (7).

**Table 7: Means, Standard Deviation, and Percentage of the Study Sample Scores on the Ability to Read and Interpret Graphs Test According to the High School Stream Variable**

| | High school stream (scientific, literary, information technology, others) | | | | | | |
|---|---|---|---|---|---|---|---|
| read and interpret graphs test | No. of items | Scientific N=11 M (SD) % | Literary N=49 M (SD) % | I.T N=52 M (SD) % | Others N=10 M (SD) % | F(3,118) | Sig |
| reading graphs test | 6 | 3.00 (2.24) 50 | 2.86 (1.50) 48 | 2.85 (1.43) 48 | 2.70 (1.42) 45 | 0.067 | 0.98 |
| interpreting graphs test | 10 | 3.73 (2.33) 37 | 3.65(1.66)37 | 4.00 (1.53) 40 | 3.30 (1.34) 33 | 0.690 | 0.56 |
| overall test | 16 | 6.73 (4.24) 42 | 6.51 (2.31) 41 | 6.85 (2.36) 43 | 6.00(2.36) 38 | 0.368 | 0.78 |

Findings in Table (7) indicate that the test mean scores of students who graduated from the information technology stream were the highest on the overall test with a mean of (6.85); followed by scientific stream graduates (6.73). The findings indicate the existence of the same pattern when it comes to interpreting graphs; as information technology stream graduates scored the highest mean (4.00), followed by scientific stream graduates (3.73). It is evident from the table that these differences among mean scores of the sample in students' ability to read and interpret graphs, based on the high school stream variable are statistically insignificant.

Third: To study the impact of the number of science and mathematics courses taken by students to develop their abilities to read and interpret graphs, the researchers have calculated the mean scores and standard deviation of the participants in the sample in accordance with the number of science and mathematics courses they have attended during their study at the University. Analysis of variance (ANOVA test) was used to investigate whether any statistically significant differences exist in the participants mean scores on the number of science and mathematics courses taken at University. Table (8) shows these values.

**Table 8: Means, Standard Deviations, and Percentages of the Participants' Scores on the Ability to Read &Interpret Graphs Test According to the Number of Science and Mathematics Courses they have Attended**

| | Number of science and mathematics courses that were attended | | | | | |
|---|---|---|---|---|---|---|
| read and interpret graphs test | 0<br>N=38<br>M (SD ) % | 1<br>N=41<br>M (SD ) % | 2<br>N=21<br>M (SD ) % | 3<br>N=22<br>M (SD ) % | F(3,118) | Sig |
| reading graphs test | 2.50 (1.75) 42% | 2.85 (1.35) 48% | 3.48 (1.44) 58% | 2.86 (1.39) 48% | 1.89 | 0.135 |
| interpreting graphs test | 3.84 (1.48) 38% | 3.71 (1.78) 37% | 3.62 (1.50) 36% | 3.95 (1.68) 40% | 0.191 | 0.903 |
| overall test | 6.34 (2.60) 40% | 6.56 (2.50) 41% | 7.10 (2.34)44% | 6.82(2.75) 43% | 0.44 | 0.723 |

Table (8) shows that the test mean scores of pre-service teachers who have not taken any science or mathematics courses at the University were the lowest, reaching only (6.34) with a percentage of 40%; whereas students who have attended two science or mathematics courses at the University had the highest mean score (7.10) with a percentage of 44%. As for the subscales, pre-service teachers who have attended three courses in science and mathematics have higher levels of ability in interpreting graphs, with a mean of (3.95) and a percentage of 40%; while the mean scores of pre-service teachers who have attended two courses in science or mathematics have the highest level of ability in reading graphs. Table (8) also shows that no significant differences exist among the sample's mean scores in the ability of reading and interpreting graphs according to the number of science and/or mathematics courses they had attended.

## *6. Discussion*

This study aims to discuss the impact of the following factors on classroom teacher's attitudes toward graphs and their ability to read and interpret them: (1) high school stream; (2) academic level at university (freshman, sophomore, junior, senior) and; (3) the number of science and mathematics courses they have taken at the University.The results show that pre-service classroom teachers' attitudes toward graphs on the overall scale were neutral, where the mean of the pre-service teacher scores on the attitudes toward graphs scale as a whole was (3.09) with a percentage of 62%.The moderate attitudes possessed by pre-service teachers toward graphs highly depend on their previously gained experience in science and mathematics. It seems that science and mathematics courses that students have taken at schools have insignificant effect when it comes to graphs, whether in reading, interpreting or constructing them. Or there is a possibility that those teachers at schools were not concerned with training students to read and interpret graphs, which in turn has a negative impact on students' attitudes toward graphs.The results obtained by Gioka (2007) argue that teachers at schools do not have enough time to focus on the graph skills, as they are required to cover a large amount of content at a specific time; thus, teachers focused more on teaching concepts, theories and facts compared to graphs.Findings also show that pre-service teachers' attitude become more positive as the student advance through their academic level and with the increase in the number of science and mathematics courses studied by students at the University. These results are consistent with those of (Mumba et al., 2009), which assert that a correlation exists between the number of science courses and attitudes towards graphs. This can be explained with the fact that with the progress of students in the academic year at the university, they are exposed to a larger number of academic courses in science and mathematics, and these courses include a large number of graphs, which in turn increase the students' experiences in reading, interpretation, and constructing graphs. This makesstudents more confident and grants them a feeling of safety when dealing with graphs. It also fosters their interest in making use of graphs in the classroom while practicing teaching in the future.

The study revealed that the students' ability to read and interpret graphs is below the average of what is academically expected, where the percentage of the test as a whole(41%); these findings are consistent with those of (Bowen & Roth, 2005) which indicate that pre-service teachers lack the knowledge and skills necessary to read and interpret graphs. The results are also consistent with (Tairab& Al-Naqbi, 2004) which show that the students' ability of graph interpretation was quite low. However, the results of this study differ from those of (Al-Zoabi, 2007) which indicate that Al-Hussein bin Talal University students majoring in physics have accepted level of skills in reading and interpreting graphs.

We can explain the findings of this study by stating the fact that a large numbers of students majoring in classroom teacher in Jordanian universities have graduated from the literary stream or information technology stream, have not taken science courses during high school, and have only taken simple mathematics courses, and did not appear to have been exposed to sufficient experience related to reading and interpreting graphs. A study by Ibrahim (2005) shows that the vast majority of classroom teachers who teach the first three grades have graduated from the literary stream in high school, which has negative influence on learning and teaching science and mathematics courses.The findings have also indicated that there is a relationship between university students' academic year/ level and their ability to read graphs, and have shown that the students' ability to read graphs increase as their educational level increases. This due to the various experiences a student gains through successive years of learning, which makes them more capable of reading graphs. Therefore, the researchers asserted that it is critical for educational institutions in Jordan to pay more attention to attitudes toward graphs, as they are correlated to their ability of reading and interpreting them, especially considering that reading and interpreting them does not depend on age, and students are capable of developing these skills whenever were given the proper environment that is conductive to learning (Roth, 2002).As a result, teacher preparation programs should focus on helping pre-service teachers to develop the graph skills and develop positive attitudes towards the graphs, regardless of stream who graduated from at high school. Therefore, the supervisors of the teacher preparation programs must develop appropriate strategies that promote pre-service teacher attitudes toward graphs and develop their ability to read and interpret the graphs and use them in their classroom.

## 7. Recommendations

The following is a list of recommendations that would contribute positively to develop pre-service classroom teachers' attitudes toward graphs and their abilities to read and interpret them:

- Encouraging instructors at Jordan universities to pay more attention to graphs and use them in science and mathematics courses.
- Including a number of questions that require the students to read and interpret graphs, images, and shapes in science and mathematics exams.
- Conducting further studies on how to read and interpret charts, images, tables, and shapes.
- Training pre-service elementary school teachers on how to read graphs, images and illustrations, and how to use them when teaching science and mathematics.

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