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ELEMENTARY EDUCATION PRE-SERVICE TEACHERS' ATTITUDE TOWARDS GRAPHS

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Abstract. *This study examined pre-service elementary education teachers' attitude towards graphs. Attitude was defined in terms of six aspects: Effort, Value, Cognitive competency, Affect, Difficulty and Interest. Data was collected through a questionnaire. Pre-service teachers felt they had cognitive competence for graphing, valued graphs and expressed affection for graphs regardless of their perceived difficulties and low interest in graphs. Value was the only aspect that correlated with all other five aspects, in particular with Affect. Surprisingly, the number of mathematics courses taken by pre-service teachers did not make any difference in their attitude towards graphs. However, the number of science courses they took in high school made a difference in their attitude towards graphs. These findings have implications for teacher education and mathematics and science teaching and learning.*

Key words: *attitude, teacher, graph, cognitive competence, affect and value.*

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Introduction

Research studies show that teachers have graphing difficulties and misconceptions such as static confusion between slope versus height (Ritter & Coleman, 1995), failure to identify variables (Bowen & Roth, 2005), failure to determine linearity of scale and positioning the zero point or axis (Ritter & Coleman, 1995), and failure to distinguish a bar graph from histogram (Roth, McGinn & Bowen, 1998). Although several studies have examined teachers' graphing difficulties and misconceptions, no study has examined elementary education pre-service teachers' attitude towards graphs. Yet, research shows that attitudes affect teachers' instructional practice and that positive attitude among teachers leads to good learning and subsequently to better teaching in schools (Cantrell, Young & Moore, 2003). Research also shows that attitude has a significant influence on an individual's desire to learn a particular course or topic (Germann, 1988). Accordingly, elementary education pre-service teachers' willingness to learn more about graphing may depend on their attitude towards graphs. Young (1998) also argued that if pre-service teachers' attitude towards a course or topic are important then it is essential to know what those attitudes are if changes are to be made in the course. As such, the interest towards the attitudes that pre-service teachers bring into our teacher education mathematics and science methods courses is increasing among our faculty, since attitude can impede learning or hinder the extent to which our pre-service teachers develop useful skills such as graphing skills and their feelings towards graphs. We also believe that pre-service teachers' negative attitudes can impede their appreciation of the value of graphs professionally, personally, and for their students. In view of this, more attention to elementary education pre-service teachers' attitudes towards graphs is warranted, as it may contribute to better mathematics and science teaching and learning in schools.

Therefore, this study examined elementary education pre-service teachers' attitude towards graphs. The term *attitude* is a complex construct and may be determined by examining cognitive and affective aspects. The cognitive aspect is a set of knowledge while the affect aspect relates to feelings towards something. Gogolin and Swartz (1992) asserted that total attitude is made up of many factors in which the attitude may be negative or positive. As a result, attitude in this study was defined in terms of six aspects: *Effort, Value, Affect, Cognitive competence, Interest and Difficulty*. *Effort*: how hard one works to learn about graphs; *Value*: appreciation of graph usefulness and relevance of graphs in personal and professional life; *Affect*: positive and negative feelings concerning graphs; *Cognitive competence*: perception of self-competence, knowledge and intellectual skills when applied to graphs; *Interest*: how much one is attracted to graphs; and *Difficulty*: perceived difficulty of graphing as a topic.

Three research questions guided this study: (a) What are the levels of attitude towards graphs among pre-service teachers with respect to the six aspects of attitude as stated above? (b) What are the relationships among the six aspects of attitude towards graphs? (c) How do pre-service teachers' attitude towards graphs differ with regard to concentration areas (Mathematics, Science, English, Social Science, Special Education and Others) and the number of mathematics and science courses taken?

This study has significant implications for teacher education and the teaching and learning of science and mathematics. For example, the findings presented here are important to those who are involved in mathematics and science teacher education programs as they strive to improve graphing skills among teachers. It is also assumed that attention directed towards identifying pre-service teachers attitude towards graphs and subsequent improvement on their attitude towards graphs will have a profound effect on their application of teaching graphs in schools. This study also contributes to existing literature on graphing with regard to teachers.

Methodology of Research

A sample comprised 128 elementary education pre-service teachers at a research University in the Midwest of the USA. There were 111 females and 17 males. Pre-service teachers were in six concentration areas of elementary education degree program (Mathematics=17, Science=18, English=26, Social sciences=39, Special Education=12 and Others =16). The 'Others' category comprised Music, Foreign Language, Art, and Physical Education concentration areas. The age of the pre-service teachers ranged from 20 to 30 years. At the time of data collection pre-service teachers were enrolled in six sections of two science methods courses.

Data was collected through a 40-item Likert-scale questionnaire. The items were adopted from Survey of Attitudes Towards Statistics (STATS) (Dauphinee, Schau & Stevens, 1997). The first section of the questionnaire had items on demographic information such as gender, degree concentration areas, and math and science courses taken at high school and college levels. The second section had statements on the six attitude aspects: *Effort, Value, Cognitive competence, Affect, Difficulty, and Interest*. Each statement was valued in Likert-scale format, ranging from 1 to 5, where 1 indicates "Strongly Disagree" and 5 indicates "Strongly Agree".

Data was analyzed by computing descriptive statistics, correlations among the six aspects of attitude, and reliability values for the instrument and individual attitude aspects. One Way ANOVA and t-tests were performed to investigate differences among sub-groups on each of the six aspects of attitude.

Results of Research

Reliability values

The reliability value for the questionnaire was 0.91. The reliability values for the six attitude aspects ranged from low to high: *Difficulty* (0.26), *Effort* (0.37), *Cognitive Competence* (0.75), *Interest* (0.76), *Value* (0.78), and *Affect* (0.83). Although reliability values for *Effort* and *Difficulty* aspects of attitude were low, most reliability values were high enough to indicate some internal consistency in each attitude aspect section and the questionnaire.

Levels of attitude towards graphs

Effort: Table 1 below shows that pre-service elementary teachers said they strive to complete graph assignments (Mean = 4.63; SD =0.52), work hard on questions that involve graphing in their courses (Mean=4.25; SD = 0.66), and would like to help other students learn about graphs (M = 4.05; SD =0.77). However, they were indifferent on the proposition that learning graphs requires a great deal of discipline by a learner (M = 2.99; SD = 0.88). In addition, most pre-service teachers seemed to disagree that they study hard to understand graphs (M = 2.41; SD = 0.97).

Table 1. Means on effort aspect of attitude.

Items	Mean	SD
E1. I complete all my graph assignments.	4.63	0.52
E2. I work hard on questions that involve making or reading graphs in my courses.	4.25	0.66
E14. I study very hard to understand graphs.	2.41	0.97
E24. Learning graphs requires a great deal of discipline by a student.	2.99	0.88
E27. I attend all lessons including those that involve graphs.	3.93	0.87
*E38. I would not like help other students learn to make graphs.	4.05	0.77

*N= 128; *Negatively worded items & scored in reverse; E stands for Effort;*

Value: Table 2 below shows that pre-service teachers expressed neutral to positive views on the value of graphs. In particular, they viewed graphs as valuable in understanding today's world (M = 4.32; SD = 0.74), useful in their future teaching career (M = 4.25; SD = 0.75), and somehow relevant and applicable in their lives (M = 3.96; SD = 0.81), though they felt conclusions from graphs are rarely presented in everyday life (M = 3.67; SD = 0.86). They also seemed to have moderate but relatively positive view on the proposition that graphing skills will make them more effective teachers (M = 3.85; SD = 0.86). However, they were less enthusiastic about graphing being a required part of elementary teacher education program (M = 3.7; SD = 0.99).

Table 2. Means on value aspect of attitude.

Items	Mean	SD
*V7. Graphs are worthless in understanding today's World	4.32	0.74
V9. Graphing should be a required part of Elementary teacher education program.	3.70	0.99
V10. Graphing skills will make me a more effective teacher in school.	3.85	0.86
*V13. Graphs are not useful in my future job/career.	4.12	0.85
*V16. Graphs are not applicable in my life outside my teacher education training program.	3.89	0.77
V17. I use graph skills in my everyday life.	2.90	1.02
V21. Conclusions from graphs are rarely presented in everyday life.	3.67	0.86
*V25. I will have no use for graph skills in my teaching job.	4.25	0.75
*V33. Graphs are irrelevant in my life.	3.96	0.81

*N= 128; *Negatively worded items & scored in reverse; V stands for Value*

Cognitive competence: In general, most items on this aspect of attitude received positive views from pre-service teachers as shown in Table 3 below. For example, pre-service teachers reported they had ideas about graphs (M = 4.56; SD = 0.73), knew how to make (M = 4.02; SD = 0.69) and read graphs (M = 4.05; SD = 0.61), did not make a lot of errors when working on graphs (M = 4.06; SD = 0.68) and they had no trouble understanding graphs (M = 4.19; SD = 0.77). However, they disagreed with the proposition that most individuals have to learn a new way of thinking in order to make or read graphs

(M = 2.85; SD = 0.82).

Table 3. Means on cognitive competence aspect of attitude.

Items	Mean	SD
*C5. I have trouble understanding graphs	4.19	0.77
*C11. I have no idea about graphs.	4.56	0.73
*C26. I make a lot of errors when I work on graphs.	4.06	0.68
C31. I easily learn how to read graphs.	3.98	0.72
C32. I know the rules for making graphs.	4.05	0.61
C36. Most students have to learn a new way of thinking in order to make or read graphs.	2.85	0.82
C39. I know how to read graphs very well.	4.02	0.69

*N= 128; *Negatively worded items & scored in reverse; C stands for Cognitive competence*

Affect: In general, pre-service teachers expressed high affection towards graphs. For example, Table 4 shows that pre-service teachers were not scared of graphs (M = 4.54; SD = 0.61) and did not indicate that graphs made them nervous (M = 4.14; SD = 0.85), stressed or frustrated (M = 4.12 SD = 0.81). They also liked anything about graphs (M =3.99; SD = 0.83). However, pre-service teachers expressed very low enjoyment for taking courses that have a lot of graphs (M = 2.78; SD = 0.86).

Table 4. Means on affect aspect of attitude.

Items	Mean	SD
A3. I like graphs.	3.75	0.89
*A4. I become nervous when I have to do graphs	4.14	0.85
*A15. I get frustrated when we go over graphs in class	3.96	0.99
*A18. I feel stressed working with graphs in my courses.	4.12	0.81
A19. I enjoy taking courses that have a lot of graphs.	2.78	0.86
*A28. I am scared of graphs	4.54	0.61
*A37. I don't like anything about graphs.	3.99	0.83

*N= 128; *Negatively worded items & scored in reverse; A stands for Affect*

Difficulty: Table 5 below shows that pre-service teachers did not view graphs as very difficult to understand (M = 4.15; SD = 0.68). In addition, they viewed graphing as easy for them (M = 3.91; SD = 0.79) and not as a complicated process (M = 3.63; SD = 0.90). They also strongly viewed graphing as a highly technical process (M = 2.64; SD = 0.87) and difficult for individuals to gain graphing skills quickly (M = 2.75; SD = 0.84).

Table 5. Means on difficulty aspect of attitude.

Items	Mean	SD
D6. Graphs are very easy for me.	3.91	0.79
*D8. Graphing is a complicated process.	3.63	0.90
D22. Graphing skills are quickly learned by most students.	2.75	0.84
*D34. Graphing is a highly technical process.	2.64	0.87
*D35. I find it difficult to understand graphs.	4.15	0.68

*N= 128; *Negatively worded items & scored in reverse; D stands for Difficult*

Interest: Table 6 shows that pre-service teachers' interest in graphs ranged from low to moderate. Although they had moderate interest in understanding information presented in graphs (M = 3.39; SD = 0.78) they expressed very low interest in talking about graphs to other people

(M = 2.48; SD = 0.98) and using graphs in their everyday lives (M =2.67; SD = 0.88). Furthermore, they had indifferent view on learning about graphs (M = 3.29; SD = 0.87).

Table 6. Means on interest aspect of attitude.

Items	Mean	SD
*I12. I am not interested in talking about graphs to other people	2.48	0.98
I20. I am very interested in using graphs in my everyday life.	2.67	0.88
I23. I am interested in understanding information presented in graphs	3.39	0.78
*I29. I am not interested in learning about graphs.	3.29	0.87

*N= 128; *Negatively worded items & scored in reverse; I stands for Interest*

Comparisons among concentration areas

In general, Cognitive competence aspect of attitude received the highest mean score (3.96) followed by Affect (3.90), Value (3.85) and Effort (3.71) as shown in Table 7 below. On the other hand Difficulty (3.42) and Interest (2.96) received moderate mean scores among pre-service teachers. This implies that pre-service teachers recognized the value of graphs regardless of any perceived difficulties and moderately low interest in graphs. Table 7 also shows similar trends of mean scores for six aspects of attitude among the sub-groups. However, English and Social sciences sub-groups expressed the lowest interest in graphs than the other sub-groups. Surprisingly, the pre-service teachers in science concentration area (M= 3.34; SD = 0.5) were slightly more interested in graphs than those in mathematics concentration area (M= 2.99; SD = 0.3).

Table 7. Comparisons among concentration areas.

	Concentration areas for Elementary Education Degree (Sub-groups)								
	Sample (N=128)	Science N= 18	Math N= 17	English N= 26	Social Science N= 39	Special Education N= 12	Others N= 16		
Aspect	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	F (5,122)	Sig
Effort	3.71(0.8)	3.72(1.1)	3.86(0.8)	3.60(0.9)	3.67(0.8)	3.77(0.8)	3.77(0.7)	1.166	0.330
Value	3.85(0.4)	3.98(0.4)	4.02(0.4)	3.74(0.4)	3.69(0.4)	3.92(0.4)	3.93(0.5)	1.671	0.147
Cog. C	3.96(0.5)	4.27(0.6)	4.06(0.5)	3.75(0.5)	3.87(0.5)	4.02(0.7)	3.84(0.5)	3.930	0.002*
Affect	3.90(0.5)	4.33(0.4)	3.96(0.5)	3.55(0.6)	3.77(0.6)	4.00(0.6)	3.74(0.5)	4.423	0.001*
Difficulty	3.42(07)	3.69(0.7)	3.35(0.8)	3.20(0.4)	3.37(0.6)	3.63(0.7)	3.24(0.7)	4.986	0.000*
Interest	2.96(0.5)	3.34(0.5)	2.99(0.3)	2.65(0.5)	2.81(0.5)	3.12(0.4)	2.97(0.5)	2.028	0.079

*Significant at P<0.05

As shown in Table 7 above, One Way ANOVA revealed significant differences among sub-groups on three aspects of attitude towards graphs: Cognitive competence [F(5,122)= 3.930, p<.05]; Affect [F(5,122)= 4.423, p<.05] and Difficulty [F(5,122)= 4.986, p<.05]. On the other hand, there were no significant differences among sub-groups on the other three aspects of attitude: Effort [F (5,122) = 1.166, p>.05]; Value [F (5,122) = 1.671, P>.05], Interest [F (5, 122) = 2.028, p>.05]. Posthoc Tukey comparison tests showed that the significant differences on Cognitive competence and Affect aspects of attitude was among Mathematics, English and Social Sciences sub-groups while the significant difference on

Difficulty was among Mathematics, English and Others sub-groups. Surprisingly, Posthoc Tukey comparison tests showed no significant differences between Special Education and Mathematics sub-groups on Difficulty, Cognitive competence, and Affect aspects of attitude.

Comparing math and science courses taken

Table 8 below shows insignificant differences between pre-service teachers who had taken four or less college mathematics courses and those that had taken more than four college mathematics courses.

Table 8. Comparing between college math courses taken.

	College Math Courses Taken			
	1-4 courses N=51	5 or more courses N= 62	t	*Sig.*
	Mean (SD)	Mean (SD)		
Effort	22.3 (2.2)	22.3 (2.5)	0.037	0.971
Value	34.5 (4.8)	34.8 (4.5)	0.424	0.673
Cog. C.	27.5 (3.1)	27.8 (3.4)	0.471	0.639
Affect	27.1 (3.7)	27.4 (4.5)	0.513	0.607
Difficulty	16.8 (1.9)	17.3 (2.5)	1.315	0.191
Interest	11.6 (2.5)	11.9 (2.9)	0.542	0.589

*Significant at P<0.05; N= number of participants

Table 9 shows that there was a significant difference on cognitive competence aspect of attitude between pre-service teachers who had taken four or less college science courses and those that had taken five or more science courses. However, there were no significant differences between the two sub-groups on the other five aspects of attitude.

Table 9. Comparing between college science courses taken.

	College Science Courses Taken			
	1-4 courses N= 51	5 or more courses N= 59	t	*Sig.*
	Mean (SD)	Mean (SD)		
Effort	22.0 (2.3)	22.5 (2.4)	1.170	0.245
Value	34.2 (4.5)	34.9 (4.8)	0.754	0.427
Cog. C.	26.9 (3.5)	28.4 (2.9)	2.481	0.015*
Affect	26.6 (4.5)	27.8 (3.9)	1.580	0.117
Difficulty	16.8 (2.4)	17.3 (1.7)	1.379	0.171
Interest	11.6 (2.4)	11.8 (3.0)	0.459	0.647

*Significant at P<0.05; N= number of participants

As shown in Table 10 below, there was no significant difference between pre-service teachers who had taken four or less high school mathematics courses and those that had taken five or more mathematics courses at high school on all the six aspects of attitude.

Table 10. Comparing between high school math courses taken.

	High School Math Courses Taken			
	1-4 courses N= 41 Mean (SD)	5 or more courses N= 72 Mean (SD)	t	*Sig.*
Effort	22.2 (2.4)	22.3 (2.3)	0.323	0.747
Value	34.0 (5.2	35.0 (4.2)	1.181	0.240
Cog. C.	27.1 (2.9)	28.1 (3.4)	1.518	0.132
Affect	26.8 (4.3)	27.6 (4.1)	1.011	0.314
Difficulty	17.2 (1.9)	17.0 (2.2)	0.443	0.658
Interest	11.3 (2.9)	12.0 (2.6)	1.315	0.191

*Significant at P<0.05; N= number of participants

Table 11 shows significant differences between pre-service teachers who had taken four or less high school science courses and those that had taken five or more science courses on four aspects of attitude: Value, Cognitive competence, Affect and Interest. On the other hand there were no significant differences between the two sub-groups on effort and difficulty aspects of attitude.

Table 11. Comparing between high school science courses taken.

	High School Science Courses Taken			
	1-4 courses N= 46 Mean (SD)	5 or more courses N= 67 Mean (SD)	t	Sig.
Effort	22.2 (2.2)	22.3 (2.5)	0.343	0.733
Value	33.0 (4.1)	35.8 (4.6)	3.385	0.001*
Cog. C.	26.8 (2.8)	28.3 (3.4)	2.383	0.019*
Affect	25.9 (4.1)	28.2 (4.0)	2.986	0.003*
Difficulty	16.7 (2.0)	17.3 (2.2)	1.493	0.138
Interest	10.9 (2.9)	12.4 (2.4)	2.991	0.003*

*Significant at P<0.05; N= number of participants

Table 12 shows a significant difference between juniors and seniors on the cognitive aspect of attitude. On the other hand, the differences between the two sub-groups on other five aspects of attitude were insignificant.

Table 12. Comparison among juniors and seniors.

	College Standing			
	Junior N = 22 Mean (SD)	Senior N = 91 Mean (SD)	t	*Sig.*
Effort	21.5 (2.4)	22.5 (2.3)	1.869	0.064
Value	33.7 (3.2)	34.9 (4.9)	1.068	0.288

	College Standing			
	Junior N = 22 Mean (SD)	Senior N = 91 Mean (SD)	t	*Sig.*
Cog. C.	26.3 (2.7)	28.0 (3.3)	2.172	0.032*
Affect	26.8 (3.1)	27.4 (4.4)	0.590	0.556
Difficulty	16.7 (2.3)	17.1 (2.1)	0.893	0.374
Interest	11.7 (2.3)	11.8 (2.8)	0.169	0.866

*Significant at P<0.05; N= number of participants

Relationships among aspects of attitude

The relationships among the six aspects of attitude towards graphs, namely Effort, Value, Affect, Cognitive competence, Difficulty and Interest were investigated using Pearson product-moment correlation coefficients. According to Cohen (1988), the size of a correlation is an indicator of the practical significance of a relationship, with correlations of about 0.3(irrespective of sign) and higher taken to indicate moderate practical effect. Therefore, Table 13 below shows that significant correlations among the six aspects of attitude ranged from weak (0.26) to strong (0.71). Value was the only aspect that was positively related to the other five aspects of attitude towards graphs, in particular with Affect. A strong positive significant relationship (0.71) was found between Cognitive competence and Enjoyment. This implies that elementary education pre-service teachers who had high affection towards graphs felt they had graphing knowledge and skills.

Table 13. Correlations among six aspects of attitude.

	Value	Cogn.Comp	Affect	Difficulty	Interest
Effort	.49*	.35*	.33*	.11	.45*
Value		.48*	.62*	.34*	.57*
Cogn.C			.71*	.62*	.23
Affect				.64*	.58*
Difficulty					.26*

**Correlation is significant at p<.01(2-tailed)*

On the other hand, moderate correlations were found between Effort and Affect (0.33), Value and Difficulty (0.34) and Cognitive competence and Effort (0.35). There was a somehow weak relationship between Difficulty and Interest (0.26). Correlations between Effort and Difficulty and Interest and Cognitive competence were not significant. A possible explanation is that elementary pre-service teachers who had difficulties with graphs had less interest in graphs and they were not likely to attempt to learn about graphs.

Discussion

The purpose of this study was to examine pre-service elementary education teachers' attitude towards graphs. Attitude was defined in terms of six aspects: *Effort, Value, Cognitive competency, Affect, Difficulty* and *Interest*.

The results show that pre-service teachers had neutral to positive feelings concerning graphs; perception of self-competence for graphs; and valued graphs regardless of their perceived difficulties and moderate interest in graphs. However, there were significant differences on Cognitive competence,

Affect, and Difficulty between pre-service teachers in Mathematics concentration areas and those in English, Social Sciences and Others. A possible explanation for this finding is that pre-service teachers in mathematics concentration areas are likely to have more affection towards graphs than those in English and Social Sciences. Furthermore, pre-service teachers in English and Social Sciences concentration areas are likely to view graphs as more difficult than those in Mathematics. However, there were insignificant differences between pre-service teachers who had taken more mathematics courses and those who had taken less mathematics courses at either the college or high school levels. On the other hand, there were significant differences between pre-service teachers who had taken more science courses and less science courses at college and high school levels. These findings suggest that the number of mathematics courses taken by pre-service teachers may not have made any difference in their attitude towards graphs. In contrast, the number of science courses they took in high school seemed to have made some difference in their attitude towards graphs.

These findings have implications for teacher education and mathematics and science teaching and learning. For example, though most pre-service teachers valued graphs they expressed an indifferent interest in them. Such attitude can impede teaching and learning of graphs among teachers. Such attitudes can also hinder the extent to which teachers will develop graphing intuitions and useful application of graphs in their teaching jobs, personal lives, and lives of their students. Although pre-service teachers expressed self-competence for graphing, they viewed graphing as a highly technical process that is difficult to learn quickly. These outcomes also reinforce our view that graphing in teacher education should be increased, since a teacher who feels insecure or scared of or not interested in a topic is unlikely to support its teaching. Therefore, teacher educators should focus on helping pre-service teachers to develop graphing skills and positive attitude towards graphs regardless of concentration areas for their elementary education degree because graphs are used in many subject disciplines. It would also be useful for teacher educators to consider developing strategies that will foster pre-service teachers' positive attitude towards graphs, and help them reflect on the nature of graphs. Future research should investigate: the relationship between pre-service teachers' attitude towards graphs and achievement on graphs; graphing preferences among pre-service teachers; and the relationship between graphing preference and achievement on graphs.

Conclusions

On the whole, elementary education pre-service teachers valued graphs, expressed affection and self-competence for graphing regardless of their perceived graphing difficulties and indifferent interest in graphs. A strong relationship between Cognitive competence and Affect led us to conclude that elementary education pre-service teachers with high affection for graphs are likely to think they have graphing knowledge and skills. On the other hand, non-significant correlations between Effort and Difficulty and Interest and Cognitive competence led us to conclude that elementary pre-service teachers who viewed graphs as difficult were likely to express low self-competence and less interest in graphs. Surprisingly, this study found that the number of mathematics courses taken by pre-service teachers may not have made any difference in their attitude towards graphs. However, the number of science courses they took in high school seems to have made some difference in their attitude towards graphs.

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