The Content and Format of a Professional Development Program and Its Attitudinal Effect on Teachers of Mathematics

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Abstract - *The West Chester University Teachers Teaching with Technology Pre-Service/In-Service Professional Development Program* housed at West Chester University located in Pennsylvania, USA, has provided professional development in the area of technology for thousands of high school and middle school mathematics teachers around the world. Each summer the program offers several graphing handheld institutes for teachers of mathematics/science. These workshops provide a breeding ground for a new and improved teacher of mathematics. Improved methods of teaching undoubtedly lead to more advanced students. In this study eight different workshops were studied. Two of these workshops were 3 consecutive full days long and the rest were 5 consecutive full days long. The same attitudinal survey was administered both before each workshop and again at the conclusion of each workshop. The study included 63 educators, mostly mathematics teachers. This study showed that a five day institute is more effective than a three day institute and that graphing calculator institutes have a positive attitudinal affect on teachers of mathematics.

Keywords - Graphing handhelds; Mathematics education; Professional development; Teacher attitudes.

I. Introduction

Professional development is a continual process. There are both content and pedagogical areas that teachers must be kept abreast of; and, there are new issues today and new pedagogical methods that are preferred over the time-honored ones (Koolbreeze, 2009). Veteran teachers need ongoing and regular opportunities to learn from one another. Professional development should be ongoing, experiential, collaborative, and connected to and derived from working with students and understanding their culture. Research shows that an inspiring and informed teacher is the most important school-related factor influencing student achievement (Edutopia Staff, 2008). Undoubtedly, great effort and sufficient resources should be put into professional development programs for educators. "Teachers should be provided with opportunities to improve upon their qualifications through quality improvement programs. Under the quality improvement programs a variety of short term courses need to be provided to meet the training needs for all levels of faculty" (Iyer, 2009).

In addition to needing professional development, mathematics teachers also need to embrace technology in the mathematics classroom. "Using technology in teaching is becoming more and more critical in the global information age. The U.S. Congress Office of Technology Assessment has said that a lack of training for teachers in using technology greatly impedes the ability to integrate technology into the classroom; and The U.S. Congress Office of Technology Assessment also offers an overview of research-based tips and suggestions for training teachers to use technology" (Butler, 2008). For example calculators, when used appropriately, can be a learning tool for mathematics. "Appropriate use of calculators is a way of increasing the amount and the quality of learning afforded students during the course of their mathematics education" (Pomerantz, 1997). Calculators are a valuable educational tool and help to alleviate monotonous tasks and assist with the conceptual development of higher mathematical concepts. The major mathematical organizations NCTM, AMATYC, and MAA have developed standards which provide guidelines for mathematics instruction in grades K-12 and in some areas of the undergraduate mathematics curriculum (Gallitano et al., 2009). Reform efforts in mathematics instruction emphasize the “Rule of Three: every mathematical topic should be presented from the symbolic, algebraic, and graphic approach" (Clutter, 1999). It's important that mathematics transferors of knowledge educate our students and prepare them for a society that is very technologically oriented.

II. Statement of the Problem

For mathematics teachers both professional development and embracing technology in the classroom is essential for excellence. It is important that teachers show to the students an alternative and practice way for the theoretical constructs explained during the lecture" (Ando et al., 2009). Any improvement in education must start with improvement of the teachers already in the classroom (Wu, 1999). "Learning should be seen as an active, cognitive, constructive, significant, mediated and self-regulated process" (Viamonte, 2010). Professional development helps mathematics teachers to enrich and remediate their knowledge. Therefore, the more effective the professional development program the more advantageous it will be for both the teacher and the students. Attributes of meaningful professional development programs include format, curriculum, comradeship, instructors, facilities, and more.

"Research from over 100 studies indicates that the use of calculators (a) promotes achievement, (b) improves problem-solving skills, and (c) increases understanding of mathematical ideas" (Suydam, 1987). In addition, "students using calculators possess a better attitude toward mathematics and an especially better self-concept in mathematics than non-calculator students. This statement applies across all grades and ability levels" (Hembree and Dessart, 1986). There is a strong need for meaningful professional development in the area of the use of technology in the mathematics classroom.

III. Methodology

The West Chester University Teachers Teaching with Technology In-service/Pre-service Professional Development Program was founded in 1995. Under the aegis of the program all day week long graphing handheld institutes or three day graphing handheld institutes are hosted for mathematics teachers. During the school year two or three day follow up institutes are also offered. These institutes are instructed by Texas Instruments professionals who are well trained in graphing handheld methodology and technology. The institute's curriculum is written by mathematicians and mathematics educators who are well versed in the integration of the graphing handheld into the mathematics curriculum. The graphing handhelds used are one of the TI models, such as the TI-84 Plus Silver Edition, the TI-89 Titanium, the new touchpad TI-Nspire, the Voyage 200, or the new touchpad TI-Nspire (CAS). The institute's instructors also use many other types of technology during the institutes, including the CBR, the CBL2, the computer, TI-interactive software, and so forth.

During the summer 2009, the Program's director collected data from the participants in both the three day and five day institutes using an attitudinal survey which is filled out by the participants both at the beginning and at the end of the institute. The survey questions deal with graphing handheld usage in the mathematics classroom and also with the teacher's attitudes concerning graphing handheld usage in the mathematics classroom. The purpose of the graphing handheld institutes is not only to provide in-service/pre-service training for mathematics teacher but also to enhance their attitudes toward graphing handheld usage in the mathematics classroom so as to encourage them to appropriately use the graphing handheld in their classroom instruction.

IV. The Results

Questionnaires were evaluated from 63 participants to evaluate their attitudes toward handheld technology in the classroom. Among these 63 participants, 23 of them attended a three day-long workshop and 40 of them attended a week-long workshop; Ninety two percent of them were between 20 and 60 years of age; About half of them were male (44%); The years of teaching experience were relatively evenly distributed from "5 years or less" to "21 years or more;" Around half of the teachers earned a bachelors degree or masters degree and the other half earned a post masters degree. Most of the participants (79%) were senior high school mathematics teachers.

Table 1: Demographic Information for the 63 workshop participants

Attribute	Categories	Percent (%)

Workshop type	Week-long workshop	63
	Three day-long workshop	37
Age	20-29	10
	30-39	30
	40-49	16
	50-59	37
	60 or more	6
	Missing	2
Gender	Male	44
	Female	54
	Missing	2
Years of Teaching Experience	5 or less	17
	6-10	16
	11-15	22
	16-20	13
	21 or more	30
	Missing	2
Highest Degree Earned	BA/BS	22
	MA/MS	25
	MA/MS+	49
	Doctorate	3
Type of School Teacher	Middle/Junior	19
	Senior	79
	Missing	2
Certification Area	Elementary Education	3
	Secondary Mathematics	84
	Secondary other	8
	Missing	5
Teaching Assignment	Algebra I	14
	Algebra II	40
	Both	27
	Missing	19
Estimated Enrollment in School	0-200	2
	201-500	22
	501-1000	25
	1000 or more	49
	Missing	2
Average Class Size in Algebra Classes	11-15	11
	16-20	22
	21-25	37
	26-30	19
	31 or more	10
	Missing	2

Participants' attitudes toward the use of graphing handheld technology in the classroom were assessed before commencing the workshop and after completing the workshop to determine the attitudinal effect of the workshop. Each participants' attitude was measured as an ordinal variable on a 5-point Likert Scale, ranging from 1 = Strongly Agree to 5 = Strongly Disagree.

Paired t-tests were used to test whether there was a statistically significant attitude response score change before and after the workshop. Paired t-tests, rather than independent two sample t-tests, were used because each participant was measured twice. Among the total 22 attitudinal questions, it was found that for nine of the questions there was statistically significant attitude response score differences before and after the workshop for the 63 pooled participants (40 participants in the week-long workshop and 23 participants in the three day-long workshop) (Table 2 and Figure 1). This shows the effectiveness of the workshop in changing participant's attitudes toward graphing handheld technology.

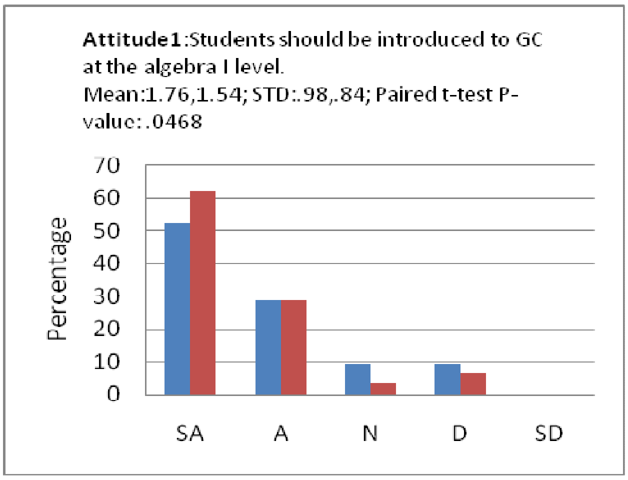
Table 2 lists the nine attitudinal questions that were significant for the participants in the workshops. Besides these nine attitudinal questions, there were three more questions where the answers significantly changed before and after the workshop for the week long group (Table 2 and Figure 1). This shows that the week-long workshop was more effective in changing participant's attitudes toward graphing handheld technology than the three day-long workshop.

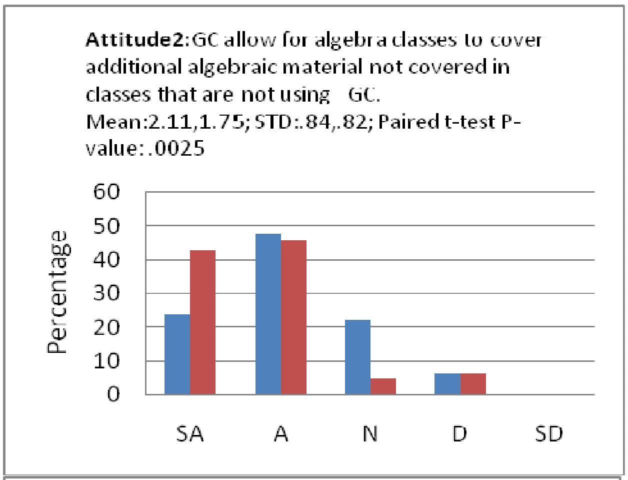
Table 2: The mean, standard deviation and p-value for the ATTITUDE question response score that significantly changed before commencing the workshop vs. after completing the workshop based on paired t-test (α=0.05)

Question #	Question	Pre-Mean +/-Std Dev	Post-Mean +/-Std Dev	P-Value
1	Students should be introduced to graphing calculators at the algebra I level.	1.76+/-0.98	1.54+/-0.84	0.0468
2	Graphing calculators allow for algebra classes to cover additional algebraic material (topics) not covered in classed that are not using graphing calculators.	2.11+/-0.84	1.75+/-0.82	0.0025
3	Graphing calculators allow for greater detail and/or difficulty of algebra topics than in classes that are not using graphing calculators.	1.87+/-0.71	1.62+/-0.66	0.0051
4	Graphing calculators allow for omission or de-emphasis of certain algebraic topics.	2.68+/-1.10	2.38+/-0.97	0.0047
5	The graphing calculator is motivational.	2.16+/-0.95	1.81+/-0.86	0.0011

6	Students should not be allowed to use graphing calculators until they have mastered the concepts or procedures.	3.10+/- 1.03	3.46+/- 0.96	0.0114
7	Graphing calculators should be used only to check work once the problem has been worked out on paper.	3.40+/- 0.96	3.71+/- 0.81	0.0188
8	Using graphing calculators will makes students try harder.	2.79+/- 0.86	2.55+/- 0.84	0.0123
9	I know ways I can use graphing calculators effectively in my classroom.	2.15+/- 1.08	1.63+/- 0.52	<0.0001
10*	More interesting algebra problems can be done when students have access to graphing calculators.	1.98+/- 0.83	1.55+/- 0.60	0.0028
11*	Graphing calculators should be required of all algebra students assuming that they would be made available to those who could not afford one.	1.95+/- 1.04	1.60+/- 0.71	0.0211
12*	I am proficient at using graphing calculators.	2.33+/- 1.23	1.98+/- 0.86	0.0249

* The 40 participants in the week long group





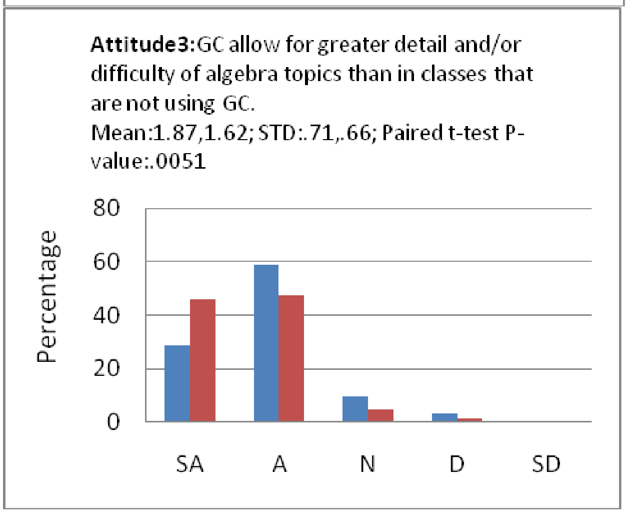
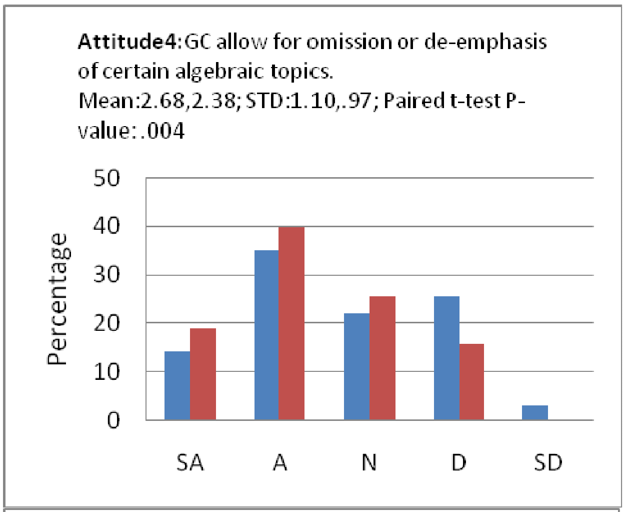
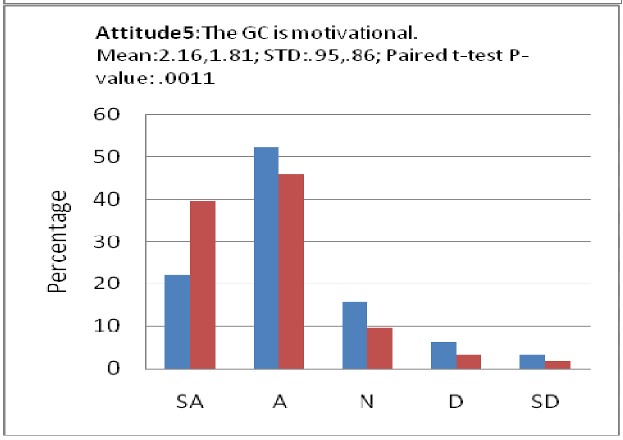
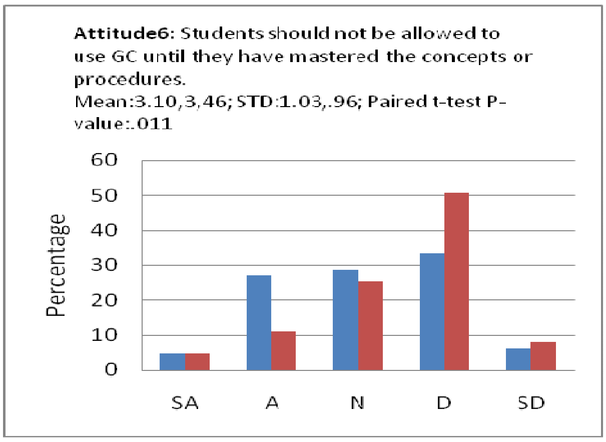
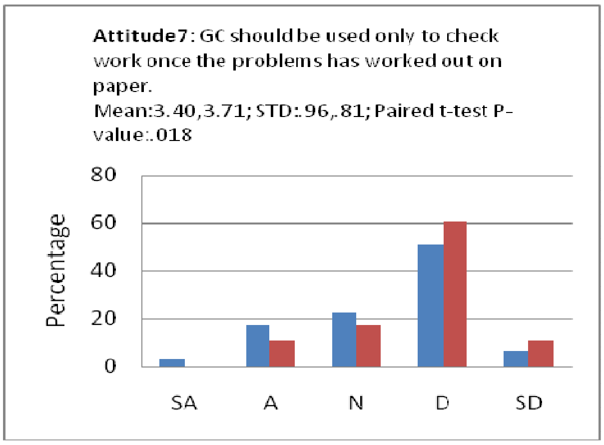


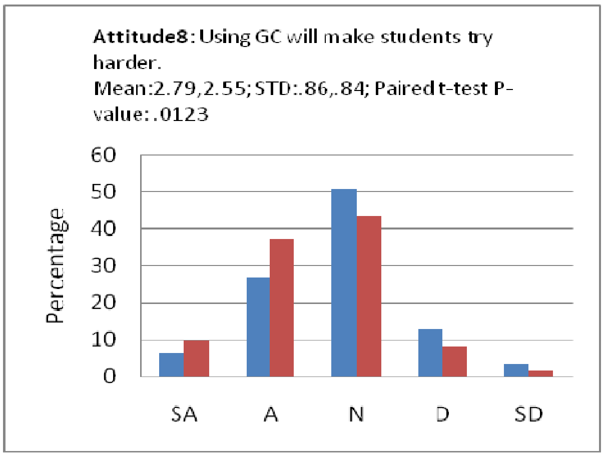
Fig. 1: Participants' attitude toward the use of graphing calculators for nine questions significantly changed for the 63 pooled participants and for an additional three questions significant changes were found for the week-long workshop group of 40 participants.

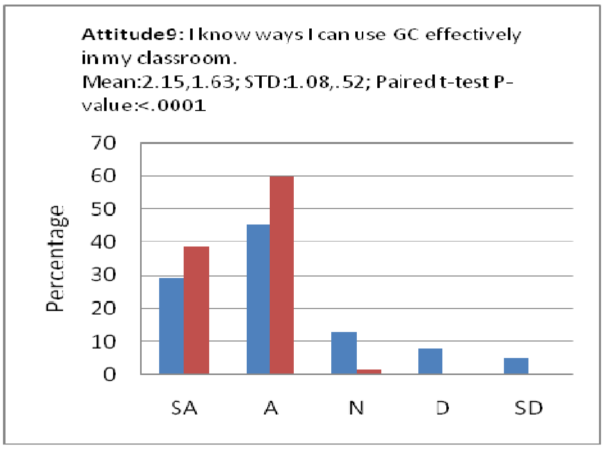

Attitude4:GC allow for omission or de-emphasis of certain algebraic topics.
Mean:2.68,2.38; STD:1.10,.97; Paired t-test P-value:.004
Percentage
50
40
30
20
10
0
SA
A
N
D
SD

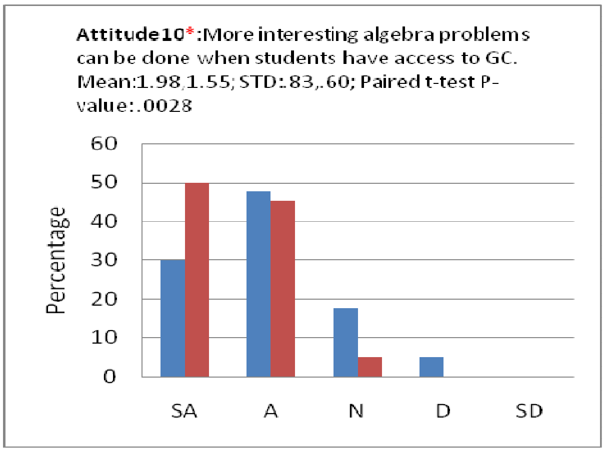

Attitude5:The GC is motivational.
Mean:2.16,1.81; STD:.95,.86; Paired t-test P-value:.0011
Percentage
60
50
40
30
20
10
0
SA
A
N
D
SD

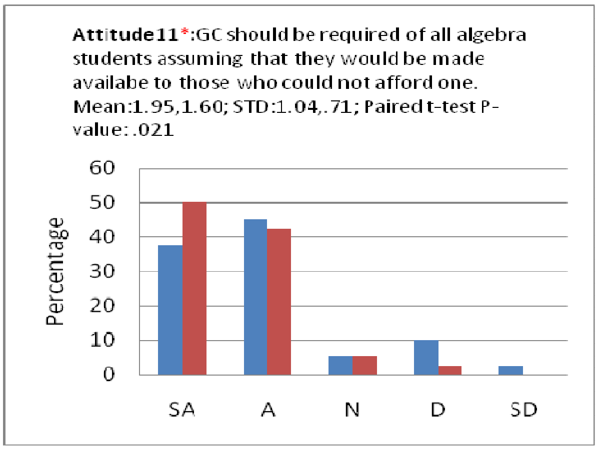

Attitude6: Students should not be allowed to use GC until they have mastered the concepts or procedures.
Mean:3.10,3,46; STD:1.03,.96; Paired t-test P-value:.011
Percentage
60
50
40
30
20
10
0
SA
A
N
D
SD


Attitude7: GC should be used only to check work once the problems has worked out on paper.
Mean:3.40,3.71; STD:.96,.81; Paired t-test P-value:.018
Percentage
80
60
40
20
0
SA
A
N
D
SD


Attitude8: Using GC will make students try harder.
Mean:2.79,2.55; STD:.86,.84; Paired t-test P-value:.0123
Percentage
60
50
40
30
20
10
0
SA
A
N
D
SD


Attitude9: I know ways I can use GC effectively in my classroom.
Mean:2.15,1.63; STD:1.08,.52; Paired t-test P-value:<.0001
Percentage
70
60
50
40
30
20
10
0
SA
A
N
D
SD


Attitude10*:More interesting algebra problems can be done when students have access to GC.
Mean:1.98,1.55; STD:.83,.60; Paired t-test P-value:.0028
Percentage
60
50
40
30
20
10
0
SA
A
N
D
SD


Attitude11*:GC should be required of all algebra students assuming that they would be made availabe to those who could not afford one.
Mean:1.95,1.60; STD:1.04,.71; Paired t-test P-value: .021
Percentage
60
50
40
30
20
10
0
SA
A
N
D
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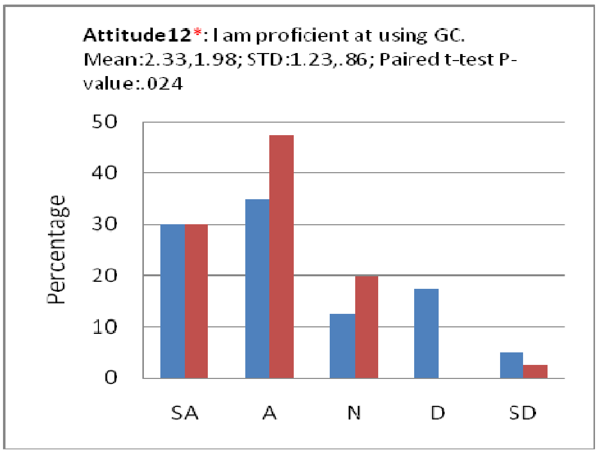


* 40 participants in the week long group.

Independent two sample t-tests were used to test the attitude response score change (the before workshop score minus the after workshop score) difference between the week-long workshop group and the three day-long workshop group. Among 22 attitude questions, six of them were found to be significantly different.

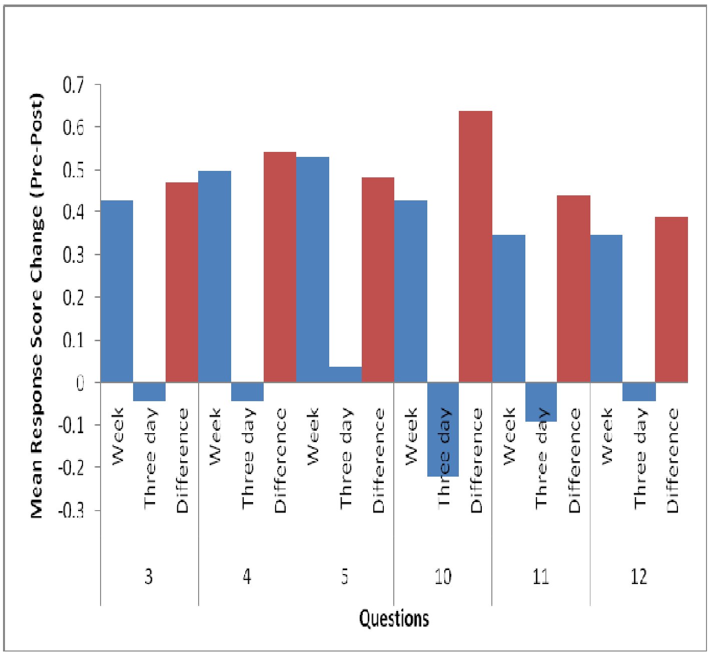
(Table 3 and Figure 2). For example, for questions 3, "Graphing calculators allow for greater detail and/or difficulty of algebra topics than in classes that are not using graphing calculators," the mean attitude response score change before commencing the workshop and after completing the workshop is 0.43 for the week-long group and -0.04 for the three day-long group. We are 99 % confident (1.00-p value) that there is a difference between these two changes.

Table 3: The independent two sample t-test results for testing the ATTITUDE question response score change (Pre-workshop minus Post-workshop) difference between the week-long workshop group and the three day-long workshop group.

Question #	Group	N	Mean (pre-post)	Std Err	T-test Method	P-value
3	Week-long (0)	40	0.43	0.11		
	Three day-long (1)	23	-0.04	0.12		
	Difference(0-1)		0.47	0.17	Pooled	0.0089
4	Week-long(0)	40	0.50	0.13		
	Three day-long(1)	23	-0.04	0.13		
	Difference(0-1)		0.54	0.20	Pooled	0.0098
5	Week-long(0)	40	0.53	0.14		
	Three day-long(1)	23	0.04	0.10		
	Difference(0-1)		0.48	0.20	Satterthwaite	0.0075
10	Week-long(0)	40	0.43	0.13		
	Three day-long(1)	23	-0.22	0.14		
	Difference(0-1)		0.64	0.21	Pooled	0.0027
11	Week-long(0)	40	0.35	0.15		
	Three day-long(1)	23	-0.09	0.11		
	Difference(0-1)		0.44	0.21	Satterthwaite	0.0187
12	Week-long(0)	40	0.35	0.15		
	Three day-long(1)	23	-0.04	0.12		
	Difference(0-1)		0.39	0.22	Satterthwaite	0.0430

Note: For the actual question please refer to Table 1 according to the question number.

Fig. 2: The ATTITUDE question response score change (Pre-workshop minus Post-workshop) difference between the week-long workshop group and the three day-long workshop group



V Additional Findings

On average, a 5 year increase of a participant's algebra class size is associated with a 0.32 increase of attitude score change (pre minus post) on the question "Students should be permitted to use the newest graphing calculators (like the TI-92/Voyager 200 which is an algebraic symbolic manipulator) in algebra classes."

On average, a 5 year increase of teaching experience is associated with a 0.23 increase of attitude score change (pre minus post) on the question "When students work with graphing calculators, they do not need to show their work on paper."

On average, the graphing calculator using teacher's attitude score change (pre minus post) for the question "Students understand algebra better if they solve problems using paper and pencil" is 0.81 smaller than for teachers that do not use graphing calculators in class.

On average, the graphing calculator using teacher's attitude score change (pre minus post) for question "I know ways I can use graphing calculators effectively in my classroom" is 1.01 smaller than for teachers that do not use graphing calculators in class.

VI Conclusion

Professional development is essential for teachers not only to stay current and enhance their teaching, but also to positively enhance their attitudes toward various aspects of their teaching. This study shows that the format of the teachers' professional development is as important an aspect of the professional development as is the topic itself. A week long workshop may be just enough time to immerse oneself into the workshop whereas a three day workshop may leave a teacher feeling a little more shallow. Why a week long professional development program was significantly more influential than a three day professional development program is not completely clear. However, since it was statistically shown that a week long program is more effective than a three day program more research in this area is encouraged.

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