ASSESSMENT OF STUDENTS ATTITUDES TOWARDS SCIENTIFIC CALCULATORS USE IN MATHEMATICS INSTRUCTION

Nabeel Abedalaziz [a]
[a] Faculty of Education, Department of Educational Psychology and Counseling,
University of Malaya, Kuala Lumpur, Malaysia
[a] Corresponding author : nabeelabdelazeez@yahoo.com

 ISSN 1923-6654 (print)
ISSN 1923-6662 (online). Available at http://www.ssrn.com/link/OIDA-Intl-Journal-Sustainable-Dev.html

Abstract: The aim of this study is to investigate student's attitudes toward scientific calculator use in mathematics instruction. Specifically, the present study sought answers to the following questions: What is the overall profile of student's attitudes towards scientific calculators use in mathematics instruction? Do student's attitudes towards scientific calculators use in mathematics instruction differ in terms of gender variable? Do student's attitudes towards scientific calculators use in mathematics instruction differ in terms of grade level variable? Do student's attitudes towards scientific calculators use in mathematics instruction differ in terms of mathematical ability level? A total of 400 basic schools students were participated in this study. Attitudes scale to assess student's attitudes toward the use of scientific calculators was developed. Results of the study show that attitudes of students towards calculators use are at high level. Significant differences were found between student's attitudes toward calculators use related with gender, class, and the level of mathematical ability.

Keywords: Anxiety, Attitudes, Calculators, Enjoyment, Usefulness**.**

INTRODUCTION

Technology plays a basic role in the changes taking place in Jordanian society. It has largely contributed to almost every sector of life: medicine, economy, and in education, particularly in mathematics. Learning and teaching mathematics nowadays should emphasize understanding, problem solving, logical reasoning, analyzing and applications. In order to achieve these purposes, students should learn with media and technologies, such as computers and scientific calculators, to make abstract things visible as objects, to animate stable pictures and to compute basic mathematical calculations which are considered to be unnecessary for students.

Minister of education in Jordan now regard facility with information and communication technologies as one of the essential capabilities that young people should acquire in order to participate successfully in contemporary social, economic and cultural life. Frameworks for professional teaching standards that describe what teachers need to know, understand, and be able to do also refer to integration of ICTs as an essential aspect of teacher’s professional knowledge and practice.

Significant funding has also been committed to providing better network infrastructure and access to improve teachers’ capacity to manage the curriculum through information and communication technologies. In the 2003s mathematics curriculum policy in Jordan began to promote the use of technology as a focus and aid to students’ learning and understanding of mathematics. The intent of this national policy framework is reflected in the mathematics curriculum statements and syllabuses that permit, encourage, or expect use of technologies such as computers, the Internet, scientific calculators or calculators with computer algebra systems. In the current context of educational policy making it sometimes seems to be assumed that supplying schools with hardware and software will increase teachers’ use of technology and encourage more innovative teaching approaches that produce improved learning outcomes for students. There is a need, therefore, to assess student's attitudes toward the use of scientific calculators in mathematics instruction.

CALCULATORS IN MATHEMATICS INSTRUCTION

The scientific calculators are not only capable of doing arithmetic operations effectively but also can be extended to the operations in trigonometry functions and logarithms as well. With powerful technologies, the students' approach to mathematics tasks may differ significantly, in an impoverished or even counterproductive way, from the original intentions [25]. Ruthven [28] reports that this technology had a strong influence both on the mathematical achievement. Many studies have indicated that the use of calculators can enhance students' ability to learn basic facts and that students who used calculators frequently exhibited more advanced concept development and problem solving skills than those who did not use them (e.g. [31, 44, 54]). These studies reduced some earlier fears that calculators could affect students' mastery of computational skills acquired from traditional paper-pencil methods [31, 32].

Previous studies (e.g. [34, 35, 36, 37, 38, 46]) indicated that using calculators for learning mathematics could help students in problem solving so that they will have more learning time, not worry about computations and instead focus on the method of problem solving and could help in developing deeper conceptual understanding because calculators could draw pictures to help the student to understand better about graphs and functions and to integrate the several fields of mathematics, such as graphs, numbers and algebra. Other research cited by Hembree & Dessart [24] indicated that fourth graders did not benefit from calculator use in the classroom.

Some experts consider the use of technology in mathematics instruction as the only way to go for conventional teaching methods [29]. Argues that the use of such technologies promise power for students to control over their own learning, and promises to give "voice" to learners. The latter arguments are considered essential for a smooth learning environment for both males and females, as it is believed that such interactive ways of learning could minimize or eliminate gender differences in learning. The interactive nature of calculators could provide the opportunity for females especially, to work independently and become more confident in learning.

Despite the use of technology such as the use of scientific calculators is considered an important tool to enhance and impart knowledge, critics of such technologies argue that some areas of the content that aim at developing critical thinking such as logical reasoning and reflective practice cannot be satisfied by this technology [29]. Access to such technologies has also been criticized for lack of epistemological access to students. It is argued that the theories of social construction of knowledge require the relationship between the person and the social phenomena as central to epistemological access i.e. knowledge is to be constructed and developed in and through social mediation [43]. Broekman [30] argues that enabling epistemological access to technology requires the consideration of developmental aspects of affinity with technology, and that affinity depends on confidence which itself develops social mediation. Positive effects of using graphing calculators include students' improved achievement, reduced anxiety in mathematics, increased self-confidence, and active involvement of students in the learning process. Waits & Demana [39] have found that calculators cause changes in the way we teach and in the way students learn. Before computers and calculators, it was necessary for students to spend time mastering and becoming proficient in the use of paper and-pencil computational and manipulative techniques. Today much of this time can be spent on developing deeper conceptual understanding and valuable critical-thinking and problem-solving skills.

RELATED LITERATURE

Schunk [33] defines attitudes as: "attitudes are internal beliefs that influence personal actions and that reflect characteristics such as generosity, honesty, and commitment to healthy living. Attitudes are inferred because they cannot be observed directly. In general, attitudes as a learned predisposition to respond to a consistently favorable or unfavorable manner with respect to a particular object can be defined [8]. Attitudes are relatively less stable than personality traits and can be used over time and across situations in the individual virtue of interaction with the environment [9]. The student attitudes toward scientific calculator measures of their skills in effective learning. Calculator attitudes have been defined as a person, or general feeling of antipathy to review calculator technology. Attitudes are learned, they can be change with the experience of the stimulus objects and with social rules and institutions [7].

Previous studies explored the overall attitudes towards calculators use in learning process [1,10, 11, 41, 50], and analyzed factors affecting students attitudes towards the use of calculators in mathematics instruction, such as gender [6,47], age or class [49], school type [6], mathematics achievement [55], and mathematical anxiety [6].

Shumway et al [49] determined the effect of availability of calculators and calculator-related curriculum resources on elementary school children's attitudes and achievement in mathematics. The pretests results indicated that the classes 2 and 3 control and treatment students had higher attitude towards calculators that toward mathematics. Pretests results for classes 4 through 6 showed lower attitude toward calculators in grade 6 than in grades 2 through 5. The posttest scores indicated that there was no significant difference in the attitudes towards mathematics or calculators for grades 2 and 3. However, there was a decrease in positive attitude toward the calculator from class 4 through 6. Furthermore, although the older students viewed the calculator somewhat favorably.

Loyd and Munger [55] examined the relationship between mathematics performance and students' attitudes toward technology (computers and calculators), and whether the relationship is similar for males and females. A practice form of the General Educational Development (GED) test was used to measure mathematics performance. Students' attitudes toward computers were assessed by the Computer Attitude Scale, and attitudes toward calculators were assessed by a 4-item measure developed by the authors. In general, students with more positive attitudes toward computers and calculators were found to perform better than students with more negative attitudes.

Thomas [41] distributed a questionnaire on use of and attitudes towards calculators and computers to every primary and secondary school in New Zealand. Information was sought on frequency of use, the kinds of mathematics topics that involved teaching with computers, types of software available, and reasons for both use and non-use of computers. The major obstacle reported by teachers was lack of access to computers and software, while lack of training and lack of confidence were also identified as significant barriers inhibiting use.

Schmidt [50] found that teachers had positive attitudes towards calculators; however, the open-ended questions revealed that fundamental perceptions about the value of calculators had not changed. The researcher expressed disappointment that the teachers had not changed their overall perceptions about teaching of mathematics in grades 5 and 6 despite a significant effort to train them on NCTM based methods and provide them with the tools to use in their classrooms. Some of the teachers may have had negative attitudes toward using the calculators and that may have influenced the students and their attitudes about calculators. Teachers as role models could have a powerful effect on students [33].

Tobin, Routitsky and Jones [11] conducted a study to measure how teachers viewed graphics calculator use. The aims were to determine the level of ownership or access by students, and to investigate teacher attitudes towards and use of graphics calculators in mathematics. Results suggested strong teacher support for the policy of introducing graphics calculators. Teachers' perceptions of usefulness generally depended on the level of access to the calculators in classrooms.

Kaino and Salani [47] analyzed gender attitudes of students in learning mathematics by using a calculator, in one of Botswana's Junior Secondary Schools. Students' attitudes were sought using a questionnaire and data was analyzed by both quantitative and qualitative methods. Attitude variables used were usefulness of calculators, enjoyment and anxiety in using calculators. The findings indicated that students of both sexes did not realize the benefits of using a calculator in mathematics learning. Generally, no gender differences were noted in the variables used. While most students were accessible to calculators, they were not accessible to calculator technology.

Goos and Bennison [10] found that a substantial majority of respondents felt confident or very confident in teaching mathematics with these three types of technology (computer, internet, and calculators), although there were differences in confidence levels when using computers, the Internet, and graphics calculators. Teachers view graphics calculators as a mathematics-specific teaching and learning resource, more readily accessible than computers, but requiring targeted professional development to overcome their lack of experience with this relatively recently introduced technology.

Abdullah, Abdullah & Tap [1] investigated the effects of scientific calculator use on students' attitudes in mathematics classrooms. A factor analysis identified three dominant factors in describing students' attitudes toward scientific calculators. Factor 1 and Factor 2 were attitudes about positive of affective results and attitudes about drawbacks of cognitive results respectively. Attitudes about positive of cognitive results were referred as Factor 3. Most of the consensus agreements were seem to focus at the Factor 1. The modest positive correlation was reported on the items of Factor 1 and Factor 3. It seems that the correlation only exist between positive of cognitive results and positive of affective results. Apparently, Factor 1 has become the central point of findings and concludes that students had positive attitudes in using scientific calculators in mathematics classrooms**.**

Khatoon and Mahmood [6] examined the effects of gender, type of school, mathematics anxiety and mathematics achievement on attitude toward IT technology. Results indicated that females hold more comfort, confidence and more positive attitude toward IT technology than males. Moreover, the students Attitudes differ by the type of school. Students with high mathematics achievement and low mathematics anxiety held more positive attitude toward IT technology. Further, this study showed a negative correlation (r=-0.36) of IT technology attitude with mathematics anxiety and positive correlation (r=0.39) with mathematics achievement.

PURPOSE OF THE STUDY

In education, computers and calculators historically have been associated with mathematics and the sciences, and are frequently incorporated into these areas of the curriculum. This may have serious implications for females because of the long history of reported sex differences in achievement and attitudes in mathematics and related disciplines. As such, the present study tried to explore a gender differences in attitudes toward the use of calculators in mathematics instruction.

NCTM Board of Directors fully supported the use of calculators in all grade levels [42]. Scientific calculators are accessible to most students in schools and presently ICT materials are used in mathematics teaching. Throughout Jordan there are moves to promote the integration of information and communication technologies into school education through curriculum initiatives, funding for infrastructure, and development of professional standards for teachers. In basic and secondary school mathematics education curriculums now permit, encourage, or require teachers and students to use technologies such as computers and scientific calculators in both learning activities and evaluation tasks. As such, assessment of student's attitudes toward the use of technologies in learning as a function of class, gender, and mathematical ability is important for future introduction of ICT materials in mathematics instruction.

In this study, eighth, ninth and tenth grade Jordanian students’ attitudes are examined to provide a contribution to the education and learning process. This study provides opportunity to determine whether there is a significant difference between the girls’ and boys’ attitudes toward calculators. Furthermore, this study attempts to discover whether the classes and mathematical ability level have an impact on students’ attitudes or not. The results obtained from the current study may be used to arrange the students’ learning process, learning environment, and the teachers and educators’ teaching methods. The classroom environment may be arranged in terms of the students’ attitudes. By knowing the students’ attitudes the teachers have an idea and may plan instructional activities to develop students’ attitudes toward scientific calculators. On the other hand, the previous research generally focused on the high school and college school students’ attitudes. Especially, in Jordan, the studies about elementary school students’ attitudes toward calculators are rare. To date there were no study investigating effect of mathematical ability level on attitudes of the students in Jordan. In conclusion, this study can be considered as one of the initial attempts to provide information about the students’ attitudes about using scientific calculators in mathematics instruction to arrange the conditions of the learning and teaching.

The present study sought answers to the following questions: What is the overall profile of student's attitudes towards scientific calculators use in mathematics instruction? Do student's attitudes towards scientific calculators use in mathematics instruction differ in terms of gender variable? Do student's attitudes towards scientific calculators use in mathematics instruction differ in terms of grade level variable? Do student's attitudes towards scientific calculators use in mathematics instruction differ in terms of mathematical ability level?

METHODOLOGY

Sample

The sample of the study consists of 400 students at basic level in Jordan. Table 1 shows the demographic characteristics of the sample. In Jordan, calculators are used more frequently for the classes 8, 9, and 10 than for the classes 11 and 12. Calculators were a priority for Mathematics 8, 9, and 10 classes, although use of this technology was also quite high for class 10. As such, the three classes had been selected.

Procedure

Data was collected from the participants on during the first semester of the 2010 academic year. At all occasions, the author was present throughout the data collection process. After a brief introduction to the research, the survey questionnaires were distributed to students. On the average, students took about 20 minutes to complete the survey forms.

Instrument

The students were grouped according to their scores in the mathematical ability scale that was administered to them on the first week of classes [52]. Based on the results of the mathematical ability scale, the members of the groups were identified and labeled as follows: the high ability group (HAG, the top 133students), the average ability group (AAG, the middle 134 students), and the low ability group (LAG, the bottom 133 students).

The current study developed a 45 items questionnaire to measure students’ attitudes toward the use of scientific calculators in mathematics instruction. The items were arranged for scoring using a 5-point Likert-type response scale, and the items were scored by the following key: 5= *strongly agree*, 4 = *agree*, 3 =undecided, 2 = *disagree*, and 1 = *strongly disagree*.

To develop the questionnaire, the initial version of the scale (45 items) was completed by a sample of 200 students, as mentioned above. Prior to analyzing data using factor analysis, data collected in this research went through Barlett's Test of Sphericity meant to measure the applicability of factor analysis. Kaiser-Meyer-Olkin Measure of Sampling Adequacy recorded at 0.603 (>0.5), hence it is good enough to use factor analysis in determining the number of factors to be retained and loading factors on the items.

SPSS 16.0 was used to perform exploratory factor analysis and principal component analysis with varimax rotation on the 45 items, suggesting three interpretable factors: Usefulness, Enjoyment, and Anxiety. Items loading more than ±0.40 were retained on the relevant factor, and items loading less than ±0.40 were omitted [21]. Thus, item analysis reduced the original 45 items to 30 items with three independent constructs.

A factor analysis was then conducted on the retained 30 items. Many items from each subscale were alternately presented or negatively worded to prevent clustering effect and to provide a check against respondents giving positive or negative response sets [23]. The results show that the factor loadings range between .42 and .63 on the Usefulness subscale, between .40 and .84 on the Enjoyment subscale, and between .51 and .74 on the Anxiety subscale (see appendix).

The Eigen values of the first three factors from principal component analysis were larger than 1: 6.41, 4.07 and 2.64 respectively. These three factors accounted for 43.74% of variance in the final version of the scale.

The behavior of individual items in relation to others within the same subscale provides good evidence for content validity because the highest factor loading is central to the domains assessed by these subscales [22]. The Cronbach's alpha coefficients calculated for the Usefulness, Enjoyment, and Anxiety subscales were 0.79, 0.71, and 0.85, respectively, and it was calculated to be .86 for the entire scale. The scale correlation coefficients ranged between 0.32 and 0.46 on calculator usefulness, between 0.33 and 0.57 on calculator enjoyment, and between 0.33 and 0.60 on calculator Anxiety. It is generally agreed that correlations in the range of 0.35 to 0.65 are useful and statistically significant beyond the1%level, whereas correlations less than 0.25 are not useful and statistically non significant [18, 19]. Thus, the results show that the alpha coefficients for all subscales were significantly high, suggesting that the internal reliability index of the three constructs and the entire scale is adequate. In addition, the results of inter correlations showed that each subscale correlates significantly with other subscales and the entire scale. According to Harrison, Seeman, and Behm [20], this result provides at least further evidence for the consistency of the entire scale and for the convergent validity of each subscale. Therefore, it can be concluded that the three factors measure calculator attitudes in a coherent way.

The relationship among the subscales is shown in Table 2. All subscales correlate significantly at the p < .01 level and the coefficients range from 0.22 to .53. This suggests that the three components were fairly independent to be used as independent variables. This allows us to examine the calculator attitudes of students by each subscale.

RESULTS

Overall profile of the calculator attitudes among basic school students

Attitudes towards calculators use was measured in terms of the usefulness, enjoyment, and anxiety in a scale developed by the author. All 400 participants responded to all items in the scale and no missing data was found in the survey. Table 3 presents the participants' mean scores with the standard deviations of the three subscales. The mean scores for the usefulness, enjoyment, and anxiety are convergent. The participants scored the lowest on the usefulness subscale (mean = 3.50), whereas they scored the highest on anxiety subscale. At the global level, the overall calculator attitude is well above the mid-point of the scale (3.00) and this indicated that participants held a positive attitude towards the calculator.

MANOVA analysis

Assumptions were checked before conducting Multivariate analysis. MANOVA has seven assumptions: sample size, independence of observations, normality, outliers, linearity, multicollinearity and singularity, and homogeneity of variance-covariance matrices. No violations were found on multivariate normality and equality of variance.

A one way, between groups multivariate analysis of variance was performed on the three dependent variables (usefulness, enjoyment, and anxiety) for the class domain (class8, class 9, and class 10). There was a significant difference by class domain on the combined dependent variable attitudes: F (6, 393) = 3.29, wilks lambda=0.98, p<0.01. Table 4 shows the summary results of one way MANOVA on the three dependent variables (usefulness, enjoyment, and anxiety) for the class. The three classes differ in their perceptions of the usefulness of a scientific calculator (usefulness): F (2, 309) = 9.85, p<0.05; their perceptions of how much they enjoy the use of calculator (enjoyment): F (2, 309), p<0.05; and in their perceptions of how much they anxious in using calculators (anxiety): F (2, 309), p<0.05.

A one way, between groups multivariate analysis of variance was performed on the three dependent variables (usefulness, enjoyment, and anxiety) for gender domain (male and female). There was a significant difference by gender domain on the combined dependent variable attitudes: F (3, 396) = 4.94, wilks lambda=0.97, p<0.01. Table 5 shows the summary results of one way MANOVA on the three dependent variables (usefulness, enjoyment, and anxiety) for gender. These results suggest that males scored higher than females in their perceptions of the usefulness of a scientific calculator (usefulness): F (1, 3398) = 10.88, p<0.05; in their perceptions of how much they enjoy the use of calculator (enjoyment): F (1, 398) = 4.85, p<0.05; and in their perceptions of how much they anxious in using calculators (anxiety): F (1. 398) = 7.70, p<0.05.

A one way, between groups multivariate analysis of variance was performed on the three dependent variables (usefulness, enjoyment, and anxiety) for mathematical ability level (high and low). There was a significant difference by school type domain (high, and low) on the combined dependent variable attitudes: F (1, 398) = 6.15, wilks lambda=0.95, p<0.01. Table 6 shows the summary results of one way MANOVA on the three dependent variables (usefulness, enjoyment, and anxiety) for mathematical ability level. These results suggest that students with high mathematical ability level scored higher than students with low mathematical ability level in their perceptions of the usefulness of a scientific calculator (usefulness): F (1, 310) = 1.75, p>0.05; in their perceptions of how much they enjoy calculator use (enjoyment): F (1, 310), p>0.05; and in their perceptions of how much anxious in using calculators (anxiety): F (1, 310), p>0.05.

ANOVA analysis

Univariate analysis of variance was used to study the effect of the class, gender, and mathematical ability level in the overall attitudes towards scientific calculator use in mathematics instruction. Table 7 indicates the summary results of Univariate analysis of variance. Students attitudes towards the use of scientific calculators in mathematics instruction are differ by class F (2, 398) = 21.60, p<0.05. Results suggest that males scored higher than female in attitudes towards the use of scientific calculators in mathematics instruction: F (1, 398) = 36.06, p<0.05. Also, students with high mathematical ability level scored higher than students with low mathematical ability level in attitudes towards the use of scientific calculators in mathematics instruction: F (1, 398) = 26.27, p<0.05.

To explore the significance of the dual attitudes differences between the students in the various educational levels in attitudes towards calculators, multiple comparisons (i.e., Scheffe Test) were used. Table 8 shows the results of Scheffe Test to explore the significance of the attitudes differences between the pair wise means of the students' attitudes in various educational levels in attitudes towards calculators. Table 8 shows:

(1)There are statistically significant differences between the means of student in the tenth class and the means of student in the ninth class in their perception about the usefulness of calculators in mathematics instruction, the enjoyment of using calculators, the anxiety of using calculators, and in overall attitudes in favor of the tenth class students.
(2)There are statistically significant differences between the means of student in the tenth class and the means of student in the eight class in their perception about the usefulness of calculators in mathematics instruction, the enjoyment of using calculators, the anxiety of using calculators, and in overall attitudes in favor of the tenth class students.
(3)There are statistically significant differences between the means of student in the ninth class and the means of student in the eight class in their perception about the usefulness of calculators in mathematics instruction, the enjoyment of using calculators, the anxiety of using calculators, and in overall attitudes in favor of the tenth class students.

DISCUSSION

The positive attitudes among students of scientific calculators found in this study reinforced the importance of technology in aiding arithmetic manipulation. Students in this era have gained broad exposure to calculators thus changes in the way numbers being calculated do not much influence their acceptance to the arithmetic manipulation technology. More importantly, the positive acceptance can be extended to unearth the potential of scientific calculators. The time has come for the curriculum policy makers to make a new move and take proactive measures to integrate more powerful technology in the mathematics classroom. The use of scientific calculators in schools is already taken off in many developed countries. Now, with the positive attitudes among students toward scientific calculators, it is logical that students will respond in the same manner if the scientific calculators were used in the mathematics classroom [1].

		Frequency	Percentage
Gender	Male	216	54
	Female	184	46
Class	Class 8	144	36
	Class 9	96	24
	Class 10	160	40
Ability level	High	133	33
	Low	133	33
Total		400	

Table 1: Demoghraphic characteristics of the sample

Component	Usefulness	Enjoyment	Anxiety
Usefulness	1.00	0.53**	0.22**
Enjoyment	0.53**	1.00	0.42**
Anxiety	0.22**	0.42**	1.00

Table 2: Correlation matrix of the subscales

Component	Number of items	mean	Standard deviation
Usefulness	10	3.50	9.96
Enjoyment	10	3.60	9.63
Anxiety	10	3.67	9.74
Overall calculator attitudes	30	3.60	28.27

Table 3: Descriptive statistics and reliability coefficient for each subscale (n=400).

Component	Sum of squares	df	Mean square	*F*-value	*p*-value
Usefulness	444.85	2	222.43	5.45	0.01
Enjoyment	690.55	2	345.27	9.06	0.00
Anxiety	477.06	2	238.53	5.66	0.00

Table 4: Results of a one way, between groups multivariate analysis of variance on the three dependent variables (usefulness, enjoyment, and anxiety) for the class.

Component	Sum of squares	df	Mean square	*F*-value	*p*-value
Usefulness	443.94	1	443.94	10.88	0.00
Enjoyment	184.77	1	184.77	4.85	0.03
Anxiety	324.44	1	324.44	7.70	0.01

Table 5: Results of a one way, between groups multivariate analysis of variance on the three dependent variables (usefulness, enjoyment, and anxiety) for gender.

Component	Sum of squares	df	Mean square	*F*-value	*p*-value
Usefulness	703.20	1	703.20	17.23	0.00
Enjoyment	600.38	1	600.38	15.76	0.00
Anxiety	544.25	1	544.25	12.92	0.00

Table 6: Results of a one way, between groups multivariate analysis of variance on the three dependent variables (usefulness, enjoyment, and anxiety) for mathematical ability level

Source	Type III Sum of Squares	df	Mean Square	*F*	*p*-value
Corrected Model	161467.75	11	14678.89	36.16	0.00
Intercept	2809419.25	1	2809419.25	6.920	0.00
Gender	14639.18	1	14639.18	36.06	0.00
Class	17537.99	2	8768.99	21.60	0.00
Ability level	10662.59	1	10662.59	26.27	0.00
gender * Class	76.70	2	38.35	0.09	0.91
gender * Ability	0.89	1	0.89	0.00	0.96
Class * Ability	1535.58	2	767.79	1.89	0.15
gender * Class * Ability	7715.00	2	3857.50	9.50	0.00
Error	157511.43	388	405.96		
Total	4958049.00	400			
Corrected Total	318979.18	399			

Table 7: Summary Results of Univariate Analysis of Variance (Three-way ANOVA) for Students Attitudes towards Scientific Calculators by Class, Gender, and School Type.

		Class 8	Class 9	Class 10
Usefulness	Class 8	-	- 7.64**	- 11.58**
	Class 9	-	-	- 3.94**
	Class 10	-	-	-
Enjoyment	Class 8	-	- 8.12**	- 11.41**
	Class 9	-	-	- 3.29**
	Class 10	-	-	-
Anxiety	Class 8	-	- 8.84**	- 11.18**
	Class 9	-	-	- 2.34**
	Class 10	-	-	-
Overall attitude	Class 8	-	-24.64**	-34.14**
	Class 9	-	-	-
	Class 10	-	-	-9.50**

****Significant at α = 0.01**

Table 8: Results of Multiple Comparisons (Scheffe Test) for the Differences between the Means of the Students Attitudes towards Scientific Calculator.

Overall, the participants showed positive attitudes towards the calculator, as shown by the mean score for each subscale being 3.5 and above (on a 5-point scale). The overall positive level of computer attitudes could be attributed to the availability and accessibility to calculators given to students at various stages of their education. In 2003, Jordanian Ministry of Education ensured that all students would be given access to an IT-enriched environment in schools, starting at the primary level [53].

However, participants from all classes perceived the calculators to be useful in mathematics instruction. It is reasonable to expect that, given the thrust of the use of ICT in the schools for teaching and learning and their exposure to calculators during teacher training, coupled with modeling by the lecturers on scientific calculator usage, these participants were in a conducive environment that nurtured a development of positive attitudes towards scientific calculator.

These findings seem to be consistent with the findings of the previous studies (e.g. [1, 10, 11, 12, and 50]). In the contrary, Khino and Salani [47] indicated that students of both sexes did not realize the benefits of using a calculator in mathematics learning**.**

The present study statistical analysis suggests that male's attitudes is significantly higher than the female's counterpart. That is, males are less anxious about using calculators, more confident about learning with calculators and perceive calculators as more enjoyable than females. The gender based results for scientific calculators attitude of this study is consistent with the study of Meelissen and Drent, [15]; Hashim and Mustapha, [14]; and Khaton and Mahmood, [6]. Contrary to the findings of these studies, Khino and Salani [47] reported that no gender significant difference in students attitude toward the use of calculator in mathematics instruction. Other studies have suggested that the masculine image of the IT technology has deterred females from benefiting from the technology and this has made them less confident or more anxious [13].

Studies have established a correlation that students who had more anxiety in learning had less enjoyment of the subject studied [13]. Anxiety in learning has been described to affect confidence among learners [20, 40]. Confidence was described as one of important affective factors in learning [51].

Many females in basic school are less confident than males with respect use technology in learning such as computer [3, 4]. Some have argued that a majority of calculators and computer games are designed for males, thereby promoting their increased confidence [2, 3, and 4]. It is worth noting that gender differences in calculator and computer attitudes increase with age [5]. While there is relatively little difference between males and females up to Grade 4, girls begin to develop increasingly negative attitudes as they reach Grades 7 and 8 [2, 3, 4, and 17].

While most students, of both sexes, consider the calculator to be useful, with more boys than girls holding this view, majority of students from both sexes enjoyed working with calculators. Boys enjoyed more to work with calculators than girls. Anxiety of majority students to use or when using calculators to learn mathematics, with girls affected more than boys can well is explained by students' lack of enjoyment in using this technology to learn the subject. Generally, the findings showed gender differences in the three considered variables, i.e. usefulness, enjoyment and anxiety between girls and boys.

Further, another variable, which comes up as a major influencing factor for calculator attitude among students, is the class. Participants in different class (class 8, class 9, and class 10) differed in their perceptions of how much they like calculators (*enjoyment*), how much they anxious in using calculators (anxiety), and in their perception about the usefulness of calculators in mathematics instruction (usefulness). Results indicated that the positive attitude towards calculators increase from grades 8 to 10.This disparity among different classes can be due to calculators is used more frequently in Years 8, 9, and 10 than in Years 11 and 12. Calculators were a priority for Mathematics 8, 9, and 10 classes, although use of this technology was also quite high in Year 10.Younger students may not make the connection between math and the calculator. Using the calculator may be fun and may be viewed more as a game than math. These findings consistent with previous studies, as an example, stuyk et al. [48] indicated that attitudes toward calculators increasing by age. In the contrary, Shumway et al. [49] found a decrease in positive attitude towards calculators from grades 4 to 6. The class team researching motivation and transitions may shed some light on this topic.

Further, students with high level of mathematics ability have more positive attitude toward calculator in comparison to the students with low level of mathematical ability. These findings are consistent with Subhi [16] who reported that attitude towards computer is directly related to gifted children's math performance and their IQ level. Khaton and Mahmood [6] indicated that attitude toward computer is more positive for students having high mathematics achievement. This finding is due to a significant positive correlation with mathematics ability and achievement [6, 52]. Although, sample was large enough but the generalization of the findings of the study is limited because test was conducted in specific geographical location of Jordan, and only on three classes. A replication of it with large and more representative sample of students of different classes and subjects from wider regions and with more rigorous design is likely to prove quite rewarding in shading more light on difference of mean computer attitude score.

In order for calculators to be a presence in the classroom, certain changes must take place in the curriculum. Teachers can encourage the use of calculator in elementary classrooms while promoting a positive attitude towards their use among parents and students. This may involve the use of calculators in estimation activities, problem solving experiences, and composition of word problems. However, programs must be in place to educate parents. The mathematics syllabus (of Jordan) stipulates clearly the objectives of using calculators in teaching, and as teachers were aware of the role of calculators [45], teachers' knowledge on the use of calculators in instruction has to be revisited. In schools environment, literature showed that many teachers still hesitate to start using calculator in mathematics instruction. Many reasons were being thrown. Besides the lack of a clear policy that has been adopted by the authority, one of the most pertinent reasons was because of the various opinions regarding the appropriateness of calculator use [26]. Some students have negative views concerning the use of calculators. They feel that calculator usage does not help in the learning of concept and skills, the calculator is just something else to learn, and they lose control of the mathematical problem. Consequently, they lack confidence in calculator mode of calculation [27]. There was a tendency among the teachers to believe that the calculators deteriorated the basic arithmetic skills of students i.e. if students learn to use the calculator, they won't learn basics mathematics facts.

REFERENCES

[1] Abdullah, M., &Abdullah, W. & Tap, A. (2005). A New Look at the Students' Attitudes toward Scientific Calculators. Malaysian Online Journal of Instructional Technology Vol. 2, No.2, pp 17-26.

[2] Barker, L. J., & Aspray, W. (2006). The state of research on girls and IT. In J. M.

[3] Kay, R. H. (2006). Addressing gender differences in computer ability, attitudes and use: The laptop effect. *Journal of Educational Computing Research*, 34, 187–211.

[4] Butter, D. (2000). Gender, girls, and computer technology: What's the status now? *Clearing House*, 73(4), 225–229.

[5] Lupart, J.L., & Cannon, E. (2002). Computers and career choices: Gender ifferences in grade 7 and 10 students. *Gender, Technology and Development*, 6, 233–248.

[6] Khatoon, T., and Mahmood, S. (2010). Computer Attitude as a Function of Gender, Type of School Mathematics Anxiety and Mathematics Achievement. *European Journal of Social Sciences – Volume 18, Number 3 (2011)*.

[7]Binder, M & Niederle, U. (2007). Institutions as determinants of preference change- A one way relation? Retrieved on 29th August, 2008 from https://papers.econ.mpg.de/evo/discussionpapers/ 2006-07.pdf.

[8] Fishbein, M. & Ajzen, I. (1975). Belief, attitude, intention and behavior: An introduction to theory and research. Reading, MA; Addison Wesley, Publishing.

[9] Robinson, P.B., Simpson, D. V., Huefner, J. C. & Hunt, H. K. (1991). An attitude approach to the prediction of entrepreneurship: Entrepreneurship. *Theory & Practice*, Summer, 13-31.

[10]Goos, M. & Bennison, A. (2004). *Teachers' use of technology in secondary school mathematics classrooms*. Paper presented at the annual conference of the Australian Association for Research in Education, Melbourne, 28 November-2 December. Retrieved 26 May 2006 from www.aare.edu.au/04pap/goo04319.pdf

[11]Tobin, P., Routitsky, A. & Jones, P. (1999). Graphics calculators in Victorian secondary schools: Teacher perceptions of use. In J. Truran & K. Truran (Eds.) *Making the difference* ((Proceedings of the 22nd annual conference of the Mathematics Education Research Group of Australasia, pp. 502-506). Sydney: MERGA.

[12] Thomas, M. O. J. (1996). Computers in the mathematics classroom: A survey. In P. Clarkson (Ed.), *Technology in mathematics education* (Proceedings of the 19th annual conference of the Mathematics Education Research Group of Australasia, pp. 556-563). Melbourne: MERGA.

[13] Culley, L. (1988). Option choices and careers guidance: Gender and computing in secondary schools. *British Journal of Counseling and Guidance*, 16, 72-82.

[14] Hashim, H. R. & Mustapha, W. N. (2004). Attitudes toward learning and working with computers of students at U9TM. The Turkish online Journal of Educational Technology, 3(1), 3-6.

[15] Meelissen, R. M. & Drent, M. (2008). Gender difference in computer attitudes: Does the school matter? *Computer in Human Behaviour*, 24(3), 969-985.

[16] Subhi, T. (1999). Attitudes toward computers of gifted students and their teachers. *High Ability Studies*, 10(4), 69-84.

[17] Loyd, B. (1989). Gender and attitudes toward computers and calculators: Their relationship to math performance. *Journal of Educational Computing Research*, 5(2), 167-177.

[18]. Brown, F. 1983. *Principles of educational and psychological testing*. 3rd ed. New York: Holt, Rinehart & Winston.

[19] Bryman, A., and D. Cramer. 1997. *Quantitative data analysis with SPSS for Windows: A guide for social scientists*. London: Routledge.

[20] Harrison, J., J. Seeman, and R. Behm. 1991. Development of a distance education assessment instrument. *Educational Technology Research and Development* 39 (4): 65-77.

[21] Field, P. 2000. *Discovering statistics using SPSS for Windows: Advanced techniques for the Beginner*. London: Sage.

[22] Francis, J. 1993. Measuring attitude toward computers among undergraduate college students: The affective domain. *Computers & Education* 20 (3): 251-55.

[23]Selwyn, N. 1997. Students' attitudes toward computers: Validation of a computer attitude scale for 16-19 education. *Computer & Education* 28 (1): 35-41.

[24]Hembree, R. & Dessart, D.J. (1986). Effects of hand-held calculators in pre-college mathematics education. *Journal for Research in Mathematics Education*, 17(2), 83-99.

[25] Hillel, J. (1992). The computer as a problem solving tool; It gets a job done, but is it always appropriate? In J. P. Ponte et al., (Eds.). *Mathematical Problem Solving and New Information Technologies: Research in Contexts of Practice*. Berlin: Springer.

[26] Kaiser, E. (1994). Calculators in the classroom. *Arithmetic Teacher*, 39(2), 6.

[27]. Ruthven, K. (1995). Pupils' views of number work and calculators. *Educational Research*, 37(3), 229-237.

[28] Ruthven, K. (1990). The influence of graphic calculator use on translation from graphic to

symbolic forms. *Educational Studies in Mathematics*, 21, 431-450.

[29] Broekman, I., et al (2002). Distributive justice and information communication technology in higher education in South Africa. *Journal of South African Higher Education, 16(1), 29-35.*

[30] Broekman, I., (1992). Culture, cognition and uncertainity: metacognition in the learning and teaching of probability theory. University of Witswatersrand.

[31] Cockroft, W.H. (1982). Mathematics Counts. Report of the committee of Inquiry into the teaching of mathematics in schools. London, HMSO.

[32] National Council of Teachers of Mathematics. (December 1974). "NCTM Board Approves Policy Statement on the use of Minicalculators in the Classroom," *NCTM Newsletter* v11; 3

[33] Schunk, D. H. (2000). *Learning theories: An educational perspective*. New Jersey: Merrill.

[34] Dick, T. (1992). Supercalculators: Implications for calculus curriculum, instruction, and assessment. In J. T. Fey (Ed.), Calculators in Mathematics Education: 1992 Yearbook of the National Council of Teachers of Mathematics (pp. 145-157). Reston, VA: NCTM.

[35] Browning, C. A. (1989). Characterizing levels of understanding of functions and their graphs. Dissertation Abstracts International, 49, 2957A.

[36]. Hollar, J. C. (1997). The effects of a graphing approach college algebra curriculum on students' understanding of the function concept. Dissertation Abstracts International, 57, 2974A.

[37] Kinney, D. P. (1997). The effect of graphing calculator use and the Lesh translation model on student understanding of the relationship between function and derivative in a nonrigorous calculus course. Dissertation Abstracts International, 57, 5090A.

[38] McClendon, M. A. (1992). The development of a graphics calculator study guide for calculus students. Dissertation Abstracts International, 52, 2450A.

[39] Waits, B.K. & Demana, F. (2000). Calculators in mathematics teaching and learning past, present, and future. In Learning Mathematics for a New Century (pp.51-65). Reston: VA: National Council of Teachers of Mathematics.

[40] Wigfield, A., & Meece, J.L. (1988). Math anxiety in elementary and secondary school students. *Journal of Educational Psychology*, 80, 210-216.

[41] Thomas, M. O. J. (1996). Computers in the mathematics classroom: A survey. In P. Clarkson (Ed.), *Technology in mathematics education* (Proceedings of the 19th annual conference of the Mathematics Education Research Group of Australasia, pp. 556-563). Melbourne: MERGA.

[42]National Council of Teachers of Mathematics. (1980). *An agenda for action Recommendations for school mathematics in the 1980's.* Reston Virginia: NCTM.

[43]Vygotsky, L. (1987). The collected works of Vygotsky. Weiber, R.W. (Ed.) New York Plenum.

[44] Howson, G. (1991). National curricula in mathematics. The Mathematical Association, Leicester.

[45]Masimaneotsile, N. (1999). The impact of calculator/computer in some Botswana senior secondary schools. Unpublished Dissertation. University of Botswana.

[46] Wilkins, C.W. (1995). The effect of the graphing calculator on student achievement in factoring quadratic equations. (Mississippi State University, 1995). Dissertation Abstracts International 56, 2159A.

[47] Kaino, L.M., & Salani, E.B. (2004). Students' gender attitudes towards the use of calculators in mathematics instruction. Paper for presentation at the International Conference on Psychology of Mathematics Education (PME), Bergen, Norway, July 14-18, 2004.

[48]Struyk, L. R., Cangelosi, J. S., and Ehlert, D. (1993). *The Impact of a Calculator- Based Mathematics Teaching In-Service Program for Elementary School Teachers*; April 1993; Eric Document Reproduction Service: ED362416.

[49] Shumway, R. J., Wheatley, G. H., Coburn, T. G., White, A. L., Reys, R. E., & Schoen, H. L. (1981). *Initial effects of calculators in elementary school mathematics.*, Journal for Research in Mathematics Education, 12(2), 119-141.

[50] Schmidt, Mary Ellen. (1997). *The Effects of a 6 month Professional Development Project on 5th and 6th Grade Teachers' Beliefs and Attitudes about Calculators 2 Years after the Project*"; Eric Document Reproduction Service: ED410102.

[51] Reys, B. J. (1989). The Calculator as a tool for instruction and learning, In P. Trafton (Ed.). *New directions for elementary school mathematics.* (pp.168-173). Reston Virginia: NCTM.

[52] Abedalaziz, N. (1995). Constructing and standardizing a mathematical ability scale from thirteen to sixteen ages in Jordan. Unpublished master degree thesis, Yarmouk university, Irbid, Jordan.

[53] Ministry Of Education (MOE) (1995). The guidelines of Mathematics curriculum for the basic stage. Amman, Jordan.

[54] Hembree, R. and Dessart, D.J. (1992). Research on calculators in mathematics education. In J. Fey and C. Hirsch (Eds), *National Council of Teachers of Mathematics, Reston, pp.23-32.*

[55]Loyd, B., Munger, G. (1989). Gender and Attitudes toward Computers and Calculators: Their Relationship to Math Performance. Journal of Educational Computing Research, 5 (2), pp. 167-177.