Bulletin of Education and Research
April 2021, Vol. 43, No.1 pp. 59-75

Effect of Quizzes on Anxiety and Performance in Mathematics at Middle level

Afshan Naseem*

Abstract

The purpose of the study was to see the effect of quizzes on anxiety and performance in mathematics at middle-level students. Seventy-two participants from a public sector high school were chosen carefully. In experimental designs, the Pretest Posttest Non-equivalent Control Group Design was selected for the study. The instruments for measuring anxiety and mathematics performance were developed by the researcher. A pilot study on another group of the student was conducted. Validity of the instruments were ensured by experts' opinion. Table of Specification was constructed. Factor analysis was applied to find out that the statements in the instrument were clear and not misleading. Collected data were analyzed by independent samples t-test. A significant effect of quizzes was found on the performance of grade VII mathematics students. The significant outcome for anxiety in mathematics was also found when the overall effect was measured.

Keywords: Effect, mathematics anxiety, mathematics performance, middle level, quizzes

* Ph.D. Scholar, University of the Punjab, Lahore-54590, Pakistan. Email: afshan.pu@gmail.com

Background of the Study

Quiz, as an assessment strategy, has been supported to be effective as it can increase performance for academic achievement (Brame & Beil, 2015; Dalfen, 2018; Salas-Morera et al., 2012). The quiz is often used as a light form of a formative assessment. Many studies have suggested that quizzes not only improve performance (Brame & Beil, 2015; Dalfen, 2018; McGoldrick & Schuhmann, 2016), but can also enhance student learning (Pastotter & Bauml, 2014), improve long-term retention (Agarwal, Bain & Chamberlain, 2012; Roediger & Butler, 2011), promote deep learning (Karpicke & Grimaldi, 2012), and reduce test-taking anxiety (Shirvani, 2009). The literature discusses that quizzes and tests are routinely used to assess and promote learning in students (Roediger et al., 2011; Stratton, 2014).

The appearance of quizzes consists of multiple-choice questions (MCQs), true and false statements, fill in the blanks or one-word answer questions. The question format depends upon the choice of the teacher. Through & quizzes, students can work collaboratively to find and discuss the reply (Quinn & Eckerson, 2010; Rezaie, 2015). DePaolo and Wilkinson (2014) explored that quizzes can be used to increase motivation for attendance and student participation in class. McGoldrich and Schuhmann (2016) worked on the impact of challenge quizzes on student knowledge; the results referred that students who took challenge quizzes scored higher on harder quizzes as compared to those who didnot.

Negative affective responses towards mathematics define mathematics anxiety. According to Ashcraft (2002), mathematics anxiety is the general feeling of tension or fear. Mathematics anxiety results how learners feel and act. It is common to encounter the feelings of uneasiness inside or outside a mathematics class. Hoorfar and Taleb (2015) described mathematics anxiety into four perspectives that include the anxiety of learning mathematics, the anxiety of solving problems, the anxiety of the mathematics teacher, and the anxiety of mathematics evaluation. Mathematics anxiety is an emotional response to what is happening to the students, and it can take place at all ages and levels of study (Gierl & Bisanz, 1995).

Home, society, and classroom are the multiple causes of mathematics anxiety (Shields, 2005). Negative responses from teachers or parents about mathematics skills in their students/children can create mathematics anxiety (Maloney et al., 2015). Teachers with higher mathematics anxiety transfer their mathematics anxiety to students (Ramirez et al., 2018). Poor teaching strategies make mathematics learning difficult for students which subsequently results in lower performance and less enjoyment of the subject. This, therefore, produces the feeling of mathematics anxiety (Hembree, 1990). Students with higher mathematics anxiety avoid doing mathematics.

Mathematics anxiety develops pressure which results in poor performance. Mathematics anxiety can lead students to lack success in the classroom, to avoid mathematics-oriented courses in the future, and to develop negative physical and emotional problems (Brunyé et al., 2013; Geist, 2015; Meloney & Beilock, 2012; Miller & Mitchell, 1994). Mathematics anxiety works in a harmful way when students respond negatively to tests and assignments such as when they submit blank assignments. Students with mathematics anxiety usually have lower beliefs for their achievement in mathematics (Miller & Bichsel, 2004). Mathematics anxiety is the general feeling of tension or fear that affects mathematics performance (Ashcraft, 2002). Mathematics anxiety is inversely linked to mathematics performance (Carey et al., 2016; Dowker et al., 2016; Foley et al., 2017, Núñez-Peña & Bono, 2019).

Using quizzes in mathematics courses has been shown effective because mathematical concepts rely on each other and require a firm foundation for the processing of upcoming concepts (Lowe, 2015). Rodriguez (2019) used quizzes to measure student achievement in the mathematics courseof 173 undergraduate students at a public university in USA. Student achievement was measured using the average of the five quizzes which were taken every two weeks during the 10-week course; it was found that quizzes and final exams were highly correlated with improved performance in exams' grades. During the quiz attitude survey, Gokcora and DePaulo (2018) found that students had a positive attitude toward participating quizzes and felt more confident to attempt their regular assessment. Further, in their experimental study, the effect of frequent quizzes was studied. It was found that students who received frequent quizzes showed high performance on the standardized test as compared to the control group.

Quizzes can be one of the special strategies implemented in the class to increase mathematical skills in students. Several studies found that mathematics teachers benefitted their students in their teaching by developing online quizzes (Blanco & Ginovart, 2012; Hester et al., 2013; Jungicet al., 2006; McCulloch et al., 2018; Varsavsky, 2004). In a study by Varsavsky (2004), conducted on 250 university students in Australia, ten weekly quizzes were used as teaching and learning activities. In the final exam, the performance of students showed strongproof that learning of students enhanced with the combination of online quizzes to the subject activities in mathematics. In 2006, Jungicet al. studied the challenges involved in teaching a mathematics class with 350 or more in university students.

Roediger et al. (2011) summarized the benefits of frequent quizzing and testing applied to the subject of mathematics. According to them, testing showed the gap in student knowledge, organized learning materials, provided feedback to teachers and students, helped transfer knowledge to new concepts, and encouraged students to study. In a study by Akyuz et al. (2015), quizzes were used as a summative assessment by the

teacher of seventh graders to assess development in mathematics students. The quizzes also gave insight to the teacher about their students' difficulties and approaches the students used while solving the mathematics problems. McGoldrick and Schuhmann (2016) used the term challenge quiz in their study on 364 students concluding that the students who took the challenge quiz earned higher grades in exams from those who did not take the challenge quiz.

In the subject of mathematics, teachers need to know the role of quizzes in the mathematics classroom and the influence of quizzes on mathematics anxiety and performance. From a Pakistani perspective, the researcher could not find the study on mathematics anxiety and mathematics performance with the implementation of quizzes. However, studies on anxiety with different subjects are found. There is need to see the effect of quizzes on anxiety and performance of mathematics students.

Objectives of the Study

Following were the two objectives devised for the study:

1. To assess the effect of quizzes on mathematics anxiety of grade VII students
2. To assess the effect of quizzes on mathematics performance of grade VII students.

Hypotheses of the Study

Six null hypotheses based on two objectives were formulated for the present study:

H_{01}: There is no significant effect of quizzes on the pre anxiety in control and experimental group of grade VII mathematics students.

H_{02}: There is no significant effect of quizzes on the post anxiety in control and experimental group of grade VII mathematics students.

H_{03}: There is no significant effect of quizzes on the pre performance in controland experimental group of grade VII mathematics students.

H_{04}: There is no significant effect of quizzes on the post-performance in control and experimental group of grade VII mathematics students.

H_{05}: There is no significant effect of quizzes in gain scores of the anxiety of grade VII mathematics students.

H_{06}: There is no significant effect of quizzes in gain scores of the performance of grade VII mathematics students.

Research Methodology

The design of the study was experimental and quantitative. A quasi-experimental design, Pretest Posttest Control Group Design was selected. The rationale of the study was to investigate the effect of quizzes on anxiety and performance of mathematics students. The

study was delimited to grade VII English medium female students of a public sector high school from Lahore. To attain the purpose of this study, a sample of 72 students of grade VII was chosen. A government girls high school was selected on voluntarily basis. Intact classes were used as it was not possible to randomly assign subjects to groups. Two groups were divided; one as an experimental group that got weekly quizzes and the second as a control group that did not get weekly quizzes. Ethical consideration was sought before the study. Pretest and posttest mathematics anxiety, mathematics performance tests and weekly quizzes were administered. Two instruments were used during the study.

Instruments of the Study

The first instrument developed by the researcher was the mathematics performance test and was administered twice along with anxiety instrument in pretest and posttest. Mathematics performance test was comprised ten multiple choice questions, eight short questions and one long question. A pilot study was conducted to ensure the reliability and validity of instrument. Table of Specification was developed, and item analysis was performed to ensure that the items in the performance test were correct and not misleading the students. The researcher prepared quizzes based on taught content by the mathematics class teacher. Allocation of chapters, rules, and marks distribution for quizzes were discussed with participants before the study begins. The quizzes format was oral and written both. Students were divided into two groups by using their class roll number.

The second instrument developed by the researcher was the measuring scale to assess mathematics anxiety in students. Richard and Suinn (1972) developed an instrument Mathematical Anxiety Rating Scale (MARS) to measure anxiety in mathematics comprised of 98 items Likert-type rating scale. The abbreviated version of MARS was developed by Alexander and Martray (1989) and named sMARS comprised of 25 items, measure three factors of mathematics anxiety: test anxiety, numerical task anxiety, and course anxiety. in 2003, Hopko et al. developed another mathematics anxiety instrument, Abbreviated Maths Anxiety Scale (AMAS) based on two factors of mathematics anxiety, i.e. evaluation and learning anxiety. The researcher developed an instrument comprised of 19 Likert-type items for measuring anxiety in mathematics with three factors: Mathematics Lesson Anxiety (4 items), Mathematics Performance Anxiety (7 items), and Mathematics Test Anxiety (8 items). The students rated themselves to each item from strongly disagree to strongly agree on a five pointLikert-type scale. The anxiety of participant was measured before and after the intervention phase.

To ensure the validity and reliability of the anxiety instrument, a pilot study on the other group of 280 grade VII students was conducted. Factor analysis was applied to find out that the statements in the anxiety instruments were clear. The internal consistency

was measured by Cronbach Alpha Value. Further, Kaiser-Meyer-Olkin (KMO), Bartlett's Test of Sphericity and factor analysis (Varimax Rotation) were used to inspect the inner structure of mathematics anxiety scale. The internal consistency reliability for the total scale and its subscale was calculated was determined. Tuan et al. (2005) explain discriminative validity that used to measure the degree to which each scales distinguished a dimension which is diverse from other scales. The collected data were examined and analyzed by independent samples t-test. To estimate the mean differences between two similar groups independent sample t-tests were applied.

The descriptive statistics (mean and standard deviation) and Cronbach Alpha values for the scale and subscale and Discriminant validity (in terms of mean correlation with scale) are shown in Table 1. The results also tell the values of means correlations described discriminative validity, ranged from .39 to .43, exposed the independence of each sub scale. The reliability of the anxiety scale had high internal consistency with Cronbach alpha=0.87. Table 1 exhibits the Cronbach alpha values for mathematics lesson anxiety was 0.81, for mathematics performance anxiety was 0.85, and for mathematics test anxiety was 0.77.

Table 1
Descriptive Statistics, Cronbach Alpha Values and Discriminative Validity

Variables	No. of Items	*M*	*SD*	Cronbach's α	Mean Correlations
Mathematics Lesson Anxiety(MLA)	04	9.34	4.78	0.81	.42
Mathematics Performance Anxiety(MPA)	07	18.39	8.06	0.85	.39
Mathematics Test Anxiety(MTA)	08	22.98	8.15	0.77	.43

Tables 2 and 3 show the outcomes of the exploratory factor analysis that was utilized to build up the construct validity of the scale applied for estimating mathematics anxiety. The index range of KMO goes from 0 to 1, with 0.50 considered appropriate for factor analysis and Bartlett's Test of Sphericity ought to be critical (p<.05) suggested by Hair et al. (1995) and TabachnickandFidell (2014). Values form Table 2 meet the criteria that are suitable for factor analysis. The total variance 50% was explained by the three factors. Table 3 shows its pattern Matrix.

Table 2
KMO Value and Bartlett's Test of Sphericity for Anxiety Scale of Mathematics

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.81
Bartlett's Test of Sphericity	Approx. Chi-Square	2323.372
	Df	171
	Sig.	.000

Table 3
Factor Loading for Anxiety Scale for Mathematics

Items	Factor 1 Mathematics LessonAnxiety	Factor 2 Mathematics Anxiety	Performance	Factor 3 Mathematics Test Anxiety
Item1	.74			
Item2	.79			
Item3	.85			
Item4	.66			
Item5		.60		
Item6		.74		
Item7		.87		
Item8		.79		
Item9		.63		
Item10		.85		
Item11		.37		
Item12				.48
Item13				.70
Item14				.59
Item15				.42
Item16				.60
Item17				.74
Item18				.63
Item19				.54

Data Analysis and Interpretation

First four hypotheses were formulated to measure the effect of quizzes on anxiety and performance of mathematics students on the basis of pretest and posttest in control and experimental groups. Tables 4 to 7 display the results of independent samples t-test statistics; anxiety and performance in mathematics in pre and post phasesmentioned in Tables 4 and 5, whereas Tables 5 and 7 show the results for gain scores of experimental and control group mathematics anxiety and performance with 2- tailed significance.

Table 4
Descriptive Statistics of Anxiety and Performance in Mathematics on the Basis of Experimental and Control Groups at Pretest and Posttest Phases

Variables	Group	*N*	*M*	*SD*	Mean difference
Pretest anxiety	Control	36	65.11	9.93	-0.83
	Experimental	36	65.94	9.64	
Posttest anxiety	Control	36	64.25	9.64	4.50
	Experimental	36	59.75	11.38	
Pretest performance	Control	36	9.50	3.57	-.39
	Experimental	36	9.89	4.96	
Posttest performance	Control	36	10.33	3.82	-3.97
	Experimental	36	14.31	5.98	

Note: N = 72 participants

The means and standard deviations of the anxiety and performance test scores of mathematics students for control and experimentalgroups at pre-test and post-test phases shown in Table 4. For the control group, pretest anxiety scores averaged 65.11 (*SD* = 9.93), while posttest anxiety scores averaged 64.25 (*SD* = 9.64). For the experimental group, pretest anxiety scores averaged 65.94 (*SD* = 9.64), while posttest anxiety scores averaged 59.75 (*SD* = 11.38). For the control group, pretest mathematics performance test scores averaged 09.50 (*SD* = 03.57), while posttest mathematics performance test scores averaged 10.33 (*SD* = 03.82). For the experimental group, pretest mathematics performance test scores averaged 09.89 (*SD* = 04.96), while posttest mathematics performance test scores averaged 14.31 (*SD* = 05.98). These mean scores are also shown in figures 1 and 2, display the clear picture and tendency of anxiety and performance between the experimental and control groups at pre-test and post-test phases.

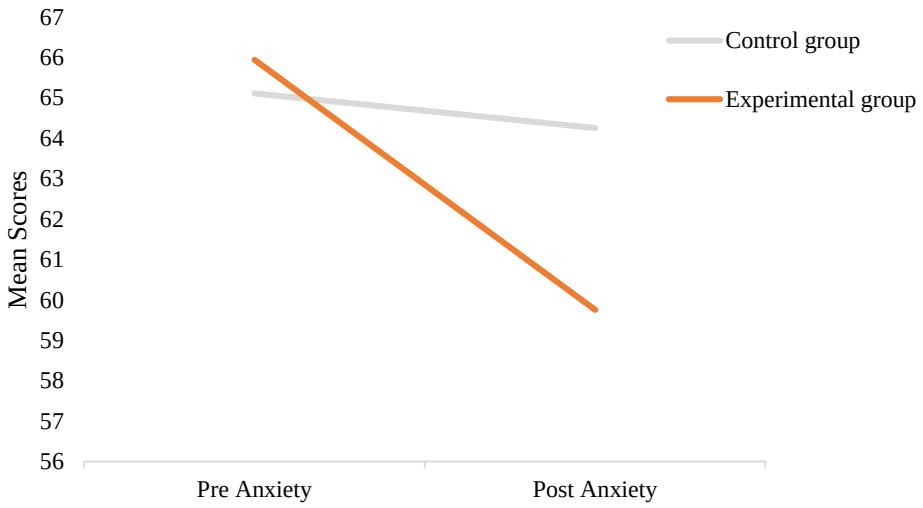

Figure 1. Anxiety Scores in Experimental and Control Groups Between Pre and Post Anxieties for Mathematics Students

Figures 1 and 2 show the experimental and control group differences in mathematics anxiety and mathematics performance in VII grade students, respectively on the bases of their mean scores.

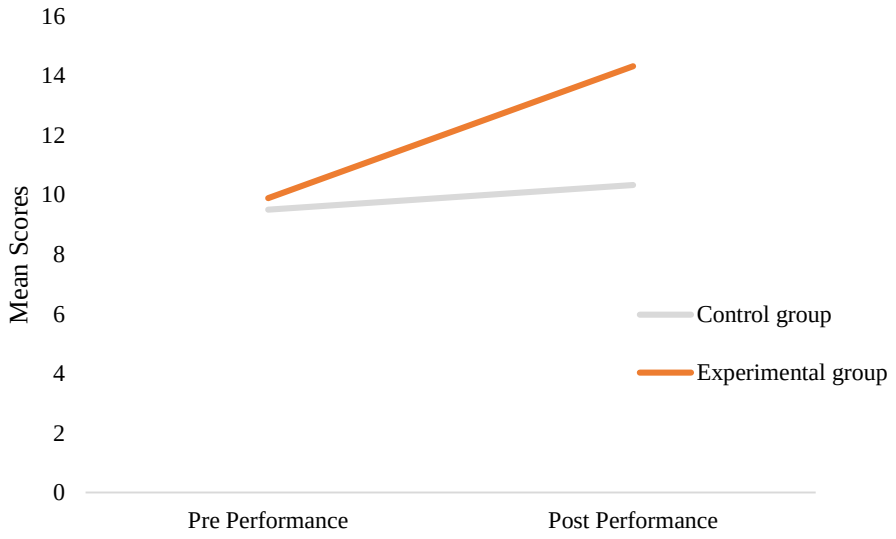

Figure 2. Performance Scores in Experimental and Control Groups Between Pre and Post Performances for Mathematics Students

Table 5

Differences Statistics in Anxieties and Performances on the basis of Experimental and Control Groups with 2- Tailed Significance

		Levene's Test for Equality of Variances		*t*	*df*	Sig. (2-tailed)	Effect size
		f	Sig.				
Pre Anxiety	Equal variances assumed	.40	.528	-.361	70	.719	.001
	Equal variances not assumed			-.361	69.94	.719	
Post Anxiety	Equal variances assumed	.74	.394	1.810	70	.075	.04
	Equal variances not assumed			1.810	68.16	.075	
Pre Performance	Equal variances assumed	2.07	.155	-.382	70	.704	.002
	Equal variances not assumed			-.382	63.65	.704	
Post Performance	Equal variances assumed	7.59	.007	-3.361	70	.001	
	Equal variances not assumed			-3.361	59.49	.001	.16

* $p \leq .05$

Table 5 indicates the significance value for Levene's test for mathematics and anxiety within control and experiment groups in pretest and posttest. If the value of Levene's test is larger than .05 then facts for analysis would be used for *Equal variances assumed,* and when the value of Levene's test is less than the significant value, represents that the variances for the two groups (experimental/control) are not the same. Then, in this case, the information will be used given in *Equal variances not assumed* (Pallant, 2016).

The outcomes shown in Tables 4 and 5 described that independentsamples t-test was led to relate pretest mathematics anxiety scores for control and experimental groups. No noteworthy change was found in scores for pretest anxiety control (M = 65.11, SD = 9.93) and posttest anxiety experimental (M = 65.94, SD = 9.64; t (70) = -.361, p = .72, two-tailed). The degree of the differences in the means (mean difference = -0.83, 95% *CI:* –5.43 to 3.77) was the smallest effect size (eta squared = .001). The rules for inferring eta value are proposed as 0.02=small effect, 0.06=moderate effect and 0.14=large effect (Cohen, 1988, p. 284).

The result when compare the posttest mathematics anxiety scores for control and experimental groups did not show any significant difference in scores for posttest anxiety control group (M = 64.25, SD =9.64) and posttest anxiety experimental group (M = 59.75, SD = 11.38; t (70) = 1.81, p = .08, two-tailed). The magnitude of the differences in the means (mean difference = 4.50, 95% *CI:* –0.46 to 9.46) was small to moderate effect size (eta squared = .04).

When an independent samples t-test was used to compare the pretest mathematics performance scores for control and experimental groups, no significant difference was found in scores for pretest performance control (M = 9.50, SD = 3.57) and pretest performance experimental (M = 9.89, SD = 4.96; t (70) = -.382, p = .70, two-tailed). The magnitude of the differences in the means (mean difference = -0.39, 95% *CI:* –2.42 to 1.64) was very small effect size (eta squared = .002). Another result was showed when compare the posttest mathematics performance scores for control and experimental groups. There was a significant difference in scores for posttest performance control (M = 10.33, SD = 3.82) and posttest performance experimental (M = 14.31, SD = 5.98; t (59.49) = -3.36, p = .001, two-tailed). The magnitude of the differences in the means (mean difference = -3.97, 95% *CI:* -6.34 to -1.61) was large effect size (eta squared = .16).

On the basis of the results obtained from the analysis, first three hypotheses were accepted. No significant differences were found in pretest anxiety, posttest anxiety and pretest performance of VII grade mathematics students in control and experimental groups. The fourth hypothesis was rejected, a significant difference was found in posttest performance of VII grade mathematics students in control and experimental groups.

Fifth and sixth hypotheses were formulated to measure the effect of quizzes on overall anxiety and overall performance of mathematics students in control and experimental groups. Gain score was calculated, the difference between posttest and pretest scores. Result from independent sample t-test was presented in Tables 6 and 7 on the basis of gain scores obtained for overall anxiety and performance.

Table 6
Descriptive Statistics of Overall Anxiety and Performance of Grade VII Mathematics Students

Variables	Group	*N*	Mean gain scores	*SD*	Mean difference
Overall anxiety	Control	36	-.86	3.69	5.33
	Experimental	36	-6.19	13.47	
Overall performance	Control	36	.83	2.36	-3.58
	Experimental	36	4.41	3.88	

Note: N= 72 participants

The means and standard deviations of mathematics anxiety and performance test gain scores for control and experimental groups displayed in Table 6. For the control group, anxiety gain scores averaged -.86 (*SD* = 3.69), while the experimental group anxiety gain scores averaged -6.19 (*SD* = 13.47). For the control group, mathematics performance test gain scores averaged 0.83 (*SD* = 2.36), while the experimental group overall mathematics performance test gain scores averaged 4.41 (*SD* = 3.88).

Table 7
2- Tailed Significance of Overall Anxiety and Performance of Grade VII Mathematics Students

		Levene's Test for Equality of Variances		*t*	*df*	Sig. (2-tailed)	Effect size
		F	Sig.				
Overall anxiety	Equal variances assumed	30.812	.000	2.29	70	.025	
	Equal variances not assumed			2.29	40.24	.027	.12
Overall performance	Equal variances assumed	4.270	.042	-4.74	70	.000	
	Equal variances not assumed			-4.74	57.79	.000	.28

*$p \leq .05$

Table 7 shows the value of Levene's test is less than the significant value, represents that the variances for the two groups (experimental/control) are not the same, the information will be used given in *Equal variances not assumed* (Pallant, 2016). There was significant difference in gain scores for anxiety control (M = -.86, SD = 3.69) and anxiety experimental (M = -6.19, SD = 13.47; t (40.24) = 2.29, p = .027, two-tailed). The degree of the differences in the means (mean difference = 5.33, 95% *CI:* 0.63 to 10.04) was almost large effect size (eta squared = .12).

Further, when compare the mathematics anxiety gain scores for control and experimental groups, there was significant difference found in gain scores for performance control (M = .83, SD = 2.36) and anxiety experimental (M = 4.41, SD = 3.88; t (57.79) = -4.74, p = .000, two-tailed). The magnitude of the differences in the means (mean difference = -3.58, 95% *CI:* 5.09 to -2.07) was verylarge effect size (eta squared = .28). On the basis of the results obtained from independent sample t-test, hypotheses fifth and sixth were rejected. Significant differences were found in gain scores of anxiety and performance in control and experimental groups of VII grade mathematics students.

Discussion and Conclusions

The study was conducted to measure the effect of quizzes on anxiety and performance of grade VII mathematics students. The findings from the result of the current research specified the significant difference in mathematics anxiety and performance based on gain scores between experimental and control groups. Literature is full of studies on mathematics anxiety. Although the instrument for measuring mathematics anxiety was developed by the researcher, sub-constructs on the scale were also reported in other researches (Alexander &Martray, 1989; Richard & Suinn, 1972). The information from this study referred to the psychometric properties utilized as the premise of the choice of mathematics anxiety instrument: that expanded trust in the utilization of the instrument and results collected afterwards (Tables 1 and 2). The independence of sub-factors, relationship with the main scale, and power of factor loadings for subscales declared through the collected data set. The current study identifies that quizzes in mathematics subjects are useful for addressing mathematics anxiety and performance in the classroom setup. Our main purpose was to found a baseline understanding of quizzes affecting mathematics anxiety and performance of grade VII female students at a public sector school. Through this experimental study, mean scores show the differences in pre and post mathematics anxieties in both groups. The decrease in mean score from pre-test to post-test signifies the positive impact of quizzes. It can be concluded that students could overcome their anxiety by using quizzes in their classroom learning. Overall students had low anxiety and high performance after the quiz intervention. Our findings support the fact that using quizzes in mathematics has a strong impact on performance (Brame & Beil, 2015; Dalfen, 2018; Gokcora & DePaulo, 2018; Salas-Morera et al., 2012).

Students are fearful when they face mathematics tests or exams. It is important for teachers to be aware of this fear and support their students by using several strategies which would enable them in coming out of this apprehension and aggressive situation, which is due to the presence of tests or exams. Students will, resultantly, gain the confidence to face mathematical situations with great courage. From the current study, researcher concluded that the effect of the quizzes was positive as the result showed a decrease in mathematics anxiety and increase in student performance.

The discussion above clarifies that quizzes can be valued as one of the significant element that essentially contribute to improving performance in mathematics students at the middle level. So, the present research is an effort to define the effect of quizzes on anxiety and performance at the middle level in mathematics. If quizzes are managed regularly throughout a term, they encourage students to study and review the material regularly instead of depending on last-minute exam preparation (Connor-Greene, 2000; McDaniel et al., 2007).

Recommendation

Daily, weekly, oral, written, individual, or group quizzes help students in doing mathematics and these assume a significant part in the usefulness of mathematics subject. Future researchers can see the effect of quizzes by using qualitative research techniques or by using both qualitative and quantitative research methods. Further research may include research with male students as well as female students. The principals, administrators, and the teachers should work on a plan that includes quizzes in their teaching strategy of mathematics so that students learn mathematics, perform different mathematical tasks with confidence, and participate in mathematics tests or examinations without any fear.

References

Agarwal, P. K., Bain, P., & Chamberlain, R. (2012). The value of applied research: Retrievalpractice improves classroom learning and recommendations from ateacher, a principal, and a scientist. *Educational Psychology Review, 24*(3), 437-448.

Alexander, L., & Martray C. R. (1989). The development of an abbreviated version of the Mathematics Anxiety Rating Scale. *Measure Evaluation Counsel Development, 22*, 143-150.

Ashcraft, M. H. (2002). Math anxiety: Personal, educational, and cognitive consequences. *Current Directions in Psychological Science, 11*(5), 181-185. http://doi.org/ 10.1111/1467-8721.00196

Blanco, M., & Ginovart, M. (2012). On how moodle quizzes can contribute to the formative e-assessment of first-year engineering students in mathematics courses. *RUSC, Universities and Knowledge Society Journal, 9*(1), 354-370. https://doi.org/10.7238/rusc.v9i1.1277

Brame, C. J. & Biel, R. (2015). Test-enhanced learning: The potential for testing to promote greater learning in undergraduate science courses. *CBE-Life Sciences Education 14*, 1-12. http://doi:10.1187/cbe.14-11-0208

Brunyé, T., Mahoney, C., Giles, G., Rapp, D., Taylor, H., &Kanarek, R. (2013). Learning to relax: Evaluating four brief interventions for overcoming the negative emotions accompanying math anxiety. *Learning and Individual Differences, 27*,1-7.

Carey, E., Hill, F., Devine, A., & Szucs, D. (2016). The chicken or the egg? The direction of the relationship between mathematics anxiety and mathematics performance. *Frontiers in Psychology, 6*. https://*doi*.org/*10.3389/fpsyg.2015.01987*

Cohen, J.W. (1988). *Statistical power analysis for the behavioral sciences.* (2nd ed.). Lawrence Erlbaum Associates.

Connor-Greene, P. A. (2000). Assessing and promoting student learning: Blurring the line between teaching and testing. *Teaching of Psychology, 27*(2), 84-88.

Dalfen, S. (2018). *A comparison of quiz grading criteria, exam question type and novelty, and their effect on exam scores* [Doctoral dissertation, City University of New York]. https://academicworks.cuny.edu/gc_etds/2845/

DePaolo, C. A., & Wilkinson, K. (2014). Recurrent online quizzes: Ubiquitous tools for promoting student presence, participation and performance. *Interdisciplinary Journal of E-Learning and Learning Objects, 10*, 75-91.

Dowker, A., Sarkar, A., & Looi, C. Y. (2016). Mathematics anxiety: What have we learned in 60 years? Frontiers in Psychology, 7, 508. https://doi.org/10.3389/ fpsyg.2016.00508

Foley, A. E., Herts, J. B., Borgonovi, F., Guerriero, S., Levine, S. C., &Beilock, S. L. (2017). The math anxiety-performance link. *Current Directions in Psychological Science, 26*(1), 52-58. https://doi.org/10.1177/0963721416672463

Gierl, M. J. & Bisanz, J. (1995). Anxieties and attitudes related to mathematics in grades3 and 6. *Journal of Experimental Education, 63*(2), 139-158.

Gokcora, D., & DePaulo, D. (2018). Frequent quizzes and student improvement of reading: A pilot study in a community college setting. *SAGE Open, 8*(2), 1-9. https://doi.org/10.1177/2158244018782580.

Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2014). Multivariate data analysis (7th ed.). Pearson.

Hembree, R. (1990). The nature, effect, and relief of mathematics anxiety. *Journal for Research in Mathematics Education, 21,* 33–46. http://doi.org/10.2307/749455

Hester, S., Buxner, S., Elfring, L., & Nagy, L. (2014). Integrating quantitative thinking into an introductory biology course improves students' mathematical reasoning in biological contexts. *CBE-Life Sciences Education, 13*(1), 54-64.https://doi.org/ 10.1187/cbe.13-07-0129

Hoorfar, H., & Taleb, Z. (2015). Correlation between mathematics anxiety with metacognitive knowledge. *Procedia-Social and Behavioursal Sciences*, *182*, 737-741.

Hopko, D. R., Mahadevan, R., Bare, R. L., & Hunt, M. K. (2003). The Abbreviated Math Anxiety Scale (AMAS): Construction, validity, and reliability. *Assessment, 10,*178-182. https://doi.org/10.1177/1073191103010002008

Jungic, V., Kent, D., & Menz, P. (2006). Teaching large math classes: Three instructors, one experience. *International Electronic Journal of Mathematics Education, 1*(1), 1-15.

Karpicke, J. D. & Grimaldi, P. (2012). Retrieval-based learning: A perspective for enhancingmeaningful learning. *Educational Psychology Review, 24*(3), 401-418.

Lowe, T. W. (2015). Online quizzes for distance learning of mathematics. *Teaching Mathematics Applications, 34,* 138-148.

Maloney, E., & Beilock, S. (2012, August). Math anxiety: Who has it, why it develops, and how to guard against it. *Trends in Cognitive Sciences, 16*(8), 404-406.

Maloney, E. A., Ramirez, G., Gunderson, E. A., Levine, S. C., &Beilock, S. L. (2015). Intergenerational effect of parents' math anxiety on children's math achievement and anxiety. P*sychological Science, 26*(9), 1480-1488. https://*doi*.org/*10.1177/ 0956797615592630*

McCulloch, A. W., Hollebrands, K., Lee, H., Harrison, T., & Mutlu, A. (2018). Factors that influence secondary mathematics teachers' integration of technology in mathematics lessons. *Computers & Education, 123,* 26-40. https://doi.org/ 10.1016/j.compedu.2018.04.008

McDaniel, M. A., Roediger, H. L., & McDermott, K. B. (2007). Generalizing test-enhanced learning from the laboratory to the classroom. *Psychonomic Bulletin & Review*, *14*(2), 200-206.

McGoldrick, K. &Schuhmann, P. W. (2016). The impact of challenge quizzes on student knowledge. *American Economic Review, 106*(5), 373-377. http://dx.doi.org/ 10.1257/aer.p20161056

Miller, H., & Bichsel, J. (2004). Anxiety, working memory, gender, and math performance. *Personality and Individual Differences*, *37*(3), 591-606.

Miller, L. D., & Mitchell, C. E. (1994). Mathematics anxiety and alternative methods of evaluation. *Journal of Instructional Psychology*, *21*(4), 353.

Núñez-Peña, M. I., & Bono, R. (2019). Academic anxieties: which type contributes the most tolow achievement in methodological courses? *Educational Psychology*, *39*(6), 797-814.https://doi.org/10.1080/01443410.2019.1582756

Pallant, J. (2016). *SPSS survival manual: A step by step guide to data analysis using IBM SPSS* (6th ed.). Routledge.

Pastotter, B. & Bauml, K. T. (2014). Retrieval practice enhances new learning: The forward effect of testing. *Frontiers in Psychology*, *5*, 286.

Quinn, T., & Eckerson, T. (2010). Motivating students to read with collaborative reading quizzes. *English Journal*, *100*(1), 89-91.

Ramirez, G., Hooper, S. Y., Kersting, N. B., Ferguson, R., & Yeager, D. (2018). Teacher math anxiety relates to adolescent students' math achievement. *AERA Open 4*(1). http://doi.org/10.1177/2332858418756052

Rezaei, A. R. (2015). Frequent collaborative quiz taking and conceptual learning. *Active Learning in Higher Education*, *16*, 187-196.

Richardson, F. C., & Suinn, R. M. (1972). The Math Anxiety Rating Scale: Psychometric data. *Journal of Counseling Psychology 19*(6), 551-554. https://doi.org/ 10.1037/h0033456

Rodriguez, B. K. N. (2019). *Math: The girl that all the nerds want* [Master's Theses (M.Ed.), University of California]. UCLA Electronic Theses and Dissertations. https://escholarship.org/content/qt6dj9098b/qt6dj9098b.pdf

Roediger, H. L., & Butler, A. C. (2011). The critical role of retrieval practice in long term retention. *Trends in Cognitive Sciences*, *15*(1), 20-7.

Roediger, H. L., III, Putnam, A. L., & Smith, M. A. (2011). Ten benefits of testing and their applications to educational practice. *Psychology of Learning and Motivation, 44,*1-36.

Salas-Morera, L., Arauzo-Azofra, A., & García-Hernández, L. (2012). Analysis of online quizzes as a teaching and assessment tool. *Journal of Technology and Science Education, 2*(1), 39-45.

Shields, D. J. (2005). Teachers have the power to alleviate math anxiety. *AcademicExchange Quarterly*, *9*(3), 326-330.

Shirvani, H. (2009). Examining an assessment strategy on high school mathematics achievement: Daily quizzes vs. weekly tests. *American Secondary Education, 8*(1), 34-45.

Stratton, P. I. (2014). *Highly effective instructional practices in high school mathematics classes* (Publication No. 3683746) [Doctoral dissertation, National-Louis University]. ProQuest Dissertations and Theses Global.

Tabachnick, B. G., & Fidell, L. S. (2014). Using multivariate statistics (6th ed.). Pearson. Tuan, H. L., Chin, C. C., & Shieh, S. H. (2005). The development of a questionnaire to measure students' motivation towards science learning. *International Journal of Science Education, 27*(6), 639-654.

Varsavsky, C. (2004). *Can online weekly quizzes contribute to learning in mathematics* [Proceedings]. 9th Asian Technology Conference in Mathematics (pp. 161-168). ATCM Inc.http://atcm.mathandtech.org/EP/2004/2004C209/fullpaper.pdf