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Assessing students' perceptions of democratic practices in the mathematics classroom

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Though there exists considerable literature exploring the connections between mathematics education and democratic society, much of this literature is theoretical about what could or should occur. This situation has led some researchers to call for the development of empirical research regarding democratic practices in the mathematics classroom. This paper attempts to advance quantitative empirical research in this area by presenting a questionnaire that examines students' perceptions of four democratic factors: freedom, engagement, equality and justice. The proposed questionnaire is factorable and explains 58.72% of the variance of a more general democracy score. The questionnaire was distributed to 398 ninth grade students, and the data collected was analyzed by computing a one sample t-test to assess participants' scores in relation to the four democratic factors. The results indicated scores are 'less than the good'.

Keywords: Democratic practices, mathematics classroom, questionnaire

Introduction

Democratic teaching practices may have a positive influence on students' learning outcomes in the mathematics classroom. This may be because successful democratic teaching and learning is conceived as situations where individuals are able to think for themselves, judge independently, and discriminate between good and bad information (Dewey as in Orrill, 2001). Therefore, it is desirable or necessary to enact democratic practices in the mathematics classroom. In addition, such democratic practices need to be assessed to ensure they are appropriately implemented, and to see if they influence specific variables of students' mathematics learning positively (e.g. emotions). One way to assess democratic teaching and learning practices and their relation with other variables is through quantitative methods, with a questionnaire as the main tool. The present research tries to do this and presents a questionnaire to assesses four democratic practices: freedom, equality, engagement and justice in the mathematics classroom.

Research goals and rationale

Vithal (1999) argues that the literature exploring connections between mathematics education and democratic society is generally theoretical, which indicates the need for research that studies what happens actually in the mathematics classroom regarding this link. Aguilar and Zavaleta (2012) agree with Vithal and point to the need for empirical studies to test and expand such theoretical ideas. The present research offers one step towards providing such empirical research, in that it offers a questionnaire to assess students' perceptions of democratic practices relating to four democracy components: Freedom, engagement, equality and justice. It does so in the context of the Palestinian ninth grade mathematics classroom.

Literature review

Democracy in general is described as consisting of distinct components. Kesici (2008) found that teachers, who adopted democratic practices, talked about democratic classrooms where fair behaviors are demonstrated towards students, students' range of personal freedom is enlarged, and students are provided with equality of opportunity. Thus, Keisci (2008) presents three categories of democracy: fairness, freedom and equality, where fairness can be related to justice and freedom and equality can be related to equity which includes the consideration of individual needs. Regarding equality, Kesici (2008) emphasizes that equality does not mean that teachers should treat all students the same way, but they should give equal opportunity to all students, so to meet their needs.

Democracy in the mathematics classroom

Aguilar and Zavaleta (2012) identified three links between mathematics education and democracy. Firstly, mathematics education can provide students with the skills to analyze critically real life phenomena. Second, the mathematics classroom can encourage values and attitudes essential to building and sustaining democratic societies. Third, mathematics education can function as a social filter that restricts students' opportunities for development and civic participation.

The possible links between mathematics education and democracy have attracted the attention of mathematics education researchers for at least three decades, where different aspects of teaching and learning practices have been studied in the mathematics classroom. Some of these aspects are: authority (Amit & Fried, 2005), students' voice (Daher, 2017; Kaur, Anthony, Ohtani, & Clarke, 2013), the right to equal access to mathematical ideas (Allen, 2011; Ellis & Malloy, 2009), promoting equality (Croom, 1997), promoting democracy (Allen, 2011; Ellis & Malloy, 2009), diversity of curriculum and classroom (Ellis & Malloy, 2009), revisiting old ideas in new ways (Ellis & Malloy, 2009), dialogue (Ball, Goffney, & Bass, 2005; Skovsmose, 1998), proving (Almeida, 2010; Skovsmose, 1998), and engaging in ethnomathematics (Ball et al., 2005; Skovsmose, 1998). This literature has indicated the complexity of the construct of 'democratic practice' in teaching and learning mathematics, which indicates the need for an assessment tool to better understand this construct.

Assessing democratic practices in the classroom

Educational researchers have offered various questionnaires to assess democratic practices in the classroom (Daher & Saifi, 2018; Kubow & Kinney, 2000). For instance, Ahmad, Said, and Jusoh (2015) designed a questionnaire to assess the relationship between democratic classroom practices and students' social skills development. In addition, the tools used to collect data related to democracy in the mathematics classroom have included open ended questions (Daher, 2012) and questionnaires with Likert items (Bulut & Yilmaz, 2014). The questionnaire suggested by Bulut and Yilmaz (2014) consists of a single scale to assess democratic practice. In the present research we suggest a questionnaire that offers multiple factors relating to democratic teaching and learning practices described in the literature.

Methodology

Research context and sample

398 Grade 9 students participated in the research. The distribution of these students according to gender and level in math is described in Table 1.

		Level in math					
		Poor	acceptable	good	very good	Excellent	Total
Gender	male	41	34	33	22	10	140
	female	59	65	76	52	6	258
Total		100	99	109	74	16	398

Table 1: The distribution of the sample according to gender and level in math

The descriptive statistics of the questionnaire items are given in Table 2.

Item	M	SD	Skew
We can express ourselves freely in the mathematics lesson.	2.84	1.35	.19
We can express our opinion regarding the teacher's presentation.	2.67	1.30	.32
We can express our opinion regarding the teacher's solution methods.	2.70	1.29	.32
We can give different solution methods for a mathematical problem.	2.55	1.47	.281
We can give a faulty solution method for a mathematical problem.	2.46	1.30	.77
The mathematics teacher does not give additional time for solving problems.	3.62	1.34	-.66
The mathematics teacher ignores some students' discussions.	3.39	1.46	-.37
The mathematics teacher does not give the same time to all students to answer questions.	3.08	1.40	-.01
The mathematics teacher does not give the same time to all students during discussions.	3.16	1.31	-.07
The mathematics teacher does not give different solutions to accommodate differences between individual students.	2.92	1.53	.11
The mathematics teacher ignores some students' solutions.	3.41	1.41	-.35
The mathematics teacher encourages us to give new mathematical ideas.	2.58	1.29	.48
The mathematics teacher encourages us to justify our mathematical ideas.	2.48	1.29	.45
The mathematics teacher encourages us to give different answers to a mathematical question.	2.50	1.46	.52
The mathematics teacher encourages us to engage in mathematical discussions.	2.30	1.26	.73
The mathematics teacher encourages us to ask questions.	2.25	1.24	.62
The mathematics teacher does not clarify the reasons for giving marks on the mathematics exam.	3.34	1.20	-.14
I cannot have explanations in the mathematics classroom on the issues that I have not understood.	3.69	1.25	-.61

Table 2: Means, standard deviations and skewness of the questionnaire items (N=398)

Analysis method of the level of democratic behavior scores in the Palestinian ninth grade

To calculate democracy mean scores for the students participating in the research, we computed first grouped frequency distributions (Stockburger, 1998). Then we compared the resulting democracy mean scores with a 'good democracy score' and a 'normal democracy score'. We computed the normal democracy score by dividing 4 by 5 (4 items divided by 5 possible scores where 1 is the lowest score of any item, and 5 is the highest). This resulted in0.8 which was used to calculate intervals on a scale presented in Figure 1. We considered point (1.8) to be a 'low democracy score', (2.6) to be a 'normal democracy score' and (3.4) to be a 'good democracy score' on this scale. Thus, the scores between 1 and 1.8 were considered 'very low democracy scores', the scores between 1.8 and 2.6 'low democracy scores', the scores between 2.6 and 3.4 'normal democracy scores', the scores between 3.4 and 4.2 'good democracy scores', and the scores between 4.2 and 5 'very good democracy scores'.

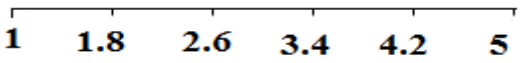

Figure 1: Intervals related to the democracy scores of any item

To compare the students' mean scores with the 'normal democracy score' and the 'good democracy score' we used a one-sample t-test and compared with the appropriate democracy value.

Results

Initially, the factorability of the 18 democracy items was examined. Several well recognized criteria for the factorability of a correlation were used. Firstly, it was observed that all the items correlated at least .3 with at least one other item, suggesting reasonable factorability. Secondly, the Kaiser-Meyer-Olkin measure of sampling adequacy was .89, above the commonly recommended value of .6, and Bartlett's test of sphericity was significant ($\chi^2(153) = 2562.90$, $p < .001$). The diagonals of the anti-image correlation matrix were also all over .5. Finally, the communalities were all above .4, further confirming that each item shared some common variance with other items. Given these overall indicators, factor analysis was deemed to be suitable with all 18 items.

Table 3 presents factor loadings based on rotated principal components analysis with Oblimin rotation for 18 items from the above scale (N = 218).

Principal component analysis was used because the primary purpose was to identify and compute composite scores for the factors underlying the scale. Initial eigenvalues indicated that the first four factors explained 33.56%, 9.96%, 7.81% and 7.39% of the variance respectively. The fifth factor had an eigenvalue 5.02, while the other factors (from the sixth to the eighteenth) explained less than 4% of the variance.

Our adoption of the four-factor model depended on the results of the principal factor analysis, including the total-variance-explained table and the scree plot (see Figure 2 below). There was little difference between the four-factor Varimax and Oblimin solutions, thus both solutions were examined in subsequent analyses before deciding to use a Varimax rotation for the final solution.

According to this solution, the four factors explained 58.724% of the variance in the democracy scores.

Item	Component			
	F	En	Eq	J
We can express our opinion regarding teacher's presentation.	.78			
We can express our opinion regarding the teacher's solution methods.	.75			
We can express ourselves freely in the mathematics lesson.	.74			
We can give different solution methods for a mathematical problem.	.74			
We can even give a faulty solution method for a mathematical problem.	.47			
The mathematics teacher encourages us to justify our mathematical ideas.		.75		
The mathematics teacher encourages us to engage in mathematical discussions.		.73		
The mathematics teacher encourages us to ask questions.		.72		
The mathematics teacher encourages us to give new mathematical ideas.		.71		
The mathematics teacher encourages us to give different answers to a mathematical question.		.68		
The mathematics teacher does not give the same time to all students to answer questions.			.77	
The mathematics teacher does not give the same time to all students during discussions.			.77	
The mathematics teacher does not give different solutions to accommodate differences between individual students.	-.45		.63	
The mathematics teacher ignores some students' discussion.			.60	
The mathematics teacher ignores some students' solutions.			.54	
The mathematics teacher does not clarify the reasons for giving marks on the mathematics exam.				.77
I cannot have explanations in the mathematics classroom on the issues that I have not understood.				.72
The teacher gives additional time for solving.				-.49

Table 3: Factor loadings based on Oblimin-rotated principal components analysis (N=398), F=Freedom, En=Engagement, Eq=Equality, J=Justice

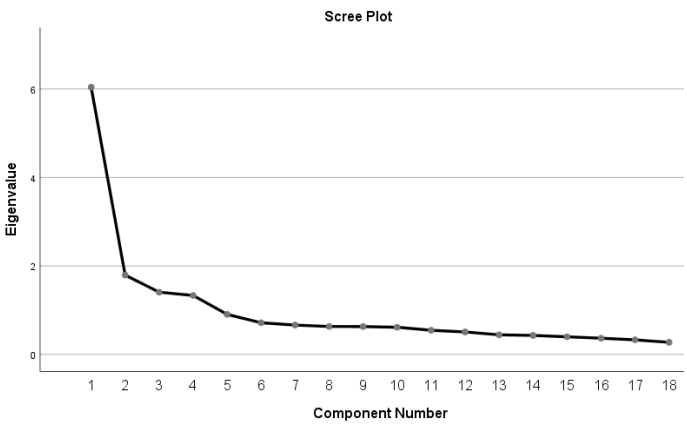

Figure 2: Scree Plot of the items factorization

Validity and reliability analysis

Validity and reliability analyses were performed for the four factors. To ensure validity, the first-version of the questionnaire was presented to experts in mathematics education or in the social aspect of learning to analyze it and thus verify its validity for data collection. After this analysis, the necessary corrections were made to the scale in accordance with their comments, which gave the present 18-item 5-point Likert type rating scale. To ensure reliability, Cronbach's Alpha was computed for each of the four democratic factors. This computation gave .81 for Freedom, .82 for Engagement, .78 for Equality, and .54 for Justice. These reliability results indicate good reliability for the constructs: freedom, engagement, and equality (Field, 2009) because these reliabilities are around .80. However, the reliability of justice is not sufficient, and we suggest the need to add additional items to the questionnaire in order to improve the reliability of this construct (Field, 2009). The Cronbach Alpha computation for the whole questionnaire is .88 which indicates high reliability.

Level of democratic practices in Palestinian middle schools

To assess the level of democratic practices in the Palestinian mathematics classrooms, we computed means and standard deviations for the four factors: freedom, engagement, equality, justice s. We also conducted a one-sample t test to assess the statistical significance of the variation of each factor with a low, normal and good level of democratic practice (see Table 4).

		T value		
Component	M (SD)	Low	Normal	Good
Freedom	2.64 (1.01)	16.60**	0.87	
Engagement	2.42 (1.00)	12.34**	-3.58**	
Equality	2.81 (2.04)		3.97**	-11.40**
Justice	2.45 (0.91)	14.22**	-3.26**	
General democracy	2.59 (0.77)	20.54**	-.135	

Table 4: Level of democratic practices in the Palestinian mathematics classrooms (N=398), ** p<.000

Discussion and conclusions

Empirical research regarding democratic practices in the mathematics classroom is still in its infancy. One way to develop such empirical research is to develop quantitative tools, such as questionnaires, to assess the level of democratic practice in mathematics classroom. The present research offers a questionnaire that assesses four democratic factors: freedom, engagement, equality and justice. These four constructs/factors explain 58.72% of the variance in the overall democracy score across our sample. Previous research, using questionnaires to assess democratic practice has suggested one scale consisting of only one factor that explains 47.701% of the variance of an overall democratic score. I argue that a scale with four factors addresses the concerns regarding scales with only one or two factors, which may not provide an accurate representation of the

construct (Pett, Lackey & Sullivan, 2003). Also, further democracy constructs, such as autonomy and decision making, could also be assessed in future research.

The questionnaire suggested in the present research may help researchers study the level of democratic practice in mathematics classrooms. Here, I used the suggested questionnaire to examine the democratic practices in Palestinian ninth grade mathematics classrooms. The results indicate that the level of democratic practice in this context is less than good. There may be various reasons that explain this level of democratic practice, such as authoritarian styles of teaching by teachers (Ramahi, 2015). These authoritarian styles cannot foster critical or independent thinking, which may impact negatively the future functioning of students. In addition, the 'less than good' level of democratic practice may be a result of students' and teachers' limited awareness of the student's right to a democratic space in the mathematics classroom.

The present research indicates the need to improve the level of democratic practice in the Palestinian mathematics classroom. This could be done by different means. First, by holding workshops for mathematics teachers with the goal to increase their awareness of democracy factors and discuss with them ways to increase democracy in their classrooms. These workshops need to be based on pedagogic approaches that enhance student agency and voice, foster creative and critical thinking, and enable students to collaborate, share their mathematical ideas, and negotiate their decisions regarding their mathematical learning (Daher, 2017; Ramahi, 2015). Moreover, these workshops need to be supported by the ministry of education as it calls for inclusive education in the schools (Ministry of Education & Higher Education, 2015). Second, special emphasis needs to be put on enhancing students' awareness of their democratic rights. These workshops to advance democratic practices in the Palestinian context could benefit from similar attempts around the world (see, e.g., Varnham, Evers, Booth, & Avgoustinos, 2014).

References

Aguilar, M. S., & Zavaleta, J. G. M. (2012). On the links between mathematics education and democracy: A literature review. *Pythagoras, 33*(2), Art. 164.

Ahmad, I., Said, H. & Jusoh, A. (2015). Empirical evidence on the relationship between democratic classroom and social skills development of students. *Mediterranean Journal of Social Sciences, 6*(2), 18–27.

Allen, K. (2011). Mathematics as thinking: A response to 'Democracy and school math'. *Democracy & Education, 19*(2), 1−7.

Almeida, D. F. (2010). Are there viable connections between mathematics, mathematical proof and democracy? *Philosophy of Mathematics Education Journal, 25*.

Amit, M., & Fried, M. (2005). Authority and authority relations in mathematics education: A view from an 8th grade classroom. *Educational Studies in Mathematics, 58*(2), 145−168.

Ball, D. L., Goffney, I. M., & Bass, H. (2005). The role of mathematics instruction in building a socially just and diverse democracy. *The Mathematics Educator, 15*(1), 2−6.

Bulut, I., & Yilmaz, F. (2014). The relationship between mathematics teachers' democratic behavior and students' mathematic success. *International Online Journal of Educational Sciences, 6*(3), 626–637.

Croom, L. (1997). Mathematics for all students: Access, excellence, and equity. In J. Trentacosta (Ed.), *Multicultural and gender equity in the classroom* (pp. 1−9). Reston, VA: NCTM.

Daher, W. (2012). Student teachers' perceptions of democracy in the mathematics classroom: Freedom, equality and dialogue. *Pythagoras, 33*(2), Art. 158.

Daher, W. (2017). Student voice in the mobile phone environment. *International Journal of Mobile and Blended Learning, 9*(3), 12–23.

Daher, W., & Saifi, A. (2018). Democratic practices in a constructivist science classroom. *International Journal of Science and Mathematics Education, 16*(2), 221–236.

Ellis, M. & Malloy, C. E. (2009). Preparing teachers for democratic mathematics education. In D. Pugalee, A. Rigerson, & A. Schinck (Eds.), *Proceedings of the Mathematics Education in a Global Community Ninth International Conference* (pp. 160−164).

Field, A. (2009). *Discovering statistics using SPSS*. London: Sage.

Kaur, B., Anthony, G., Ohtani, M., & Clarke, D. J. (Eds.) (2013). *Student voice in mathematics classrooms around the world.* Rotterdam: Sense.

Kesici, Ş. (2008). Teachers' opinions about building a democratic classroom. *Journal of Instructional Psychology, 35*(2), 192–203.

Kubow, P. K., & Kinney, M. B. (2000). Fostering democracy in middle school classrooms: Insights from a democratic institute in Hungary. *The Social Studies, 91*(6), 265–271.

Ministry of Education & Higher Education (2015). *Palestine inclusive education policy*. Ramallah, Palestine.

Orrill, R. (2001). Mathematics, numeracy, and democracy. In L. A. Steen (Ed.), *Mathematics and democracy* (xiii–xx). Princeton, NJ: National Council on Education and the Disciplines.

Pett, M., Lackey, N., & Sullivan, J. (2003). *Making sense of factor analysis*. Thousand Oaks: Sage.

Ramahi, H. (2015). *Education in Palestine: Current challenges and emancipatory alternatives*. Ramallah, Palestine: Rosa-Luxemburg-Stiftung.

Skovsmose, O. (1998). Linking mathematics education and democracy: Citizenship, mathematical archaeology, mathemacy and deliberative interaction. *ZDM, 98*(6), 195−203.

Stockburger, D. W. (1998). *Introductory Statistics: Concepts, Models, and Applications*. Retrieved from http://www.psychstat.missouristate.edu/introbook/sbk09m.htm

Varnham, S., Evers, M., Booth, T., & Avgoustinos, C. (2014). Democracy in schools: Encouraging responsibility and citizenship through student participation in school decision making. *International Journal of Law and Education, 19*(1), 23–41.

Vithal, R. (1999). Democracy and authority: A complementarity in mathematics education? *ZDM*, *31*(1), 27−36.