MATHEMATICS AS GENDERED? VIEWS FROM PALESTINIAN/ARAB ISRAELI HIGH SCHOOLERS

Laurie Rubel[1], Michal Ayalon[1], Juhaina Shahbari[2], Fatme Awad[1]

[1]University of Haifa, [2]Al-Qasemi College

In light of a gender-gap in school mathematics favoring girls among Palestinian/Arab Israelis, this study explores 147 high school students' views of mathematics with respect to gender. We administered a "Who and Mathematics" survey used in a prior study. Findings include gender-neutrality about teacher interactions, parent expectations, and future employment. Negative relations with mathematics were attributed to boys. A broader set of narratives were attributed to girls, including items about caring or worrying about success and finding mathematics interesting. These results challenge an assumption that the social construction of mathematics as masculine is universal and present a picture of how gender shapes and is shaped by mathematics education for Palestinian/Arab Israelis.

INTRODUCTION

Israel presents an interesting case with respect to gender and mathematics achievement. On the one hand, across schools separated by language of instruction, Israel posts large differences between its Jewish majority (in Hebrew-speaking schools) and Palestinian/Arab Israeli (P/AI) minority (in Arabic-speaking schools) (Rapp, 2015). These achievement differences can be interpreted as part of a legacy of inequitable access and opportunity. In Israel's Hebrew-speaking schools, there is a persistent gender gap in mathematics and science participation that favors boys (Friedman-Sokuler & Justman, 2020). In those schools, which represent Israel's majority, boys are slightly over-represented in advanced mathematics and heavily over-represented in physics and computer science coursework. In contrast, however, in Israel's Arabic-speaking schools, girls tend to outperform boys–on state and international mathematics tests and at all school levels– and are over-represented in advanced mathematics, physics, and computer science coursework (Pinson et al., 2020). Despite their eligibility, however, few Palestinian/Arab Israeli women continue to higher education in STEM fields (Fuchs, 2018); instead, teacher education is the most common undergraduate path of study (Arar & Haj-Yahia, 2016).

Prior research has pointed to various potential explanations for an absence of a gender gap favoring boys in mathematics achievement and participation at K-12 levels. For one, Palestinian/Arab Israeli girls are said to have limited opportunities for success, outside of school, as girls or women (Nasser & Birenbaum, 2005). Furthermore, the structure of Israel's separate school system has provided a narrower range of kinds of advanced course offerings to Arabic-speaking schools (Ayalon, 2002), positioning mathematics as a singular option for excellence. A third explanation, of particular

2022. In C. Fernández, S. Llinares, A. Gutiérrez, & N. Planas (Eds.). *Proceedings of the 45th Conference of the International Group for the Psychology of Mathematics Education* (Vol. 3, pp. 355-362). PME.

interest for this study, is that the social gendering of mathematics as masculine common elsewhere and among Israel's majority (Markovits & Forgasz, 2017) might not extend to Palestinian/Arab Israelis. Our goal here is to explore this conjecture, by surveying high school students among Palestinian/Arab Israelis about gender and mathematics.

PRIOR RESEARCH

Guided by prior research that deemphasizes any biological differences between sexes, our perspective is, instead, a social one: We view gender as a social construct that is performed in different ways across individuals and across contexts (Butler, 1990). In mathematics education, participation and success can be understood in terms of gendered stories about mathematics in circulation in a society: these stories are seen to shape classroom interactions, between teacher and students, and among students, and to inform students' identity development with respect to mathematics (Mendick, 2005). One explanation for gender-based differences in mathematics achievement and participation is in terms of the stories or narratives that are told and retold that construct mathematics as a masculine domain (Leyva, 2017). Many interrelated narratives comprise binary but unequal oppositions -- like analytic/emotional, objective/subjective, innately able/ hard-working, confident/lacking confidence-- wherein one in every pair is more valued *and* socially associated with masculinity (Mendick, 2005).

One set of related studies in the literature explores the gendering of mathematics through a focus on *teachers*. For example, Fenemma et al. (1990) and later, Tiedemann (2000) and Sarouphim and Chartnouy (2017), in the United States, Germany, and Lebanon respectively, point to a tendency among teachers to attribute boy's success to innate ability and girls' success to effort. These studies speculate that these narratives shape teachers' instruction and ways of relating with students in ways that benefit boys. A parallel set of studies explores *children and students.* Children's adherence to gendered stories about mathematics in which mathematics is masculinized has been shown among students at all levels, from college to elementary school and even in pre-school contexts and across a wide range of geographical contexts (e.g., Cvencek et al., 2015; Passolunghi et al., 2014).

In the Israeli context specifically, recent findings include that elementary school boys tend to more highly rate their own achievement in mathematics than girls rate theirs (Markovits & Forgasz, 2017). Whereas students tended to indicate that girls and boys are equally good at math, when shown two photographs, the majority indicated that the image perceived to be a "man" was more likely to use mathematics at work than the image perceived to be a "woman" (Forgasz & Markovits, 2018). These studies suggest that children do not adhere to explicit gendered attributions of ability in mathematics but that their sense of who participates in mathematics as adults remains gendered. However, these recent studies of Israeli school-children included only students in Hebrew-speaking schools.

In terms of Palestinian/Arab Israeli school students, the population of interest in this study, the field's knowledge rests on Forgasz and Mittelberg's (2008) comparative survey of 9th graders. In that study, Forgasz and Mittelberg compared responses of Palestinian/Arab Israelis with Jewish Israelis and with Australians and found that the Palestinian/Arab Israeli students' responses were *less* consistent with dominant narratives about gender and mathematics. An absence of a masculinazation of mathematics is a potential explanation for the success and participation of Palestinian/Arab Israeli girls and women in school mathematics. Forgasz and Mittelberg's (2008) findings are surprising, however, since the Palestinian/Arab Israeli society, in general, is considered traditional about gender roles, at least with respect to caretaking, food preparation, and childrearing (Haj-Yahya et al., 2018). Nearly 15 years later, in light of broader changes towards gender equity around the world, we are curious to repeat Forgasz and Mittelberg's survey, with a larger number of participants. Our research interest is not in intra-group comparisons, but rather, to explore Palestinian/Arab Israeli high school students' views of gender and mathematics.

METHODS

We utilized the survey "Who and Mathematics" from Forgasz and Mittelberg (2008) with our own translation of the items into Arabic. The survey comprises 30 Likert-scale items; each indicates a statement–for example, "Give up when they find a math problem too difficult" (item 4), with an associated prompt to select one from among: 1 (boys definitely more likely than girls), 2 (boys probably more likely than girls); 3 (no difference between boys and girls); 4 (girls probably more likely than boys); 5 (girls definitely more likely than boys). We administered the survey to students at four Arabic-speaking schools in Israel, in an electronic format. Participants include 147 people: 72 ninth-graders (41 identify as girls, 31 as boys) and 75 eleventh-graders (35 identify as girls and 40 as boys). We chose high-school because we assume that students at this age group are highly reflective about teachers, parents, and future employment. We chose two different age groups within high school as a way to determine if students' responses at each grade level are different.

For each item, we computed averages and standard deviations of responses. We compared the responses of girls with boys, and compared the responses of 9th graders with 11th graders, using t-tests. There were few instances of differences across these subgroups: girls and boys answered only two items differently (items 4, 10) and 9th and 11th graders answered only three items differently (items 18, 23, 25). We aggregated the responses of all 147 students. Next, using t-tests, we checked to see which items had averages statistically close to 3 (attributed to neither boys nor girls), which items had averages significantly less than 3 (attributed to boys), and which items had averages significantly greater than 3 (attributed to girls).

RESULTS

Narratives Not Assigned to Gender

On 18 of the 30 items, the average scores were not statistically distinguishable from the value *3*, meaning that these items were not attributed on average to any gender. For 10 of these items, which we show in Table 1, our results confirm the results of Forgasz and Mittelberg and, furthermore, challenge the gendered stories predicted by the literature. Included in this set are finding mathematics easy or difficult (items 18, 27), liking challenging mathematics problems (item 11), enjoy math or it's their favorite subject (items 6, 1), and multiple items about interactions with teachers (items 3, 12, 25).

Item		Predicted by Literature, as reported by F&M	F&M (2008) Nd = no difference	Mean	Std dev
1	Math is their favorite subject	M	nd	2.891	1.148
2	Think it's important to understand math	F	nd	3.163	1.034
3	Are asked more questions by your math teacher	M	nd	3.054	1.103
6	Enjoy mathematics	M	nd	3.177	1.127
11	Like challenging mathematics problems	M	nd	2.932	1.121
12	Are encouraged to do well by their math teacher	M	nd	3.054	1.032
18	Find mathematics easy	M	nd	2.939	1.093
20	Need help in mathematics	F	nd	2.871	1.195
25	Mathematics teachers spend more time with them	M	nd	2.905	1.009
27	Find mathematics difficult	F	nd	2.857	1.123

Table 1: Items Attributed Neutrally, In Agreement with Forgasz & Mittelberg (F&M, 2008).

In addition to the ten items in Table 1, we found an additional eight neutrally designated items on average, which we share in Table 2. Here we have items about parental expectations (items 9, 19), teacher expectations (item 13), and the meaning of mathematics for one's future (items 10, 14). These items were found to be gendered in previous literature and found to be gendered in Forgasz and Mittelberg's study, but in our study, were found to be neutral.

Gendered Narratives

The other 12 items produced results statistically different from the value *3*, meaning that they were attributed on average to girls or to boys. There were five items that were

attributed on average to boys, which we show in Table 3. In four of the five cases, these results confirm the earlier results from Forgasz and Mittelberg. All of these are negative statements – about negative relations with mathematics [consider mathematics to be boring (item 26), giving up in response to difficulty (item 4), being not good at mathematics (item 23)] or about negative classroom behaviors [distracting others (item 16), teasing boys who are good at mathematics (item 21)].

Item		Predicted	F&M, 2008	Mean	Std dev
9	Parents would be disappointed if they don't do well in math	M	M	3	1.104
10	Need math to maximize future employment opportunities	M	M	2.959	1.042
13	Math teachers think they will do well	M	F	3.014	1.135
14	Think mathematics will be important in their adult life	M	M	2.98	1.101
15	Expect to do well in mathematics	M	F	2.98	1.101
17	get the wrong answers in mathematics	F	M	2.932	0.956
19	Parents think it is important for them to study mathematics	M	M	3.048	0.968
30	Tease girls if they are good at mathematics	M	M	2.898	1.065

Table 2: Items Attributed Neutrally, In Disagreement with Forgasz & Mittelberg (F&M, 2008).

Item		Pred	F&M 2008	Mean	SD	t	p
4	Give up when they find a math problem too difficult	F	nd	2.769	1.147	-2.445	0.016
16	Distract other students from their mathematics work	M	M	2.408	1.145	-6.265	<.001
21	Tease boys if they are good at mathematics	M	M	2.639	1.027	-4.258	< .001
23	Are not good at mathematics	F	M	2.741	1.073	-2.92	0.004
26	Consider mathematics to be boring	F	M	2.605	1.101	-4.343	< .001

Table 3: Items Attributed to Boys.

Finally, participants on average attributed seven items to girls, which we show in Table 4. Six of these items had previously been found by Forgasz and Mittelberg to be gender

neutral. Some of these items have traditionally been associated with boys, about the link between preparation and success (item 8), liking using computers to do mathematics (item 24), and finding mathematics to be interesting (item 29). Other items that have traditionally been found to be gender neutral that pertain to success and diligence [care about doing well in math (item 7), worry if they do not do well in math (item 22)] here were attributed to girls. We summarize results and how they confirm or challenge Forgasz and Mittelberg's results in Table 5.

Item		Pred	F&M 2008	Mean	SD	t	p
5	Have to work hard in math to do well	F	F	3.293	1.21	2.94	0.004
7	Care about doing well in math	nd	nd	3.184	1.05	2.13	0.035
8	Think they did not study hard enough if they did not do well in math	M	nd	3.279	1.18	2.89	0.004
22	Worry if they do not do well in mathematics	nd	nd	3.293	1.16	3.06	0.003
24	Like using computers to work on mathematics problems	M	nd	3.197	1.08	2.22	0.028
28	Get on with their work in class	F	nd	3.224	1.12	2.43	0.016
29	Think mathematics is interesting	M	nd	3.231	1.06	2.65	0.009

Table 4: Items Attributed to Girls.

Outcome	Forgasz & Mittelberg 2008	Present study
Girls or boys: No difference	1, 2, 3, 6, 11, 12, 18, 20, 25, 27 4, 7, 8, 22, 24, 28, 29	1,2,3, 6, 11, 12, 18, 20, 25, 27 9, 10, 13, 14, 15, 17, 19, 30
"Boys more likely"	16, 21, 23, 26, 9, 10, 14, 17, 19, 30	16, 21, 23, 26, 4
"Girls more likely"	5, 13, 15	5, 7, 8, 22, 24, 28, 29

Italicized items are common, Underlined items are reversed from prior literature.

Table 5: Comparison of Current Results with Previous Results.

DISCUSSION

We note how among the 12 items found to be gendered, the direction of the gender stereotype in half of them reverses the predictions based on findings in the literature pertaining to Western contexts about masculinization of mathematics. In some cases, (items 4, 23, 26), the students attributed items to boys about negative relations with mathematics, about their finding it boring or being not good at or giving up in the face of challenge. In contrast, the students attributed to girls (items 2, 24, 29) interest in mathematics, enjoying working with technology, and an expectation that their own hard work will produce success. This is and of itself is significant because it shows how the masculinization of mathematics that is endemic in some cultures or geographies does not seem to be universal.

Our results correspond to Forgasz and Mittelberg's results with respect to 15 of the 30 items. We had expected that over the passage of 15 years, more items would shift to the gender neutral category, because of increasing gender equity, but this was not the case. Some of the items that had previously been found to be gendered (9,10,13, 14, 17, 19, 30), in this study then fell into the neutral category – these include parental or teacher expectations (9, 13, 19) and use of mathematics later in life (10, 14). The fact that these are considered neutral by high school students likely reflect recent changes in society especially in terms of more opportunities in higher education and employment for Palestinian/Arab Israeli women.

However, there were seven items that had been previously found by Forgasz and Mittelberg to be neutral, but in this study were attributed to a gender group, and mostly, to girls (7, 8, 22, 24, 28, 29). We note that many of these items pertain to success or "doing well"– caring or worrying about success and diligence with classwork – along with attributing to girls the finding of mathematics as interesting. Unlike the previous study, here more items were assigned to girls. These items communicate views of a *positive* alignment between girls and mathematics and their interest in or commitment to success, accomplishments, or recognition. Our findings are limited by the survey methodology which does not allow for insights into why students answered these items in these ways or how they might make sense of connections across the items. Further studies can complement these findings using additional qualitative methods.

References

Arar, K., & Haj-Yahia, K. (2016). *Higher education and the Palestinian Arab minority in Israel*. Palgrave Macmillan.

Ayalon, H. (2002). Mathematics and science course taking among Arab students in Israel: A case of unexpected gender equality. *Educational Evaluation and Policy Analysis, 24*(1), 63–80.

Butler, J. (1990). *Gender trouble*. Routledge.

Cvencek, D., Kapur, M., & Meltzoff, A. N. (2015). Math achievement, stereotypes, and math self-concepts among elementary-school students in Singapore. *Learning and Instruction,*

39, 1–10.

Fennema, E., Peterson, P. L., Carpenter, T. P., & Lubienski, C. A. (1990). Teachers' attributions and beliefs about girls, boys, and mathematics. *Educational Studies in Mathematics, 21*(1), 55–69.

Forgasz, H. & Mittelberg, D. (2008). Israeli Jewish and Arab students' gendering of mathematics. *ZDM Mathematics Education, 40*, 545–558.

Forgasz, H., & Markovits, Z. (2018). Elementary students' views on the gendering of mathematics. *European Journal of Educational Research, 7*(4), 867–876.

Fuchs, H., Yanay, G., & Blass, N. (2018). Technological education: Trends and developments, 2006 to 2017. S*tate of the Nation Report: Society, Economy and Policy 2018*, 211-242.

Haj-Yahya, N.H., Schnell, I. & Khattab, N. (2018). The exclusion of young Arab women from work, education and training in Israel. *Quality & Quantity: International Journal of Methodology, 52*(1), 157-173.

Leyva, L. (2017). Unpacking the male superiority myth and masculinization of mathematics at the intersections: A Review of research on gender in mathematics education. *Journal for Research in Mathematics Education, 48*(4), 397-433.

Markovits, Z. & Forgasz, H. (2017). "Mathematics is like a lion": Elementary students' beliefs about mathematics. *Educational Studies in Mathematics, 96*(1), 49-64.

Mendick, H. (2005). A beautiful myth? The gendering of being/doing "good at maths." *Gender and Education, 17*(2), 203–219.

Nasser, F., & Birenbaum, M. (2005). Modeling mathematics achievement of Jewish and Arab eighth graders in Israel: The effects of learner-related variables. *Educational Research and Evaluation, 11*(3), 277-302.

Passolunghi, M. C., Rueda Ferreira, T. I., & Tomasetto, C. (2014). Math–gender stereotypes and math-related beliefs in childhood and early adolescence. *Learning and Individual Differences, 34*, 70–76.

Pinson, H., Feniger, Y., & Barak, Y. (2020). Explaining a reverse gender gap in advanced physics and computer science course-taking: An exploratory case study comparing Hebrew-speaking and Arabic-speaking high schools in Israel. *Journal of Research in Science Teaching, 57*(8), 1177–1198.

Rapp, J. (2015). *Gender gaps in mathematics and language in Israel– What can be learned from the Israeli case?* Working paper, National Authority for Measurement and Evaluation in Education. Accessed at www.cms.education.gov.il

Sarouphim, K. M., & Chartouny, M. (2017). Mathematics education in Lebanon: Gender differences in attitudes and achievement. *Educational Studies in Mathematics, 94*(1), 55-68.

Tiedemann, J. (2000). Gender-related beliefs of teachers in elementary school mathematics. *Educational Studies in Mathematics, 41*, 191–207.