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GENDER REPRESENTATION IN THE NATIONAL ASSESSMENTS OF MATHEMATICAL ACHIEVEMENTS

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Abstract. *Balanced gender representation allows stereotype threat effect to be avoided so it is important in any type of educational materials, but it is even more so in national assessments as in some cases their outcome determines opportunities for young people. This study is centered on gender representation in the country-wide [Lithuanian] assessments of students' mathematical knowledge and skills, particularly, on the national assessments and exams level. The research data was analyzed using the authors' evaluation matrix. There were seven categories of topics found in contextual problems: free time and socialization, housework, movement, sagacity, shopping, skillfulness and sports. Study shows that some types of assessments represent genders in a more balanced way than others. When compared to other educational or entertainment sources of written information, national assessments of mathematical achievements seems to represent gender in a more balanced way.*
Keywords: *gender equality; gender representation; gender stereotypes; mathematics; assessments.*

Introduction

Gender equality is stated as one of the core priorities of the European Union (European Institute for Gender Equality, 2020) and also of Lithuania (Ministry of Social Security and Labour, 2020). To evaluate whether desired progress is being made, European Institute of Gender Equality uses the Gender Equality Index. Most recent data (European Institute for Gender Equality, 2020) shows the Gender Equality Index in Lithuania in the year 2020 to be 56.3, European Union average being 67.9. Compared to the last available data, Lithuanian index is even lower now than two years ago (56.8), while European Union average grew significantly (from 66.2 to 67.9). Situation in Lithuania is getting worse despite aiming towards a more gender-balanced society. Knowing gender equality is yet to be achieved, it is very important to analyze if tools used in education are appropriate regarding gender depiction.

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There is no doubt that gender stereotypes contribute to gender inequality. Damaging and undermeaning stereotypes are inevitable as they are factored mostly by society and its norms. Therefore as women grow up, they are progressively shaped to suit societal norms. While the majority of cultural factors can not be avoided or scientifically measured, education allows some control to be implemented.

As for Lithuanian research, several studies about gender representation related to gender equality were held, one of which was our study about gender stereotypes in the fifth grade mathematics teaching materials. Study concludes undeniable stereotypical representation of genders (Grigaliūnienė & Kačinskaitė, 2020). This study is a much needed sequel centered around gender representation in the national assessments.

Not only do assessments have psychological effects on people, some of the assessments are very important because of their outcomes. For example, exam results determine what study (and, therefore, career) opportunities young people have. It is because exam results factor competitive scores when applying for higher education. Even more so, mathematics exam has to be passed in order to apply for a state scholarship (Lietuvos Respublikos Seimas, 2020).

Given the effect of stereotype threat and the overall impact of assessments' outcomes, balanced gender representation in national assessments is undeniably very important. In this paper we present findings of contextual content of national mathematics assessments that were evaluated and a brief comparison with the results of our previous research (Grigaliūnienė & Kačinskaitė, 2020).

The aim of the research - to evaluate contextual content of mathematics assessments in order to determine how genders are represented.

Literature Review

Stereotype threat is a theory that emphasises the effect of stereotypical information for negatively stereotyped groups of people. The effect is observed when members of the stereotyped group are negatively impacted dealing with a task that makes stereotype salient (Steele & Aronson, 1995).

There are many areas in which stereotypical depiction poses as a threat to performance. Such as racial stereotypes e.g. African Americans as less intelligent than European Americans (Steele & Aronson, 1995), age stereotypes e.g. elderly performing poorer on memory tests as they age (Lamont, Swift, & Abrams, 2015) etc. One of the most studied stereotype threats is about females and their mathematical abilities in comparison with males. In many studied cases, women were shown to be impacted when experimenting with moderation of stereotypical information regarding their gender and mathematical abilities (Casad, Hale, & Wachs, 2017; Cavanagh, 2008; Ganley et al., 2013; Schmader, 2002; Shaffer,

Marx & Prislin, 2012; Smith & White, 2002; Spencer, Steele, & Quinn, 1999; Van Loo & Rydell, 2013). It is worth noting, that not all women experience stereotype threat the same therefore its impact is depending on particular women. For example, women who consider mathematics to be important are affected more severely in comparison to women, who are not interested in mathematics (Lesko & Corpus, 2006) also, women that believe in themselves more are less impacted compared to less confident women (Van Loo & Rydell, 2013).

The latter fact is very important to be noted when dealing with research that observes lack of stereotypical threat effect (e.g. Flore, Mulder, & Wicherts, 2018). While authors point out possible reasons for this, one more thing to notice is the community in which testing takes place. For this study, Dutch students were tested. Netherlands is known to be one of the highest rated countries regarding gender equality (European Institute for Gender Equality, 2020), therefore females are part of the communities that generally don't see them as less capable in mathematics or expect them to underachieve compared to males. As mentioned already, confidence in self significantly decreases the impact of stereotype threat.

Taking everything into consideration, there is no denying that gender representation should aim to be as balanced as possible. While there are cases when stereotype threat seems to be a thing of the past as the females are not impacted by the way information is presented, there is no need for gender representation to be unbalanced and stereotypical.

Methodology

The epistemic basis for this research was critical theory as defined by Paulo Freire in his book "Pedagogy of the Oppressed" (Freire, 1972). In the third chapter of his book he emphasizes the importance of any form of written information as it is a tool to shape students' worldview.

Accordingly, a research strategy was constructed. Knowing the importance of wording, content analysis was chosen as a research method as it allows to analyze patterns in the chosen study materials. Given the inherent duality and complexity of the analyzed data (repetition alone does not reveal the context), mixed research methodology was chosen. The research data was analyzed using parallel ongoing procedures strategy (as defined by (Creswell, 2003)). From the perspective of quantitative content analysis summation of recurrences, comparison of data sets, percentage distribution of data and drawing diagrams were used. From the perspective of qualitative content analysis data identification and categorization as well as identification of patterns were used.

For this study, national assessments of mathematical achievements were chosen to be analyzed. There are three main categories of assessments of mathematical achievements: national maturity exam (12th graders), assessment of

lower secondary education (10th graders) and national assessment of students' achievements (8th, 6th, 4th and 2nd graders).

Evaluation matrix was used as a research instrument for categorisation of problems found in assessments. It was aimed at calculating categorical distribution of topics depending on the gender as well as category. In this case, the evaluation matrix from the previous research was adapted to be used for this analysis (Grigaliūnienė, 2020) (Table 1). If determined to be eligible for categorisation, the problem was then categorised based on its topic. Like in previous research, five types of problems were decided to be uncategorizable: problems without a context, problems about animals, problems based on data, problems based on a family or group activity (mixed gender) and problems, where a gender cannot be determined because of plurality (Grigaliūnienė, 2020). In some cases, one problem might have had few topics.

Both qualitative and quantitative research data were integrated in the interpretation of the results.

Table 1 ***Evaluation Matrix***

Category	**Indicators**
Freetime, socialisation	after school activities, hobbies socialisation, communication reading organising/participating in parties, contests etc.
Housework	looking after flowers profession-unrelated knitting, housekeeping, cooking eating
Movement	transportation: by car, by train, by bus, by bike walking, travelling by feet flying sailing, boating
Sagacity	data: collecting, representing etc. geometry: folding figures, cutting figures out etc. solving mathematical, logical problems participating in competitions (intelligence) classwork and homework money: earning, investing, disputing etc.
Shopping	
Skillfulness	professions: builder, baker, cashier, teacher etc. repairs, installations etc. yard work: plowing, fruit picking etc.
Sports	psychical education class activities sports clubs fishing active leisure, hiking

Research Results

National maturity exam (12th graders), assessment of lower secondary education (10th graders) and national assessment of students' achievements (8th, 6th, 4th and 2nd graders) of the main session were analyzed in detail. In a few cases when there were two versions of national assessments of students' achievements for the same year only one was randomly chosen to be analyzed. Every type of assessment is analyzed in detail below.

National assessment of students' achievements for 2nd graders (denote by [NMPP2]). Four assessments for each year (2015-2019) were analyzed. Overall 40 contextual problems were analyzed, more than half of which had male protagonists. On average eight contextual problems per assessment were found. Most popular category was found to be sagacity (almost half of the analyzed problems), second being freetime. None of the assessments had problems in the housework category. Majority of the problems had protagonists acting the way it is expected of their gender. For example, females' freetime consists of painting (2015, 10), sharing stickers with friends (2017, 36), playing with friends (2017, 18), planting (2016, 35) etc. There are few cases of economical problems including having money (2018, 17.2; 2015, 11; 2015, 36; 2018, 17.1; 2018, 17.2), saving money (2018, 26), getting money as a gift (2018, 26). In one economic problem genders are compared and a boy is said to have more money than a girl (2018, 17.2), also female character is said to be saving money independently (2018, 26). In addition, females are shown to be participating in physical activities by their own choice (not in physical education class)(2015, 21; 2018, 23.3; 2019, 8), which denies the stereotype of females not being interested in sports.

National assessment of students' achievements for 4th graders (denote by [NMPP4]). Eight assessments for each year (2012-2019) were analyzed. Altogether 79 contextual problems were analyzed, on average almost ten contextual problems per assessment. Two of the most frequent categories were found to be sagacity, not far from it being freetime. Almost sixty percent of all the problems have male protagonists. In these assessments, quite a few professions were mentioned all of which were traditional to the gender representation; female characters portrayed as a baker (2012, 22), teachers (2012, 29; 2015, 33; 2016, 28; 2018, 15; 2018, 19), a cashier (2013, 10), a tailor (2015, 34), male characters as an electrician (2014, 31), a writer (2015, 6), an employee of a bowling center (2016, 28), a builder (2018, 28), a composer (2019, 6) and a farmer (2019, 12). Two of these professions involved nationally or internationally famous personas who were both male. The sagacity category offers great contrast as for every female problem there are almost four male problems. Female depiction is not demeaning; solving a task (2013, 34; 2017, 20), being at school (2015, 22.1), collecting data (2018, 18.2) and getting money as a gift (2017, 30). Male

characters, on the other hand, are involved in a variety of activities many of which involve data collection or graphing (2012, 11; 2012; 12; 2013, 29; 2014, 30; 2015, 22; 2018, 19; 2019, 32) also having or getting the money (2012, 28; 2013, 9; 2013, 13; 2018, 9; 2018, 27). Worth mentioning is the only case of a female flying on a plane (2012, 19), however, her flying is a subcontext to a male protagonist arriving to get her back home. Housework category has altogether four problems, three of which are centered around female characters and one about Jonas eating chocolate (2014, 18).

National assessment of students' achievements for 6th graders (denote by [NMPP6]). Three assessments for each year (2017-2019) were analyzed. Most frequent category was found to be freetime category, not far from it being sagacity. Altogether 39 contextual problems were found averaging 13 per assessment. There are more problems with female protagonists and this is the only case between all types of assessments. Majority of problems are well-balanced regarding gender representation as both females and males are shown to participate in various activities not constrained by their gender. For example, Agota's brother is painting the eggs (2017, 25), young mathematician Smiltė invents a sign for arithmetic calculation (2018, 14). However, Smiltė is choosing an afterschool activity and she stereotypically does not like sports (2018, 15). All in all, none of the problems either demean or praise any gender and the overall depiction of gender is satisfactory.

National assessment of students' achievements for 8th graders (denote by [NMPP8]). Seven assessments for each year (2012-2018) were analyzed. Most frequent category was found to be sagacity, second being freetime. Altogether 66 contextual problems were found averaging around 9.4 per assessment. Sixty percent of all the problems had male protagonists, however distribution in the most frequent category was equal. Most of the problems in the skillfulness category were profession-related, such as farmer (2012, 22), businessman (2015, 4), farmer (2016, 22; 2016, 22.1; 2016, 22.4; 2017, 16), writer (2017, 1.3) all having male protagonists and one with a female protagonist working as a school theatre manager (2017, 1.3). Gender representation in the sagacity category is quite satisfactory as female characters are portrayed as mathematically-skillful (e.g. 2012, 39; 2016, 11 etc.) and able to save (2018, 6.2) or to earn (2016, 13) money. However, as for the latter subcategory, depiction of male characters seems to overpower portrayal of females e.g. investing 60000 euros (2015, 4), using EU aid (2016, 22.3) and also saving money (2018, 6). Housework category consists of three problems centered around females and one with male protagonist eating breakfast (2014, 19). Shopping problems are tied to the contexts found in other categories particularly housework and skillfulness.

Assessment of lower secondary education (10th graders) (denote by [PUPP]). Twelve assessments for each year (2008-2019) were analyzed. Most

frequent category was found to be sagacity, second being skillfulness. Altogether 51 contextual problems were found averaging around 4.3 per assessment. More than sixty percent of all the problems had male protagonists. Interestingly, there were no freetime problems with male protagonists. Also there were only two sports-related problems both with male protagonists. Skillfulness category, with majority of the problems being profession-related, is dominated with male protagonists, e.g. electrician (2009, 8), business-owner (2015, 7; 2019, 11.1; 2019, 11.2; beekeeper (2015, 13.2), diver (2012, 10) etc. whereas females are depicted only two times both working as editors (2016, 15; 2016, 15.2).

The national maturity exam (12th graders) (denote by [VBE]). Nineteen assessments for each year (2002-2020) were analyzed. Three of the assessments had no categorizable contextual problems (2006, 2012, 2014). Very few contextual problems were found within the assessments as it averages only ~2.4 contextual problems per assessment. Nine of the assessments had contextual problems with exceptionally male protagonists (2002, 2003, 2004, 2005, 2007, 2009, 2011, 2013, 2015). First time contextual problems had a female protagonist was in 2008. More than half of all the problems had male protagonists. Most frequent categories were found to be freetime and socialisation, skillfulness and sports. Majority of problems have no demeaning or praising context for any gender besides historical context praising achievements of Pythagoras (2020, 22). Few are considerably stereotypical such as Greta who has to park her car in two spots because she likes to open her door widely (2018, 24), also grandma milking cows and making sourcream (2016, 20), male characters practising sports more often than females. However, whenever females are shown to be doing sports, they are either preparing for or participating in a competition (2010, 21; 2016, 23).

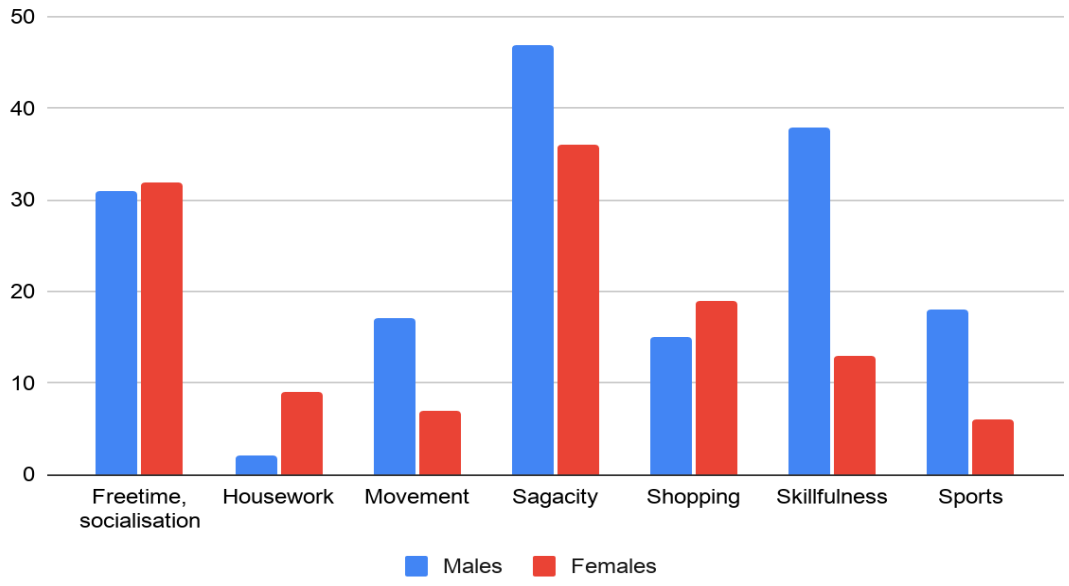

Figure 1 ***Categorical Distribution***

Categorical distribution of analyzed contextual problems regarding gender is given in the chart below (Figure 1) and quantitative summary is given in the table below (Table 2). It shows mostly balanced gender distribution in freetime and shopping categories, more or less also in sagacity. In skillfulness, movement and sports category males are dominant; in housework category females are clearly dominant.

Table 2 ***Quantitative Summary***

	NMPP2		**NMPP4**		**NMPP6**		**NMPP8**		**PUPP**		**VBE**		**Summary**	
	M	F	M	F	M	F	M	F	M	F	M	F	M	F
Freetime, socialisation	5	5	10	8	5	9	7	5	0	5	7	2	34	34
Housework	0	0	1	3	0	1	1	3	0	0	1	4	3	11
Movement	3	0	4	3	0	2	5	1	2	2	4	1	18	9
Sagacity	10	7	18	5	3	8	9	9	12	6	5	2	57	37
Shopping	3	3	2	5	3	2	3	5	4	4	1	1	16	20
Skillfulness	1	1	7	8	4	1	9	2	12	2	7	2	40	16
Sports	0	2	3	1	1	0	5	2	2	0	7	2	18	7
Summary	22	18	45	33	16	23	39	27	32	19	32	14	186	134

Discussion and Conclusions

When compared to other educational or entertainment sources of written information, national assessments of mathematical achievements seems to represent gender in a more balanced way. As for comparison with our previous research, the same conclusion could be made - when compared with teaching materials for 5th graders, national assessments tend to be more suitable.

However, some tendencies reappear. As for the most feminine category - housework - females are dominant and the only action male protagonists are shown to be making is eating. Same is true for the skillfulness category as profession-wise gender representation was found to be stereotype based showing females to be having stereotypically feminine careers and males more all-rounded profession-wise.

In our previous research we found the shopping category to be closely related to other stereotypical contexts, however, in this study this wasn't a big issue because the vast majority of the purchases were gender-neutral such as snacks, books etc. Most importantly, gender depiction is significantly more balanced in

the sagacity category as both genders are shown to be disputing money, solving problems etc.

It is also important to mention that despite the fact gender representation is more balanced in general, some assessments were better than the others (e.g. national assessment for students' achievements for 2nd graders) and some had unsatisfying tendencies (e.g. assessment of lower secondary education).

While the question of how problems should be constructed is entirely different and requires careful analysis to present guidelines, some insights for improvement are obvious enough to be stated as valid recommendations. Most importantly, gender representation should not be reduced to strereotypical situations. It is important to emphasize, that balanced gender representation does not mean majority of male protagonists showing typically feminine interests or visa versa. Having majority of female protagonists interested in racing, fencing etc. is unrealistic, but having a few characters with not-so-typical interests for their gender is encouraged. Regarding comparison between males and females, partnership and equality should be depicted rather than distinction.

Overall, gender depiction in national assessments is balanced-enough but the perfection is yet to be achieved. Since there is no reason to avoid more balanced gender representation in study and assessment materials, we would recommend in-charge people to be considerable and to take actions towards a more suitable gender depiction.

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