Gender Similarities in High School Mathematics: Affective and Cognitive Aspects

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Abstract: The study investigated gender similarities in perceived teacher affective support, mathematics self-efficacy, and mathematics achievement by using cross-sectional survey design. Data were collected by self-report questionnaire and achievement test from 727 (416 females & 311 males) grade 9 students, with the average age of 15, randomly selected from three government general secondary schools in Aksum. Data gathering tools had acceptable reliability coefficients: 0.80 for teacher affective support scale and 0.93 for mathematics self-efficacy scale. Descriptive statistics and independent samples *t*-test were used to analyze the data. The findings revealed that there were gender similarities in teacher affective support and mathematics achievement while girls found to be more self-efficacious towards mathematics. The findings can be practically used to realize successful high school mathematics teaching-learning by selecting student outcomes, designing teacher and school manager training programs, and developing curricular materials in line with the findings. Mathematics teachers in particular can practically use the findings to enhance good insights in students, successfully support their students, and work on improving mathematics self-efficacy and thereby enhance learning and achievement in mathematics for all students. Theoretically, the study confirmed Hyde's gender similarity hypothesis, and this investigation in the Ethiopian high school mathematics context, contributes to the contested research in gender and mathematics which could contribute to the theories in educational psychology. Further implications and directions for future study are forwarded.

Key words: Mathematics, self-efficacy, teacher affective support, achievement, gender.

INTRODUCTION

Most studies on gender and mathematics focus on gender differences instead of similarities which strengthen gender stereotypes (Chipman, 2005; Gallagher & Kaufman, 2005). One can find multiple studies on gender/sex differences in mathematics (Arnup, Murrihy, Roodenburg, & McLean, 2013; Ayalon & Livneh, 2013; Byrnes, 2005; Catsambis, 2005; Else-Quest, Hyde, & Linn, 2010; Eshetie, 2001; Frenzel, Pekrun, & Goetz, 2007; Gallagher & Kaufman, 2005; Isiksal & Cakiroglu, 2008; Kenney-Benson, Patrick, Pomerantz, & Ryan, 2006; Kyriakides & Antoniou,

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2009; Li, Zhang, Liu, & Hao, 2017; Pajares, 2005; Penner & Paret, 2008; [2]Seleshi, 1995, 2001, 2005; Yoo, 2017). But, there are very few studies on gender similarities in mathematics (Hyde, 2005; Hyde, Lindberg, Linn, Ellis, & Williams, 2008). Despite the preferred title in most studies, a lot of evidence empirically attest the presence of more gender similarities than differences in mathematics (Else-Quest, Hyde, & Linn, 2010; Frenzel, Pekrun, & Goetz, 2007; Hyde, 2005; Hyde, Lindberg, Linn, Ellis, & Williams, 2008; Kenney-Benson, Patrick, Pomerantz, & Ryan, 2006; Lindberg, Hyde, Petersen, & Linn, 2010; Yoo, 2017). For instance, a meta-analysis of studies across 69 countries throughout the world revealed that most effect sizes for mathematics achievement were found to be very small or negligible, and girls outperformed boys in some cases and vice versa in some other cases (Else-Quest et al., 2010). Similarly, a meta-analysis on mathematics performance concluded that gender differences in mathematics performance were very small, and depending on the sample and outcome measure, boys are sometimes favored and girls some other time" (Lindberg, Hyde, Petersen, & Linn, 2010, p. 1124).

The common use of the title 'gender/sex differences in mathematics' seems biased and can have negative effects on students, teachers, parents, researchers, and the wider community. Mentioning the bias inherent in the title, Caplan and Caplan (2005, p. 25) argue that "in the wording of the title, *Gender Differences in Mathematics*, there is no any implication that there is any question about whether there are such differences." Caplan and Caplan further claim that "when it comes to research on sex differences in mathematics abilities, researchers' bias is a huge problem with enormous consequences" (p. 26). For instance, biased research findings that claim males' superiority in mathematics may put females in stereotype threat (Chipman, 2005); mathematically talented females may be ignored by teachers and parents (Hyde, 2005), and may put low ability males at disadvantage by excluding them from any help or interventions they need (Caplan & Caplan, 2005; Hyde, 2005). Moreover, research findings that overemphasize gender differences in mathematics could reinforce gender stereotypes which could further lead to differential treatment of females and males by people and the community (Ellemers, 2018). That is, as a result of overemphasis on gender differences in mathematics, the public and media reinforce the stereotype that males are superior in mathematics. Therefore, overemphasizing gender differences in mathematics costs much, and Hyde suggests considering these overinflated assertions of gender differences.

Then, what should be done? While questioning about its possibility, Chipman (2005, p. 19) says "perhaps we should stop talking about the women and mathematics problem, and then it will vanish entirely." This may not be feasible and even Chipman hesitates about its possibility. And in fact, the problem is not talking about or studying women and mathematics. The real problem in the area is "the sheer volume of material published by researchers engaged in the persistent search for sex differences in mathematics abilities" (Caplan & Caplan, 2005, p. 25) and overemphasis. In reality, individual differences in mathematics which are rarely considered

[2] Note that Ethiopians are called in their first names unlike most other parts of the world; so in citations of works by Ethiopians, first names are used.

are much larger than gender differences in mathematics (Caplan & Caplan, 2005; Gallagher & Kaufman, 2005; Hyde, 2007). Therefore, the overemphasis of previous studies on gender differences in mathematics while the reality is not as such pronounced should be counter balanced by empirically studying gender similarities in mathematics. This could help change the mindset of researchers so that they can minimize the stereotypes and biases inherent in the research on females and mathematics. Even though researchers empirically find no or trivial gender differences in mathematics and preach about nonexistence of significant gender differences in mathematics, scholars still prefer to use the title 'gender differences in mathematics'. As Caplan and Caplan criticize, the well written book edited by Gallagher and Kaufman is entitled as 'Gender differences in mathematics' while most volumes in it attest gender similarities in mathematics. This might be due to the mindset of the editors. In addition to counter balancing previous overemphasis by studying gender similarities in mathematics, scholars argue that it is even more important to focus on individual differences in mathematics learning and abilities (Caplan & Caplan, 2005; Gallagher & Kaufman, 2005).

Based on a very comprehensive study of 46 meta-analyses reports, Hyde (2005) proposed the 'Gender Similarities Hypothesis' which states that females and males are similar on most psychological variables. Hyde did cover a very wide area of psychological variables "including cognitive abilities, communication, social behavior and personality, psychological well-being, and other miscellaneous areas" (2007, p. 259). An earlier meta-analysis of 100 studies on gender differences in mathematics performance on over 3 million students led to conclude that the differences are small (Hyde, Fennema, & Lamon, 1990). Another similar meta-analysis of 70 studies on over 63 thousand students comes to conclude that "gender differences in most aspects of mathematics attitudes and affect are small" (Hyde, Fennema, Ryan, Frost, & Hopp, 1990, p. 310). A study on mathematics performance of 2nd through 11th graders has also found no gender differences in mathematics skills (Hyde, Lindberg, Linn, Ellis, & Williams, 2008).

Scholars urge special attention and critique for gender differences in mathematics in order to balance the already happened much harm because of males' superiority stereotype (Caplan & Caplan, 2005). Moreover, the generalizability of the literature on gender and mathematics demands further investigation (Else-Quest, Hyde, & Linn, 2010).

The present study is based on gender similarity model which is a new direction in the study of gender (Hyde, 2005, 2007; Hyde & Linn, 2006; Hyde, Lindberg, Linn, Ellis, & Williams, 2008). The study tried to contribute to the literature on gender and mathematics by empirically investigating gender similarities in affective and cognitive aspects of mathematics among Ethiopian grade 9 students. More specifically, the study investigated gender similarities in grade 9 students' perceived teacher affective support, mathematics self-efficacy, and mathematics achievement in the general secondary schools of Aksum town, Tigray, Ethiopia. The study did intend to answer the question: Are there gender similarities in perceived teacher affective support, mathematics self-efficacy, and mathematics achievement among grade 9 students in Aksum town? Empirically responding to this question or achieving the purpose of this study could have theoretical and practical implications. Theoretically, the findings could contribute to the gender similarity literature from an Ethiopian, a sub-Saharan country, context. Practically, the findings could inform policy makers and practitioners about whether we should focus on helping all students learn and achieve in mathematics or if there are specific areas where we should consider gender issues.

Gender Similarities in Perceived Teacher Affective Support, Mathematics Self-Efficacy, and Mathematics Achievement

Teacher affective support.

In general, the literature on teacher affective support is scanty (Holm, Hannula, & Björn, 2016) and not consistent. Some studies indicate that in learning mathematics, female students are emotionally more vulnerable than male students (Kenney-Benson, Patrick, Pomerantz, & Ryan, 2006). Cross-national studies have also shown that female students to be more anxious in mathematics than their male counterparts (Else-Quest, Hyde, & Linn, 2010; Holm et al., 2016). Holm et al. found female students to have more negative emotional profile in mathematics than males. In mathematics classes, females may have fewer opportunities than males to explain their ideas due to cultural and sexual biases as well as teacher expectation (Stiff, Johnson, & Johnson, 1993). In a study on first year undergraduate science students, Negasi (2009) found male students to have more close relationship with their mathematics teachers and perceived their mathematics teachers as more supportive compared to their female classmates. On the other hand, female students found to be more motivated to do school work and perceived their teachers as more emotionally supportive than male students did (Skaalvik & Skaalvik, 2013).

Mathematics self-efficacy.

Gender differences in self-efficacy are often reported; some attributing the differences to stereotype (Bandura, 2006a; Pajares, 2002; Pastorelli et al., 2001) and others to differences in sources of self-efficacy (Zeldin, Britner, & Pajares, 2008). For example, Bandura (2006a) indicated that gender differences follow stereotypic classifications such that boys judge themselves as more efficacious in science and technology while girls perceive themselves as more efficacious in social, educational, and health services. More specifically, citing a work by Wigfield, Eccles, and Pintrich (1996), Pajares (2002) indicated that “boys and girls report equal confidence in their mathematics ability during the elementary years, but, by middle school, boys begin to rate themselves more efficacious than do girls” (2002, p. 118). In line with this, Schunk and Pajares (2002) also indicated that when students enter middle school, girls typically show lower self-efficacy. This implies that gender differences in mathematics self-efficacy that are attributed to stereotype favor males. Some studies (e.g., Zeldin et al., 2008) also attribute the gender differences in self-efficacy to developmental or psychological factors. According to these studies, while mastery experiences are considered as the most important for developing self-efficacy by male students, vicarious experiences and social persuasions are considered most important by female students. In contrast to these studies, earlier study on Japanese college students (Matsui, Matsui, & Ohnishi, 1990) found similarity between females and males in the four sources of mathematics self-efficacy though the study revealed significant gender differences in high school mathematics self-efficacy in favor of males.

Several studies indicate significant gender differences in mathematics self-efficacy that favor male students (Bandura, 2006a; Betz & Hackett, 1983; Else-Quest, Hyde, & Linn, 2010; Fast et al., 2010; Junge & Dretzke, 1995; Skaalvik, Federici, & Klassen, 2015; Randhawa & Gupta, 2000; Schunk & Pajares, 2002; Matsui, Matsui, & Ohnishi, 1990). In a meta-analysis of cross-national patterns of gender differences in mathematics across 69 nations throughout the world, Else-Quest et al. found boys to be more confident in their mathematics abilities than girls in which they scored one third of a standard deviation higher than girls on mathematics self-efficacy. Moreover, when middle school students are given a novel mathematical task, a study by Schunk and Lilly (1984) confirmed a significant gender difference in mathematics problem solving self-efficacy in favor of males. But the study indicated that when students receive performance feedback in the context of the instructional unit, the difference vanishes. A local study on first year undergraduate science students, has indicated that "male students devoted more effort, persisted longer, were more interested, preferred more challenging mathematics tasks, and had a sense of competence on mathematics when compared to female students" (Negasi, 2009, p. 51).

Unlike the above studies, others have found gender similarities in mathematics self-efficacy (e.g., Chen & Zimmerman, 2007; Hachett & Betz, 1989). Hackett and Betz, for instance, indicated that "sex differences in mathematics self-efficacy did not reach statistical significance" (p. 270). On the other hand, studies indicate that gender differences in self-regulatory efficacy or confidence in the use of self-regulated learning strategies favor female students (Caprara et al., 2008; Pajares, 2002; Pastorelli et al., 2001). For instance, Pastorelli et al. indicated that "girls have a higher sense of efficacy for academic activities and to resist peer pressure to engage in transgressive activities" (p. 94). Pajares also indicated that "when gender differences in the use of self-regulated learning strategies or in having confidence to use these strategies have been reported, they typically favor female students" (p. 118). The literature indicates that the use of self-regulated learning strategies correspond with higher mathematics self-efficacy (Bandura, 1993, 1997; Bandura, Barbaranelli, Caprara, & Pastorelli, 2001; Maddux, 1995; Paris & Byrnes, 1989; Romberg & Kaput, 1999; Stiff, Johnson, & Johnson, 1993).

Mathematics achievement. The literature on gender similarities in mathematics achievement is not conclusive (Pajares, 2005). Studies found significant gender differences in mathematics achievement in favor of males (e.g., Arnup et al., 2013; Karakolidis, Pitsia, & Emvalotis, 2016). For instance, even though Greece significantly narrowed gender gap in the years 2003 to 2012, Karakolidis et al. found statistically significant difference in mathematics achievement between Greek boys and girls favoring boys. Similar results were found for Australian primary school students by Arnup et al. and for Cypriot primary school students by Kyriakides and Antoniou (2009). In a cross-national gender difference study on Canadian and Indian high school students, Randhawa and Gupta (2000) found consistent and systematic gender differences in favor of males in mathematics achievement, attitude, and self-efficacy. In a comprehensive comparative study on 32 countries including African countries, like Botswana, Egypt, Ghana, Morocco, South Africa, and Tunisia, Ayalon and Livneh (2013) found significant gender gap in favor of boys particularly in the upper part of the mathematics achievement distribution. Like the global trend, studies in the Ethiopian context consistently indicated significant gender differences in mathematics achievement in favor of males (e.g., Abraha, 2015; Eshetie, 2001; Negasi, 2009; Seleshi, 1995, 2001, 2005; Tilaye, 2004). Eshetie found significant gender difference in mathematics achievement in favor of males for grades 9 and 11 students and similar results were found for grades 8 through 11 by Seleshi (1995). Regarding the presence of gender difference in mathematics achievement vertically across grades, Seleshi (2001) concluded that the disparity starts at grade 6. In contrast to this conclusion, Abraha (2015) investigated counting concept and number sense of grades 1 and 2 using the Early Grade Mathematics Assessment (EGMA) approach and found significant gender differences in favor of males.

On the other hand, several recent studies claim to have found gender similarities in mathematics achievement (Chen & Zimmerman, 2007; Else-Quest, Hyde, & Linn, 2010; Holm, Hannula, & Björn, 2016; Hyde, Lindberg, Linn, Ellis, & Williams, 2008; Lindberg, Hyde, Petersen, & Linn, 2010; Skaalvik, Federici, & Klassen, 2015; Yoo, 2017). Lindberg et al. conducted a meta-analysis of 242 studies on mathematics achievement published between 1990 and 2007 and found gender similarities in mathematics achievement. In addition to the meta-analysis, Lindberg et al. analyzed large national data sets of U.S. adolescents regarding mathematics achievement and came up with similar conclusions. In a more comprehensive meta-analysis of cross-national patterns of gender differences in mathematics across 69 nations, Else-Quest et al. found similar mean mathematics achievements for males and females. Moreover, Byrnes, Hong, and Xing (1997) conducted a study on mathematics achievement by Chinese high school students on the mathematics subtest of the Scholastic Aptitude Test (SAT) and found gender similarities. Unlike this study, a meta-analysis of Beijing Assessment of Educational Sciences (BAEQ) results from 2008 to 2013 revealed trivial gender differences in mathematics achievement for grade 5 but significant gender differences for grade 8 in favor of girls, and led to the conclusion that girls outperform boys in mathematics as they moved up the ladder (Li, Zhang, Liu, & Hao, 2017).

The international literature on gender similarities in mathematics achievement, thus, is somehow mixed. For this reason the issue of gender differences in mathematics achievement seems to be controversial (Arnup, Murrihy, Roodenburg, & McLean, 2013; Karakolidis, Pitsia, & Emvalotis, 2016; Kyriakides & Antoniou, 2009).

Gender and the Ethiopian Education System

The levels of females' participation in different spheres of activities differ across countries, and the differential participation may lead to gender gap in mathematics (Ayalon & Livneh, 2013). Studies found that gender equity in a country is associated with gender similarity in mathematics achievement, attitudes, and affect (Ayalon & Livneh, 2013; Else-Quest et al., 2010). In Ethiopia, a study indicated that "the increasing numbers of females who are now progressing through the system could in the longer term have an impact on changing societal attitudes which, in turn, will assist in moving towards removing gender disparities in education" (Rose, 2003, p. 14). Moreover, among the gender equity indicators, primary and secondary enrollment ratios are most relevant to mathematics achievement, attitudes, and affect (Else-Quest et al., 2010). Hence, it is important to look at gender and the Ethiopian education system in general and primary and secondary enrollments in particular.

The Ethiopian education system had highly inequitable access partly expressed by high gaps between males' and females' enrollments (Federal Democratic Republic of Ethiopia, Ministry of Education (MoE), 2002; Rose, 2003). The inequitable access was because of the country's developmental level and cultural influences. In Ethiopia, "girls' education is deeply influenced by such cultural and economic issues as tradition, legal systems, customs, poverty and discrimination" (Lasonen, Kemppainen, & Raheem, 2005, p. 25). Lasonen et al. indicated that "the customary laws and practices are patriarchal and hinder women's access to resources both within and outside the household" (p. 27). In Ethiopia, work condition and type is one competitor to girls' education (Camfield, 2011). There is gendered division of labor in Ethiopia, and tasks given to females are usually time consuming and difficult to combine with other tasks like reading. For instance, girls are supposed to do household chores while boys are free to play outside or may do shop or animal keeping. Particularly, for women, work condition is very difficult as "women are responsible for all household chores in addition to the support they provide in agriculture and livestock production" (Lasonen et al., 2005, p. 28).

The 1994 education and training policy placed directions to compensate the unbalanced development, in general, and the inequitable education access, in particular (FDRGE, 1994; Federal Democratic Republic of Ethiopia, Ministry of Education (MoE), 2002). For instance, the policy indicates that "the government will give financial support to raise the participation of women in education" (FDRGE, 1994, p. 32). Accordingly, different measures were taken to encourage the participation of females in education, and those measures brought enormous increments in girls' enrolments. Among the measures taken to enhance gender parity in the education and training sector are establishing and strengthening gender offices, gender forums, girls' clubs and female students' associations in regional education bureaus and higher learning institutions (Federal Democratic Republic of Ethiopia, Ministry of Education (MoE), 2015a).

Review of education statistics annual abstracts (2000/01 and 2009/10 to 2016/17) indicates that there are considerable developments in the education sector, in general, and females' participation in education, in particular. Females' enrolments have grown enormously at all educational levels. Gender parity has been improved at all levels. More specifically, these improvements in education are more substantial in Tigray regional state where this study was conducted. In Tigray region, the primary education has been improved. The primary education (grades 1-8) gross enrolment ratio (GER) has grown from 73.90 (in 2000/01) to 116.70 (in 2016/17) in the region. As the enrolment trends presented in Table 1 show, the primary education enrolments have substantially grown in the last eight years. The gender parity trend in primary education indicated that gender parity index (GPI) has improved from 0.95 (in 2000/01) to 1.00 (in 2010/11) which was sustained for few years and then declined to 0.94 (in 2016/17). The primary education enrolment trends presented in Table 1 indicate that female enrolment never surpassed male enrolment.

Table 1

Primary Enrolments by Gender and GPI for Tigray Region and National

		2009/10	**2010/11**	**2011/12**	**2012/13**	**2013/14**	**2014/15**	**2015/16**	**2016/17**
Tigray	Female	491,856	497,811	502,341	504,812	520,534	541,663	548,530	557,905
	Male	496,360	503,792	504,632	515,263	536,575	572,982	590,368	609,257
	Total	988,216	1,001,603	1,006,973	1,020,075	1,057,109	1,114,645	1,138,898	1,167,162
	GPI	---	1.00	1.01	0.99	0.99	0.97	0.95	0.94
National	Female	7,482,215	7,939,023	8,124,293	8,276,029	8,705,172	8,844,716	9,407,490	9,753,572
	Male	8,309,889	8,779,088	8,865,491	9,112,266	9,601,324	9,846,502	10,569,951	11,029,506
	GPI	---	0.94	0.95	0.94	0.93	0.92	0.91	0.90

Note. GPI = Gender Parity Index

Like the improvements in primary education in Tigray region, secondary education has also been substantially improved in the region. The secondary education (grades 9-12) gross enrolment ratio (GER) has grown from 23.00 (in 2000/01) to 44.70 (in 2016/17) in the region. As the enrolment trends presented in Table 2 indicate, the secondary education enrolments have substantially grown in the last eight years. The enrolment trends indicate that female enrolments were less than male enrolments in 2009/10 and before, and this was reversed in the years 2010/11 to 2016/17. The gender parity trend in secondary education indicated that GPI has improved from 0.61 (in 2000/01) to 1.02 (in 2016/17). In the recent four years 2013/14 to 2016/17, gender parity has been assured in the first cycle (grades 9 & 10), GPI ranging from 1.09 to 1.07 while it declined in the second cycle (grades 11 & 12), GPI ranging from 1.06 to 0.83.

Table 2

Secondary Enrolments by Gender and GPI for Tigray Region and National

		2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17
Tigray	Female	66,472	72,229	78,202	90,894	97,735	98,159	106,794	106,287
	Male	69,342	69,856	72,908	83,731	91,924	94,053	106,227	106,028
	Total	135,814	142,085	151,110	174,625	189,659	192,212	213,021	212,315
	GPI	---	---	---	---	--- (1.09, 1.06)	1.06 (1.08, 0.99)	1.03 (1.06, 0.89)	1.02 (1.07, 0.83)
National	Female	721,456	773,312	805,658	888,910	941,331	998,238	1,145,117	1,201,009
	Male	974,474	976,822	960,353	1,010,821	1,057,024	1,109,877	1,276,046	1,358,168
	Total	1,695,930	1,750,134	1,766,011	1,899,731	1,998,355	2,108,115	2,421,163	2,559,177
	GPI	---	---	0.88, 0.76	0.92, 0.81	0.94, 0.85	0.92 (0.93, 0.87)	0.93 (0.94, 0.87)	0.91 (0.92, 0.86)

Note. GPI = Gender Parity Index

METHOD

Design

The study employed a cross-sectional survey design in that students' perceptions of teacher affective support and mathematics self-efficacy were collected from grade 9 students of three high schools using self-report questionnaire. Achievement of the participants on mathematics was also measured using an achievement test. The collected data were statistically analyzed to answer the research question of the study.

Participants

In the first semester of the academic calendar 2017/18, there were 1170 (610 females) grade 9 students in Aksum General Secondary School in 22 classrooms, 683 (374 females) grade 9 students in Menilik I General Secondary School in 14 classrooms, and 1148 (553 females) grade 9 students in Kaleb General Secondary School in 20 classrooms. Thus, totally there were 3,001 (1537 females) grade 9 students in the three government general secondary schools in 56 classrooms.

In selecting the participants, efforts were made to minimize teacher variation effects in that students taught by few mathematics teachers were included in the sample. The number of mathematics teachers in Aksum, Kaleb, and Menilik I General Secondary Schools were 13 (11 males), 14 (11 males), and 8 (7 males), respectively. Then, using the lottery method, 2 mathematics teachers from each Aksum and Kaleb, and 1 mathematics teacher from Menilik I were selected, and all grade 9 students taught by those 5 mathematics teachers were included in the sample. Therefore, participants of the present study included 727 (416 females) grade 9 students selected using cluster random sampling from the three government general secondary schools (16 classrooms) in Aksum town. During the mathematics achievement test, 57 students were absent in the three schools and as a result 670 students (395 females & 275 males) sat for the test. The participants were with the age range of 14 to 24 years (M = 15.00, SD = 0.92).

Measures

Student self-report questionnaire was used to collect data about students' perceptions of teacher affective support and mathematics self-efficacy. After the measures were prepared in English, they were translated into Tigrigna, the participants' native language. The adapted and developed questionnaire was critically reviewed by three experienced professionals of whom two were English lecturers (a PhD and an MA holders) and one was an Educational Psychology professional (PhD fellow). The reviewers were all Tigrigna natives and the two were Tigrigna minor in their professional studies and hence they reviewed both the English and Tigrigna versions including the back translation into English. The three professionals reviewed the accuracy of the translations as well as the extent to which the adaptation of the teacher affective support scale into Ethiopian context was appropriate. During data collection, participants were instructed to answer with reference to their mathematics teacher and mathematics subject learning and studying. After data for perceived teacher affective support and mathematics self-efficacy were collected and the first three units in grade 9 mathematics textbook were taught, students did take a mathematics achievement test.

Teacher affective support.

Teacher affective support refers to student perceptions of "teacher behaviors, attitudes, and practices involving caring, respect, concern for and interest in students, valuing, recognition, fair treatment, high expectations, encouragement, and listening" (Sakiz, 2007, p. 23). Sakiz developed a perceived teacher affective support scale and used in her dissertation in the American mathematics classroom context with middle school students of average age 12.82 years. The scale has 9 items and reliability coefficient Cronbach's alpha of 0.92. For the present study, Sakiz's perceived teacher affective support scale was adapted and used. Sakiz was consulted and asked her permission for adapting the scale and she permitted to adapt the tool via email communication.

In adapting Sakiz's scale, the item "My math teacher treats me equal compared to other students regardless of my gender or score in math" was, for instance, adapted to "My math teacher supports students equally without any bias." The basis for this was to increase clarity and make the item more specific, i.e., treating students with respect to gender, race, and ability or score in mathematics implies multiple concepts. In addition to such adaptations, four items were added to Sakiz's scale in order to cover the concepts in the definition of the variable, and the 13-item scale (e.g., "My math teacher really cares about me"; "My math teacher values every effort I make in learning math") was developed. In translating the scale, efforts were made to contextualize the teacher affective supports students get to their real practices in the Ethiopian context. Responses were made on 5-point scales, where 1 = not at all true, 2 = a little true, 3 = somewhat true, 4 = mostly true, and 5 = completely true. The scale had acceptable reliability coefficient, Cronbach alpha, of 0.80 which is above the minimum cut point of .70 for a good measure (Cortina, 1993; Kline, 2000).

Mathematics self-efficacy.

Mathematics self-efficacy in this study is concerned with grade 9 students' beliefs in their capabilities to organize and execute the courses of actions required to learn and understand the mathematics contents in their textbook and perform well. According to Bandura (2006b), self-efficacy beliefs are measured by presenting individuals with items portraying different levels of task demands so that the individuals rate the strength of their belief in their ability to execute the requisite activities. Respondents rate the strength of their efficacy beliefs on a 100-point or 10-point (which is simpler) scale, ranging from 0 (Cannot do) through 50 or 5 (Moderately certain can do) to complete assurance, 100 or 10 (Highly certain can do).

For this study, an 18-item mathematics self-efficacy scale was developed from the first three units of grade 9 mathematics textbook (The Number System, Solutions of Equations, and Further on Sets). The scale was developed based on the 10-point simpler response format ranging from 0 (Cannot do) through 5 (Moderately certain can do) to complete assurance, 10 (Highly certain can do). The contents of the first three units in the grade 9 mathematics textbook were selected because they are covered in the first semester when data were collected. In developing the scale, Bandura's (2006b) guide for constructing self-efficacy scales was used and the three units were fairly covered to enhance content validity. The scale had a very good reliability coefficient, Cronbach alpha, of 0.93 which is above the minimum cut point of .70 for a good measure (Cortina, 1993; Kline, 2000).

Mathematics achievement.

This variable is an achievement of grade 9 students on a mathematics test developed by the researcher for the research purpose. To measure this variable, a 25-item mathematics achievement test was developed from the first three units of grade 9 mathematics textbook (i.e., The Number System, Solutions of Equations, and Further on Sets) which were covered in the first semester of 2017/18 academic calendar. The mathematics achievement test was composed of True-False (5 items), matching (5 items), and multiple choice (15 items) items. Combination of three objective type items was used to enhance the quality of the test (Mehrens & Lehmann, 1991). The multiple choice items had four alternatives.

As indicated under the mathematics self-efficacy, the contents of the test correspond to the concepts covered in the mathematics self-efficacy scale. In developing the mathematics achievement test, in addition to following the principles of measurement and evaluation, it was tried to fairly cover the three units to enhance content validity. To minimize the deficiencies apparent in item writing or test preparation, a test should be critically reviewed by teachers other than the writer (Mehrens & Lehmann, 1991). Thus, a copy of the test with answer key was given to each of the five mathematics teachers of the participants for review. Then, all the teachers carefully reviewed the test and contributed more to the correctness and validity of the items in the test. All the teachers also assured that they have covered the first three units in the textbook and hence the appropriateness of the test for their students.

Data Analysis

The collected data were analyzed using the statistical package IBM SPSS version 20. In the preliminary analyses, descriptive statistics and scale reliability analyses were used. To assess gender differences in teacher affective support, mathematics self-efficacy, and mathematics achievement, independent samples *t*-test was employed. Before running the *t*-test, the assumptions were assessed using descriptive statistics, normal Q-Q charts and plots, and histograms.

RESULTS

The present study was intended to respond to a question which was concerned with assessing if there were gender similarities in teacher affective support, mathematics self-efficacy, and mathematics achievement. Independent samples *t*-test was used to respond to this research question. The assumptions of using the independent samples *t*-test are independent observations, normality, and homogeneity of variance (Field, 2005, 2009; Gravetter & Wallnau, 2013). The assumptions of independent observations and normality were assessed for the variables mathematics self-efficacy and teacher affective support, and they were found to be tenable. These assumptions were also tenable for mathematics achievement as indicated by random sampling used, the measures of shape (skewness = .571 & kurtosis = -.127), and the normal Q-Q chart and histogram for the variable. Levene's test for homogeneity of variance also indicated that there is no violation of the assumption of variance homogeneity for all the three variables. Therefore, all the assumptions for using the independent samples *t*-test were assessed and found to be satisfied for all the three variables.

Table 3

Descriptive Statistics, Independent Samples t-Test, and Related Effect Sizes for TAS, MSE, and MAch

	Female		Male					
Variable	*n*	*M* (*SD*)	*n*	*M* (*SD*)	*t*	*df*	Sig. (2-tailed)	Cohen's *d*
TAS	416	53.02 (8.40)	311	53.22 (7.99)	-.332	725	.740	- 0.0243
MSE	416	119.37 (34.60)	311	113.90 (37.69)	2.030	725	.043	0.1521
MAch	395	45.42 (16.71)	275	44.29 (16.88)	.855	668	.393	0.0673

Note. TAS = Teacher Affective Support, MSE = Mathematics Self-Efficacy, MAch = Mathematics Achievement

As the results in Table 3 show, independent samples *t*-test indicated that the perceived teacher affective support of female grade 9 students (M = 53.02, SD = 8.40) found to be similar with that of their male counterparts (M = 53.22, SD = 7.99), $t(725)$ = - 0.33, p > .05, d = - 0.02. The independent samples *t*-test results in Table 3 further indicated that the average mathematics self-efficacy of female grade 9 students (M = 119.37, SD = 34.60) found to be significantly greater than that of their male counterparts (*M* = 113.90, *SD* = 37.69), $t(725) = 2.03$, $p < .05$, $d = 0.15$. Moreover, the independent samples *t*-test results indicated that the mathematics achievement of female grade 9 students (*M* = 45.42, *SD* = 16.71) found to be similar with that of their male counterparts (*M* = 44.29, *SD* = 16.88), $t(668) = 0.86$, $p > .05$, $d = 0.07$ (Table 3).

DISCUSSION

The findings of the study revealed that there was gender similarity in perceived teacher affective support between female and male grade 9 students in line with their mathematics teachers. That is, male and female grade 9 students similarly perceived that their mathematics teachers had positive belief and close relationship with them and that the mathematics teachers were concerned about students' learning and achievement and fairly treat students. This finding is different from previous studies which found extreme results. One study indicated that female students perceived their teachers as more emotionally supportive than male students did (Skaalvik & Skaalvik, 2013) while a local study by Negasi (2009) found that male students had more close relationship with their mathematics teachers and perceived their mathematics teachers as more supportive compared to their female classmates. Due to cultural and sexual biases and lower teacher expectation, female students may have fewer opportunities than males in mathematics classes (Stiff, Johnson, & Johnson, 1993). These biases were also common in Ethiopia, and, as a result, girls were not suggested to seek teacher help and establish closer relationships with their teachers in the Ethiopian culture. But the present finding reflects improvements in the cultural biases and teacher expectations for girls particularly in mathematics which was considered as a male subject. The gender similarity finding in teacher affective support is in line with the current gender parity status in the Ethiopian first cycle (grades 9 & 10) secondary education.

The present study has further indicated that female grade 9 students were found to be more self-efficacious towards mathematics than their male counterparts. This implies that female grade 9 students were more confident than their male counterparts to demonstrate their conceptual knowledge and problem solving skills on tasks included in their mathematics textbook. These findings are in contradiction with several studies which found significant gender differences in mathematics self-efficacy or academic self-efficacy in favor of males (Bandura, 2006a; Betz & Hackett, 1983; Else-Quest, Hyde, & Linn, 2010; Fast et al., 2010; Junge & Dretzke, 1995; Skaalvik, Federici, & Klassen, 2015; Randhawa & Gupta, 2000; Schunk & Pajares, 2002; Matsui, Matsui, & Ohnishi, 1990). On the other hand, the findings seem to be consistent with some studies which found significant gender differences in self-regulatory efficacy or confidence in the use of self-regulated learning strategies that favor female students (Caprara et al., 2008; Pajares, 2002; Pastorelli et al., 2001). In fact the present findings have marginal significance ($p = 0.043$ or small effect size, $d = 0.15$; Hyde, 2005) and hence can be considered as similar with some studies which found no significant gender difference in mathematics self-efficacy (Hachett & Betz, 1989; Schunk & Lilly, 1984).

Even though they need further investigation, the findings of the present study seem to light some insight that challenges the stereotypical thinking that females are less confident in mathematics. The findings can also be signs of improvements in cultural barriers and equitable education opportunities for male and female students in the study area. This is because the literature indicates that gender differences in mathematics self-efficacy are attributed to stereotype, inequitable educational practices, and cultural restrictions (Bandura, 2006a; Tilaye, 2004). In fact, the findings seem reflections of the secondary enrolment trends in Tigray region for the last seven years in which females' enrolments have been higher than males'.

The findings of the study further indicated that there was gender similarity in mathematics achievement between female and male grade 9 students. That is, the study found that on average, girls and boys achieved similarly on the mathematics achievement test. Scholars argue that the literature on gender differences in mathematics achievement is mixed (Arnup, Murrihy, Roodenburg, & McLean, 2013; Karakolidis, Pitsia, & Emvalotis, 2016; Kyriakides & Antoniou, 2009). Thus, the present finding concords with several studies that found gender similarities in mathematics achievement (Chen & Zimmerman, 2007; Else-Quest, Hyde, & Linn, 2010; Holm, Hannula, & Björn, 2016; Hyde, Lindberg, Linn, Ellis, & Williams, 2008; Lindberg, Hyde, Petersen, & Linn, 2010; Skaalvik, Federici, & Klassen, 2015; Yoo, 2017). On the other hand, the finding contradicts with several studies that found significant gender differences in mathematics achievement in favor of males (Arnup, Murrihy, Roodenburg, & McLean, 2013; Ayalon & Livneh, 2013; Karakolidis, Pitsia, & Emvalotis, 2016; Kyriakides & Antoniou, 2009; Randhawa & Gupta, 2000). Particularly, the present findings seem to be unique in the Ethiopian context as previous studies (Abraha, 2015; Eshetie, 2001; Negasi, 2009; Seleshi, 1995, 2001, 2005; Tilaye, 2004) concurrently found significant gender differences in mathematics achievement in favor of male students.

The findings have also shown that female and male students similarly perceived their mathematics teachers as affectively supported them; female students are more confident than males in mathematics. Besides, females also achieved in the subject similar with their male classmates, and this is a new feature that contradicts the traditional belief that 'mathematics is a masculine subject'. The findings are in line with Hyde's (2005) gender similarity hypothesis that "males and females are similar on most, but not all, psychological variables. That is, men and women, as well as boys and girls, are more alike than they are different" (p. 581). These findings could be indications of possible changes that came in students' belief system which indicates that females are equally confident and able in mathematics as their male classmates. The findings lead to the conclusions that female and male grade 9 students similarly perceived that their mathematics teachers had positive belief and close relationship with them, and that the mathematics teachers were concerned with their students' learning and achievement and they fairly treated students. Girls were more confident than boys to demonstrate their conceptual knowledge and problem solving skills on tasks included in their mathematics textbook. Regarding mathematics achievement, girls and boys achieved similarly on the mathematics achievement test although girls had better confidence in mathematics. These impressive findings are yet very open for exploration and favorable area of investigation for educators and researchers.

The findings can be practically used to realize successful high school mathematics teaching-learning which could in turn enhance success in mathematics and related fields in higher education. The findings of gender similarities in teacher affective support and mathematics achievement and narrow gender difference in mathematics self-efficacy are good opportunities for the education system. The findings can be used in designing the nature of classroom environment and teacher support that could equally benefit all students. The findings could also suggest designing similar ways of enhancing female and male students' mathematics self-efficacy which may thereby enhance all students' mathematics achievement. Theoretically, the findings are new insights that more or less support Hyde's (2005) gender similarity hypothesis and could possibly contribute to changing the traditional belief that mathematics is a male subject. Finally, most studies in the area are conducted in western and eastern cultural contexts, and hence the present study contributes to minimizing the gaps in research literature conducted in Sub-Saharan African or more specifically in the Ethiopian culture.

LIMITATIONS AND FUTURE DIRECTIONS

The study had some limitations which should be acknowledged and kept in mind when interpreting the findings. First, the study was based on data collected from grade 9 students' self-report perceptions. Including teachers as research participants would have the possibility to add more value to the study. Second, even though the questionnaire was translated into Tigrigna language which is the participants' mother tongue, the participants had reading skill deficiency even in their own native language. This could have affected the collected data using the questionnaire to some extent. Third, students' cheating in the mathematics achievement test which is very common in most tests might have affected the level of mathematics achievement to some extent.

Replication of this study on a wider study area could be very important. Future research should try to minimize or avoid the limitations identified in the present study. That is, future research should try to collect comprehensive data from students and teachers. In future studies, the reading skill deficiency of high school students can be solved by reading the questionnaire items by data collector to the participants, and the cheating problem on achievement tests can also be minimized by preparing totally or partially workout items.

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