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PROFESSIONAL DISPOSITIONS OF GRADUATE PRE-SERVICE MATHEMATICS TEACHERS AMONG THREE COLLEGE OF TEACHER EDUCATION IN ETHIOPIA

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Abstract. The general objective of this study was to examine the professional disposition (attitude and self-efficacy) of pre-service teachers hold at the end of teacher education programs in terms of gender and modality. To do this, we used a quantitative research approach. The source of data was 3rd-year mathematics pre-service teachers who have graduated in the 2018/19 academic year. The study used self-reported questionnaires. Thus, 536 (309 male and 227 female) third-year pre-service mathematics teachers from the three sampled institutions (Kotebe metropolitan university, Hawassa college of teacher education, and Arba Minch college of teacher education) and trained under three modalities (generalist, specialist, or linear) have participated. The result showed that the ongoing teacher education program helps them to have a strong attitude and self-efficacy towards mathematics and mathematics teaching without gender difference. However, variations were observed in attitudes and self-efficacy across modalities. In general, it can be concluded that the teacher education program helps pre-service mathematics teachers to develop a strong attitude and self-efficacy towards mathematics and teaching mathematics. Therefore, it is recommended that further qualitative and detailed analysis should be conducted in order to find which part of the education system or educational inputs help pre-service mathematics teachers in colleges of teacher education to develop positive attitude and self-efficacy towards mathematics and teaching mathematics and should be shared to other universities and colleges.

Keywords: attitude; self-efficacy; mathematics; teaching mathematics

Introduction

Teacher education is the procedure designed to equip pre-service teachers with the knowledge and professional disposition necessarily required to perform their tasks effectively in the classroom, schools, and wider community

in their future careers. This is to means that the field of mathematics teacher education is grounded on the assumption that someone has to be educated in mathematics to be able to teach it effectively in their future career. So, the major aim of teacher education must be to produce graduate school teachers who are confident and competent in mathematics. To realize this, colleges of teacher education should create adequate learning opportunities for pre-service teachers aiming to develop knowledge of mathematics, knowledge of students, and knowledge and ability to use and evaluate instructional materials and resources (NCTM 1989). In addition to these variables, in teacher education, it is necessary to have in mind the effect of college teacher education programs in terms of the development of professional dispositions. This includes their attitude and self-efficacy towards mathematics and its teaching (Korthagen & Kessels 1999).

This study focused on these two variables (attitude and self-efficacy towards mathematics and teaching mathematics) since are the major descriptors of the affective domain in mathematics education. For example, attitudes of the individual are directly related to liking mathematics, to mathematics anxiety, to getting pleasure from it, to valuing it, and being involved with mathematics (Duatepe & Çilesiz 1999). In other words, they pre-determine the performance of the pre-service teachers to the mathematics knowledge and the teaching skills they have after graduation.

Attitude towards Mathematics and Mathematics Teaching

In the general sense, the term is attitude is defined as an affective state of readiness or the inclination of individuals which is observed in a form where individuals accept or refuse a certain person, group, institution, or thought (Özgüven 1999). Particularly, in mathematics education, attitude can be considered as a tendency to engage in or avoid mathematical activities, a belief that one is good or bad in mathematics, and a belief that mathematics is useful or useless (Mullis, Martin, Foy & Arora 2012).

Attitude can consist of two components: attitudes towards mathematics and attitude towards teaching mathematics. Attitude towards mathematics includes liking, enjoyment, and interest in mathematics or on the contrary, maths phobia. There is also the teacher's confidence in his or her mathematical abilities: the teacher's mathematical self-concept and the teacher's valuing of mathematics. While attitude towards teaching mathematics is the teacher's attitudes to the teaching of mathematics. These include liking, enjoyment, and enthusiasm for teaching mathematics and confidence in the teacher's mathematics teaching ability or their opposites (Ernest 1989).

Positive attitudes facilitate learning and teaching and increase success; on the other hand, negative attitudes reduce success. Positive attitudes that pre-ser-

vice teachers develop towards mathematics and teaching mathematics during teacher preparation programs have an important role in creating a permanent change in students' behaviour. Many believe that in order to teach mathematics well, one needs to have a positive attitude toward the subject and its teaching. The stage at which pre-service teachers begin the task of improving these attitudes are in the teacher education institutions (Semerci & Semerci 2004). Thus, the teacher education program is become relevant when it can help the pre-service teachers to develop a positive attitude towards mathematics and teaching mathematics. Otherwise, it hinders their future professional career.

To conclude, the teacher preparation program should have an impact on the development of pre-service teacher's attitudes to mathematics and its teaching since both have a powerful impact on the atmosphere and ethos of the mathematics classroom. When pre-service teachers develop a positive attitude, the education program becomes relevant for them to develop knowledge and teaching skills necessarily required for their future teaching career.

Self-efficacy towards Mathematics and Mathematics Teaching

Self-efficacy is a teacher's belief in his or her ability to complete the steps required to accomplish a particular teaching task in a given context (Zimmerman 2000). Mathematics self-efficacy is one's conviction or confidence in their abilities to solve problems in mathematics whereas mathematics teaching self-efficacy is the belief or perception of an individual in their abilities to teach mathematics successfully (Kahle 2008).

Teachers' teaching self-efficacy has been found as an important ingredient for teachers to be effective and strongly influences their instructional effectiveness as well as students' sense of efficacious capabilities and outcomes (Tschannen-Moran & Hoy 2001). Teacher self-efficacy can be linked to numerous important teacher outcomes. Greater self-efficacy has been associated with teachers expressed professional commitment for both pre-services (Evans & Tribble 1986) and in-service teachers (Coladarci 1992). Again, teachers who have higher self-efficacy would once again choose teaching as a career if given the choice and more likely to stay in teaching once they have entered the field (Burley, Hall, Villeme & Brockmeier 1991). One of the routes that affect teacher's self-efficacy is the formal teacher education program in the college of teacher education (Zeichner & Gore 1990).

Therefore, it is during the pre-service years of teaching that self-efficacy is most malleable. So, it is important to provide basic opportunities and experiences to aid self-efficacy development during this period. Thus, in the case where students develop strong self-efficacy towards mathematics and its teaching, the education system becomes relevant for them to develop knowledge and teaching skills.

Statement of the problem

Teachers are major parts of teaching-learning activities. To be successful in these activities, the teacher's proficiency level should be high. Proficiency is the status of having professional knowledge, skill, and values to exhibit the professional disposition the profession requires. The teacher's values are necessary knowledge, skill, and disposition for performing the teaching profession effectively (Tepe & Demir 2012). However, the knowledge and skills of teachers do not matter in the teaching profession if the necessary disposition development (like attitude and self-efficacy) is not quite strong and it is unthinkable that these teachers can be successful in their job (Ilhan & Cicek 2017). Thus, to be successful in the teaching profession, teacher's attitudes and self-efficacy should be high and positive. If these are not strong, teachers can't show the required performance in the profession even if they want.

In Ethiopia, various studies unfold results like the weak performance of mathematics teachers on knowledge of mathematics teaching-learning methods and weak mathematical knowledge that are essential to implementing fruitful changes in the classroom learning culture (Birhanu 2010; Yohannes 2007). Particularly Fekede and Tynjala (2015) and Demeke (2014) revealed that the motivation of teachers in performing their tasks and work is highly affected. Many mathematics teachers are de-motivated and unsatisfied in performing their work properly and they are ready to leave the profession.

Even though the curriculum of the pre-service primary teacher education program reformed and restructured in 2013, studies at the national level by the Ethiopian Ministry of Education (MoE) and other studies indicated that the questions of quality education were continued in terms of development of attitude and self-efficacy, professional competency of teachers and professionalism in the teacher education program. Furthermore, MoE (2016) confirmed that the poor capacity of the teacher education institutions and their teacher training programs are unable to produce competent teachers and/or produce a low quality of graduates.

Thus, it is vital to conduct research to know the relevance of the ongoing teacher education program for the development of the required professional dispositions. It is one of the indicators of the extent of the quality of the program for producing proficient teachers.

Research questions

The general objective of this study was to examine the professional disposition (attitude and self-efficacy) pre-service teachers hold at the end of the teacher education programs in terms of gender and modality. Thus, this study tried to answer the following research questions:

– Do the pre-service teacher's attitude and self-efficacy towards mathematics and teaching mathematics show significant development in terms of gender and modality at the end of the program?

– What is the effect of modalities on the development of the pre-service mathematics teacher's attitude and self-efficacy towards mathematics and teaching mathematics?

Research Method and Design

This study was quantitative non-experimental research that examines the effect of Ethiopian pre-service teacher education program on the development of professional dispositions like attitude and self-efficacy. It was also a survey study. To examine this development of pre-service mathematics teachers, the study used a primary source of data for the collection of data. The surveyees were 3rd-year mathematics pre-service teachers who have graduated in the 2018/19 academic year. To collect these primary data, the study used self-reported questionnaires.

Sampling and Sampling technique

This study was conducted in three colleges of teacher education located in Addis Ababa city and Southern Nations, Nationalist and People's Region (SNNPR). These were: Kotebe Metropolitan University from Addis Ababa city (AA), Hawassa College of teacher education, and Arba Minch college of teacher education from SNNPR. It did not include Colleges of Teacher Education (CTEs) in other regions of the country since they used their local language as a medium of instruction fully or partially. Thus, the regions were selected purposively. This is because (1) English is served as a medium of instruction and (2) the same curricula materials are used. From SNNPR, Hawassa, Arba Minch, and Hossana CTEs were selected randomly and Kotebe metropolitan university was taken from Addis Ababa city as it is the only CTE that trains teachers in Addis Ababa. However, Hossana college of teacher education from SNNPR was used as a site for piloting the data gathering instruments.

In Ethiopia, three teacher training modalities were actively run-in colleges of teacher education. All CTEs have a generalist modality. However, depending on the situations and their demanding need, regions add either specialist or linear modality in their program.

In general, the population of this study was all third-year pre-service mathematics teachers in the sampled colleges of teacher education that have graduated in generalist modality (teaches grade 1 – 4), specialist modality (teaches grade 5 – 6), and linear modality (teaches grade 5 – 8) modality. This is because the graduate students are expected to know the program very well and already developed some knowledge and skills as a result of the teacher education program.

In these sampled CTEs, there are about 711 regular pre-service school mathematics trainee teachers that have graduated in the 2018/19 academic year. However, among these third-year pre-service teachers in all modalities, 536 (309 male and 227 female) pre-service mathematics teachers from the three institutions participated in the study.

Table 1. Number of graduate pre-service mathematics teachers in 2011 E.C (2018/19) in the three CTEs

CTEs	***Modality/program***	***Pre-service teachers***		
		Male	***Female***	***Total***
Kotebe	Generalist	20	9	29
	Specialist	63	71	134
	Linear	–	–	–
Hawassa	Generalist	117	96	213
	Specialist	–	-	-
	Linear	53	7	60
Arba Minch	Generalist	119	100	219
	Specialist	–	–	–
	Linear	39	17	56
Total		411	300	711

Source: Education Statistics Annual Abstract, Ministry of Education, 2017and CTE's registrar

Data Collection Instruments

First instruments were developed and/or adapted through a thorough review of the literature and then reviewed and edited by educational experts. Then, they were piloted and analysed. After the necessary modification, the last best items were administered for data collection.

In order to administer the finalized instruments, first appointments were arranged when and how the researchers met the participants just by making communication with their respective department heads. During the administration period, proper orientations were given to all participants like the purposes of the instruments and how they respond to each item. When the questionnaires were administered, no time limit was set so that students can do all items at their own pace.

For the positive sense questions a value 5=strongly agree, 4=agree, 3=undecided, 2=Disagree, 1=strongly disagree. For the negative sense questions,

the values were assigned in the opposite sense. That is, the scoring scale is reversed and reconsidered as 1=strongly agree, 2= Agree, 3=undecided, 4=Disagree, 5=Strongly disagree. Then One-Way ANOVA procedure was carried out to analyse the difference of pre-service teachers' attitudes and self-efficacy towards mathematics and teaching mathematics in terms of their gender and program type.

Self-reported Questionnaires: These self-reported questionnaires were developed to determine pre-service teacher's attitudes and self-efficacy to mathematics and mathematics teaching.

To measure the attitude towards mathematics and mathematics teaching, the attitude scale which was developed by the Fennema-Sherman (Fennema & Sherman, 1976), and the parallel scales for attitude towards teaching mathematics were used with some modification. The instrument of attitude scale was a composite of six sub-categories: usefulness (value), enjoyment, motivation, anxiety, and success and recognition in mathematics teaching.

The items in the questionnaires asked pre-service mathematics teachers to indicate their degree of agreement with each statement in the Likert scale, from strongly disagree to strongly agree for attitude towards mathematics and teaching mathematics. For the positive sense questions, a value of 5 was assigned to "strongly agree", decreasing values of 4, 3, 2, 1 was given to the other scale, where "strongly disagree was assigned the value 1. For the negative sense questions, the values were assigned in the opposite sense.

Similarly, to assess primary school pre-service teacher's self-efficacy towards mathematics, items were directly adapted from Han, Liou-Mark, Yu, and Zeng, (2015), with little modification. The instrument was again based on a 5-point scale with 1 indicating strongly disagree and 5 indicating strongly agree. Likewise, to measure the Mathematics Teaching Self-Efficacy (MTSE) of pre-service teachers, a Likert scale was prepared which was adapted from the study conducted by Kahle, (2008) and Gavora, (2010). The MTSE questionnaire is based on a 5- point scale. Similarly, the respondents were asked to indicate their level of confidence from 'strongly disagree' to 'strongly agree'.

Piloting the Instruments

To check the reliability and to discover the difficulties in understanding the words and elimination of ambiguities, piloting was done before using the original version for final administration. The original version of the questionnaires comprised of 24 items to assess attitudes toward mathematics, 32 items to measure attitude towards teaching mathematics, 16 items of self-efficacy towards mathematics, 22 items for self-efficacy towards teaching mathematics. Some of the items in the questionnaires were prepared pairwise; a posi-

tive and negative sense. Then they were piloted at Hosanna college of teacher education with a sample of 61 pre-service mathematics teachers. Then these were analysed to see the value of Cronbach alpha.

Table 2. Summary of the alpha value of the initial data under each variable and number of items before and after deletion

Variables	***Number of items initially***	***Initial Alpha value***	***Number of items after deletion***	***Alpha value after deletion***
Attitude towards Mathematics	24	0.606	15	0.711
Attitude towards teaching mathematics	32	0.549	18	0.807
Self-efficacy towards mathematics	16	0.592	10	0.885
Self-efficacy towards teaching mathematics	20	0.632	12	0.859

Initially, there was an unacceptable value of alpha for all variables. Thus, without compromising the content validity of the instruments, listwise an item deletion process was performed to increase the value of alpha. When an item was deleted either its positive sense or negative sense remained in the instrument. Consequently, as displayed in the table-2, 15 items (10 positive and 5 negative items) for attitude towards mathematics, 18 items for teaching mathematics attitude (8 positive and 10 negative), 10 items (4 positive and 6 negative items) for mathematics self-efficacy, and 12 items (5 positive and 7 negative items) for teaching mathematics self-efficacy were chosen that made the instrument to more manageable without compromising its validity. In addition, their alpha values reached a value of 0.711 for mathematics attitude and 0.807 for teaching mathematics attitude, 0.885 for self-efficacy towards mathematics, 0.859 for self-efficacy towards teaching mathematics, which is good for the reliability of a questionnaire (Field, 2009).

These good reliability coefficients infer that the instruments have high internal consistency reliability that can be administered. In addition, the instruments were also checked for language uses and their readability by the researcher himself and other colleagues in the department of science and mathematics education. The tools were finally administered to a total of 536 pre-service mathematics teachers, of which 309 were males and 227 were females. Again, of these, 351 were generalist, 95 were specialist, and 90 were linear.

Result and Discussion

This part answered the research question to what extent the pre-service mathematics teachers develop attitude and self-efficacy towards mathematic and teaching mathematics as a result of teacher education programs. It presents the effect of a teacher education program on the professional disposition of pre-service teachers and how was their disposition being varied across the three modalities and gender. It includes attitude and self-efficacy towards the subject (mathematics) and towards teaching the subject (teaching mathematics). These are important variables and considered to have a very crucial effect and predictor on the performance of their future career (Farooq & Shah, 2008; Majeed, Darmawan & Lynch, 2013).

In this respect, descriptive statistics have been calculated to see the mean variation on attitudes and self-efficacy development of pre-service teachers.

Attitude

Based on the respondent's score for attitude towards mathematics and teaching mathematics in the three modalities, the following table presents the descriptive statistics analysis of the data.

Table 3. Means and standard deviations of mathematics and mathematics teaching attitude of pre-service mathematics teachers

Variables	*N*	*Minimum*	*Maximum*	*Mean*	*SD*	*Skewness*
Generalist						
Attitude towards mathematics	351	1.00	5.00	3.84	0.65	-0.370
Attitude towards teaching mathematics	351	1.00	5.00	3.49	0.56	-0.206
Specialist						
Attitude towards mathematics	95	1.73	5.00	4.23	0.52	-1.498
Attitude towards teaching mathematics	95	2.28	5.00	3.89	0.69	-1.206
Linear						
Attitude towards mathematics	90	1.67	4.60	3.87	0.55	-1.806
Attitude towards teaching mathematics	90	2.61	4.94	3.91	0.63	-1.22

Table-3 reveals the mean score for attitude towards the mathematics of the pre-service teachers who trained in generalist modality to be 3.84 out of a to-

tal score of 5. Whereas their mean score for attitude towards teaching mathematics to be 3.69. Similarly, the mean score of attitudes towards mathematics and teaching mathematics found being 4.23 and 3.89 for specialists and 3.87 and 3.91 for linear modality respectively.

Based on the descriptive analysis, it can be concluded that the pre-service teachers' attitude towards mathematics, towards teaching mathematics, is moderately positive in all of the programs. This result showed that there were no significant differences in subject streams or programs. The table-3 also showed that in all the cases, the skewness of the variables was in the range of -2 and 2. Thus the variables are at least approximately normal.

Table 4. Test of Homogeneity of Variances of and data independence of attitude in the three modalities across gender

Variables	*Mean score*		*Levene's Test for Equality of Variances*		*Test of independence using Fisher exact test*	
	Male	*Female*	*F*	*Sig.*	*Value*	*p*
Generalist						
Attitude towards Mathematics	3.699	3.93	0.018	0.895	4.342	0.360
Attitude to Mathematics teaching	3.45	3.52	4.003	0.046	4.514	0.324
Specialist						
Attitude towards Mathematics	4.32	4.14	9.745	0.002	5.501	0.055
Attitude to mathematics teaching	3.87	3.99	.053	0.819	4.650	0.063
Linear						
Attitude towards Mathematics	3.86	3.91	2.792	0.098	1.086	0.896
Attitude to Mathematics teaching	3.88	3.95	1.024	0.314	3.434	0.169

The table-4 above and the t-test result showed that the assumption of equal variances (first line of t-test results) holds for attitude towards mathematics scale in generalist ($p = 0.895$), and for linear ($p = 0.098$). However, attitude towards mathematics in the case of specialists ($p < 0.05$) did not meet the assumption of equal variances. Similarly, the assumption of equal variances holds for attitude towards teaching mathematics scale in specialist ($p = 0.819$) and linear ($p = 0.314$) except generalist ($p < 0.05$).

Based on the output in table-28 the value of Levene statistics was lower showing that a higher degree of homogeneity. Also, to check data independ-

ence, Fisher's Exact test was applied so that the result indicated that there is at the 5% significance level, Fisher's exact test finds no evidence of an association between male and female attitude in all of the modalities.

In the case where the Levene test for homogeneity is violated, the equivalent non-parametric test analysis like the Mann Whitney U test can be used. In addition, various literature suggested that if the sample sizes are quite different, then take the ratio of the standard deviations in the two groups and round it to the nearest whole number. If this rounded number is 1, don't worry about the lack of homogeneity of variance. Based on this assumption, the sample size is different and the ratio of their standard deviation for attitude scale for specialist students was 0.6 and the nearest whole number is one. Similarly, since the sample size of the two groups is different for generalist attitude towards teaching mathematics and the ratio of their standard deviation was 0.9 and its nearest whole number is 1. The following table presents the homogeneity of generalist attitude towards teaching mathematics and specialist attitude towards mathematics.

Table 5. Mann-Whitney U test for homogeneity of generalist attitude towards teaching mathematics and specialist attitude towards mathematics

Variables	***Sex***	***N***	***Mean Rank***	***Sum of Ranks***	***Mann-Whitney U***	***Asymp.Sig. (2-tailed)***
Generalist attitude towards teaching mathematics (N=351)	Male	193	173.6477	33514	14793.0000	0.631
	Female	158	178.8734	28262		
Specialist attitude towards Mathematics (N=95)	Male	48	50.86	2441.50	990.500	0.305
	Female	47	45.07	2118.50		

Table-5 above provides the Mann-Whitney U, and the Sig. (significance) level or p. The mean ranks of the genders did not differ significantly on generalist attitude towards teaching mathematics ($p = .631$) and specialist attitude towards mathematics ($p = .305$). In general, from table-4 and table-5 the date satisfied the assumption of homogeneity.

Table 6. Results of independent group t-test performed to determine whether attitude towards mathematics and teaching mathematics scores differ or not in terms of gender

Variable	*Gender*	*N*	*Mean*	*SD*	*T*	*df*	*p*
Overall							
Attitude towards mathematics	Male	309	3.9388	0.6658	-0.417	534	0.677
	Female	227	3.9626	0.63784			
Attitude towards teaching mathematics	Male	309	3.8258	0.64849	-1.593	534	0.112
	Female	227	3.9134	0.60097			
Generalist							
Attitude towards mathematics	Male	193	3.699	0.63	-0.609	349	0.031
	Female	158	3.93	0.67			
Attitude towards teaching mathematics	Male	193	3.45	0.54	-0.917	349	0.360
	Female	158	3.52	0.597			
Specialist							
Attitude towards mathematics	Male	48	4.32	0.38	1.677	93	0.097
	Female	47	4.14	0.63			
Attitude towards teaching mathematics	Male	48	3.87	0.71	-2.186	93	0.543
	Female	47	3.99	0.65			
Linear							
Attitude towards mathematics	Male	68	3.86	0.61	-0.347	88	0.730
	Female	22	3.91	0.35			
Attitude towards teaching mathematics	Male	68	3.88	0.68	1.699	88	0.093
	Female	22	3.95	0.57			

In case of generalist modality, the findings $t\ (349) = -0.609$, $p < 0.05$, indicated that there was a significant difference in attitudinal development of pre-service mathematics teachers towards mathematics between male ($M = 3.699$, $SD = 0.63$) and female ($M = 3.93$, $SD = 0.67$). Furtherly, the finding table-6 above showed that there was no significant difference between males and females in attitude towards mathematics in specialist ($t\ (93) = 1.677$, $p = 0.097$) and in linear ($t\ (88) = -0.347$, $p = 0.730$) program. The overall result shows also that there is no significant difference between males and females in attitude towards mathematics ($p = 0.677$) and teaching mathematics ($p = 0.112$).

Therefore, in general speaking, the attitude of pre-service mathematics teachers at the end of the program was not associated with gender. In addi-

tion, females compared to males were found to display a consistently more positive attitude.

Similarly, as regard attitude towards teaching mathematics development, the findings in table-6 (*t (349) = -0.917*, *p = 0.360*), indicated that, there was no a significant difference between male (*M = 3.45, SD = 0.54*) and female (*M = 3.52, SD = 0.597*) in generalist program. The same results were also shown for attitude towards mathematics teaching in specialists (*t (93) =-2.186, p = 0.543*) and linear (*t (88) =1.699, p = 0.93*) program. Thus, there is no significant difference in attitude towards teaching mathematics in generalists, specialists, and linear by gender. Again, females compared to males were found to display a consistently more positive attitude towards teaching mathematics.

Table 7. Comparison of attitude towards mathematics and its teaching across modalities

Variables	*Modality*	*Mean*	*SD*	*Mean square*	*F*	*P*	*eta square*
Attitude towards mathematics	Generalist (N=351)	3.84	0.65	4.497	10.916	0.000	0.04
	Specialist(N=95)	4.23	0.52				
	Linear (N=90)	3.87	0.55				
Attitude towards mathematics teaching	Generalist (N=351)	3.49	0.56	1.755	4.484	0.012	0.02
	Specialist(N=95)	3.89	0.69				
	Linear (N=90)	3.91	0.63				

We can see that from table-7 the significance value is less than 0.05 for both variables and therefore, there is a statistically significant mean difference in the development of attitude towards mathematics and teaching mathematics scale among the three modalities. Moreover, specialists (*M=4.227*) and linear (*M=3.87*) students have developed a relatively higher attitude towards mathematics than generalist (*M=3.815*) pre-service teachers. The same result also was reported across the three modalities developed an attitude towards teaching mathematics.

Moreover, Eta-squared is commonly used in ANOVA and t-test designs as an index of the proportion of variance attributed to one or more effects. Eta-squared quantities the percentage of variance in the dependent variable (Y) that is explained by one or more independent variables (X). It is also the measure of effect size. In this case, the dependent was the attitude scale and the independent were the two modalities. According to Cohen (1988), 0.01 is a small effect, 0.05 is a medium effect and 0.14 is a large effect. It is calcu-

lated as the sum of squares between groups divided by the totals sum of the square. Finally, the results in a table-7 presented that the eta square of attitude towards mathematics and teaching mathematics of pre-service mathematics teachers due to modalities were 0.04 (3.9%) and 0.02 (2%). According to Cohen (1988), these values showed that effect size was medium.

Self-efficacy

To answer the research question related to self-efficacy, the participants were administered a questionnaire on the mathematics self-efficacy scale, and their responses were analysed using descriptive statistics. The results of the analysis are presented in the following tables.

From table-8 below, it can be seen that the mean responses of individual items are all above the value 3.0. This indicates that the majority of the participants have a high level of confidence towards mathematics and teaching mathematics on each item under the three modalities.

Table 8. Means and standard deviations of mathematics self-efficacy of pre-service mathematics teachers under three modalities

Variables	*N*	*Minimum*	*Maximum*	*Mean*	*SD*	*Skewness*
Generalist						
Self-efficacy towards mathematics	351	1.2	5.00	3.96	0.67	-1.245
Self-efficacy towards teaching mathematics	351	1.00	5.00	3.59	0.73	-0.084
Specialist						
Self-efficacy towards mathematics	95	1.3	5.00	3.99	0.63	-1.253
Self-efficacy towards teaching mathematics	95	1.00	5.00	3.82	0.79	-1.150
Linear						
Self-efficacy towards mathematics	90	2.3	5.00	4.22	0.52	-1.13
Self-efficacy towards teaching mathematics	90	2.25	5.00	3.93	0.67	-1.22

Table-8 shows that the mean score of the pre-service mathematics teachers in self-efficacy towards mathematics and teaching mathematics 3.96 and 3.59 for generalist respectively; 3.99 and 3.82 for specialist respectively and 4.22 and 3.93 for linear respectively. Based on this descriptive analysis, it can be

concluded that the pre-service teachers' self-efficacy towards mathematics and teaching mathematics is highly positive in all of the three modalities.

Table 9. Test of Homogeneity of Variances and data independence of attitude in the three modalities across gender

Modality	***Variables***			***Levene's Test for Equality of Variances***		***Test of independence using Fisher's exact Test***	
		Male	Female	***F***	***Sig.***	***Values***	***p***
Generalist	Self-efficacy towards Mathematics	3.94	3.98	2.872	0.091	1.659	0.819
	Self-efficacy to Mathematics teaching	3.61	3.56	0.033	0.855	3.848	0.419
Specialist	Self-efficacy towards Mathematics	3.97	4.00	0.471	0.494	2.347	0.856
	Self-efficacy to Mathematics teaching	3.89	3.76	0.263	0.609	2.579	0.712
Linear	Self-efficacy towards Maths	4.27	4.09	0.065	0.799	2.263	0.559
	Self-efficacy to Mathematics teaching	3.90	3.96	0.921	0.340	0.898	0.847

The homogeneity table-9 above shows that the assumption of equal variances (first line of t-test results) holds for self-efficacy towards mathematics and teaching mathematics in all of the modalities, i.e., generalist ($p = 0.091$ and $p = 0.855$), for specialist ($p = 0.494$ and $p = 0.609$) and for linear ($p = 0.799$ and $p = 0.340$). In addition, based on the output in table-9, the value of Levene statistics was lower showing that a higher degree of homogeneity. Furthermore, Fisher's Exact test result shows that at the 5% significance level, no evidence of an association was found between male and female attitudes ($p>0.05$). Thus, the collected data were assumed to independent in terms of gender.

Table 10. Results of independent group t-test performed to determine whether attitude towards mathematics and teaching mathematics scores differ or not in terms of gender

Variable	***Gender***	***N***	***Mean***	***SD***	***t***	***df***	***p***
Overall							
Self-efficacy towards mathematics	Male	309	4.02	0.66	0.45	534	0.653
	Female	227	3.99	0.62			
Self-efficacy towards teaching mathematics	Male	309	3.89	0.72	1.259	534	0.209
	Female	227	3.81	0.71			

Generalist							
Self-efficacy towards mathematics	Male	193	3.94	0.70	-0.497	349	0.620
	Female	158	3.98	0.62			
Self-efficacy towards teaching mathematics	Male	193	3.61	0.75	-0.912	349	0.362
	Female	158	3.56	0.68			
Specialist							
Self-efficacy towards mathematics	Male	48	3.97	0.58	-0.208	93	0.836
	Female	47	4.00	0.69			
Self-efficacy towards teaching mathematics	Male	48	3.89	0.75	0.781	93	0.437
	Female	47	3.76	0.83			
Linear							
Self-efficacy towards mathematics	Male	68	4.27	0.53	1.406	88	0.163
	Female	22	4.09	0.48			
Self-efficacy towards teaching mathematics	Male	68	3.90	0.68	0.271	88	0.787
	Female	22	3.96	0.67			

The findings in table-10 above indicated that there was no significant difference in self-efficacy of pre-service mathematics teachers towards mathematics and teaching mathematics between males and females in the three modalities.

Therefore, the hypothesis that there is no significant difference in self-efficacy towards mathematics and teaching mathematics by gender is accepted.

Table 11. Comparison of self-efficacy towards mathematics and its teaching across modalities

Variables	***Modality***	***Mean***	***SD***	***Mean square***	***F***	***p***	***Eta²***
Self-efficacy towards mathematics	Generalist	3.959	0.665	2.509	6.167	0.002	0.03
	Specialist	3.986	0.632				
	Linear	4.222	0.524				
Self-efficacy towards teaching mathematics	Generalist	3.594	0.727	4.031	8.149	0.000	0.03
	Specialist	3.823	0.788				
	Linear	3.927	0.673				

One-way between-groups analysis of variance was conducted to explore the impact of modalities on the development of self-efficacy towards mathematics and teaching mathematics as indicated in table-11. There was a statistically significant difference at the $p < .05$ level in self-efficacy towards mathematics and teaching mathematics for three modalities groups ($F (2,536) = 6.16, p < 0.05$) and $F (2, 536) = 8.149, p < 0.05$) respectively. Despite this statistical significance, the actual difference in mean scores between groups was quite small. The effect size, calculated using eta squared, was .03. Therefore, results in table-11 showed that the eta square of self-efficacy towards mathematics and teaching mathematics of pre-service mathematics teachers due to modalities were 0.03 and 0.03. According to Cohen (1988), these values showed that effect size was medium.

Discussion

It is thought that attitudes towards mathematics have a long background for mathematics education than other educational fields. In addition, students' success in mathematics highly depends upon the attitude they have towards mathematics. So, it plays a crucial role in the teaching and learning processes of mathematics. For example, students who have shown a positive attitude towards the subject tend to perform well (Alpacion, Camanan, Gregorio, Panlaan, & Tudy, 2014). In the last two decayed, researchers indicated that pre-service teachers with positive attitudes towards mathematics would be more successful than individuals with a negative attitude (Memnun & Akkaya, 2012). There is also a strong belief among pre-service teacher educators that positive attitudes need to be fostered for prospective primary school teachers (Relich, Way & Martin 1994).

In this study, the majority of pre-service mathematics teachers have shown a positive attitude towards mathematics and teaching mathematics at the end of the teacher education program which is similar to the conclusion of the findings of the study conducted by Relich, Way, and Martin in 1994. In addition, Hill and Bilgin, (2018) indicated that in their final year pre-service teachers had a somewhat positive attitude toward mathematics. This result also strengthens the findings of Relich, Way, and Martin (1994) and it revealed that the pre-service teachers' attitude towards teaching mathematics improved as they progressed through the programs. Many other studies also presented the same conclusions about the attitude of pre-service mathematics teachers towards mathematics and teaching mathematics (Awofala 2016; Tabuk 2018).

In this study also, no gender difference was not observed in attitude towards mathematics and teaching mathematics. Again, this result is aligned with the findings of other previous authors like Karjanto, (2017), Mata, Mon-

teiro, and Peixoto, (2012), Awofala, (2016) and Tabuk, (2018). They found that there were no statistically significant results between males and females in attitudes toward mathematics and teaching mathematics.

The second variable is self-efficacy, teacher's self-efficacy is the confidence the teacher has in his/her capability to perform tasks in mathematics. It goes beyond just having professional knowledge and skills. Thus, having a high level of self-efficacy about one's ability is important as it motivates one to succeed in life. In this regard, Gavora (2010) pointed out that the teacher's high self-efficacy enables him/her to use his professional knowledge and skills successfully. In other words, low mathematics self-efficacy may inhibit the use of professional knowledge and skills and which may affect students' learning negatively. Researchers also found that at the end of teacher education, pre-service teachers were improved and had above-average levels in both Mathematics Self-efficacy and Mathematics Teaching Self-efficacy (Charalambous & Philippou, 2003; Gavora, 2010; Zuya, Kwalat & Attah, 2016; Giles, Byrd & Bendolph, 2016; Unlu & Ertekin, 2013) which supported the findings of this study.

Moreover, one of the possible factors shaping self-efficacy towards mathematics and teaching mathematics is gender (Han, Liou-Mark, Yu & Zeng 2015). In this regard, so far conflicting findings were released in the last one decay, some study findings do not show any significant variation between male and female self-efficacy at the end of the teacher education program (Uzuntiryaki & Aydin, 2008; Al-Alwan, & Mahasneh 2014) while others conclude that self-efficacy has a significant association with gender (Dursun 2010). As many of the findings, in this study, no significant difference was not detected in the self-efficacy of pre-service mathematics teachers towards mathematics and teaching mathematics between males and females regardless of the study program.

Various researches also were conducted showing the relationship between mathematics knowledge, attitude, and self-efficacy. Some studies showed a strong association between teacher's mathematical knowledge, attitude, and self-efficacy towards mathematics and teaching mathematics. For example, Swackhamer, Koellner, Basile, and Kimbrough, (2009) found that the number of mathematics courses taken by teachers as part of a professional development project was positively associated with the teachers' self-efficacy. Morrell and Carroll, (2003) investigated the contributions of the different types of coursework to the development of pre-service teachers' self-efficacy. They found statistically significant increases in teaching efficacy for all methods courses. Similarly, Gencturk, (2015) indicated that the gains in teachers' mathematical knowledge predicted changes in the quality of their lesson design, mathematical agenda, and classroom climate. Teachers' attitudes were

related to the quality of their lesson design, mathematical agenda, and the quality of the tasks chosen. In general, Wilkins and Ma, (2003) said that:

"*A person's mathematical disposition related to her or his beliefs about and attitude towards mathematics may be as important as content knowledge for making informed decisions in terms of willingness to use this knowledge in everyday life. (p. 52)"*

In summary, as Stipek, Givvin, Salmon and MacGyvers, (2001) explained, teacher confidence is important not only potential to replicate positive or negative affect in students but also because teacher confidence has been linked to the quality of pedagogy.

Conclusion

The findings show that the ongoing teacher education program helps pre-service mathematics teachers to have a strong attitude towards mathematics and teaching. It also indicates that the program influences majority of males and females to develop a strong attitude towards mathematics and teaching mathematics without gender difference especially in specialist and linear programs. However, variations were observed in the development of these attitudes across modalities. Specialist and linear programs made the pre-service mathematics teachers have a stronger attitude than generalist pre-service mathematics teachers at the end of the program.

Again, the result of pre-service mathematics teacher's scores on self-efficacy towards mathematics and teaching mathematics indicate that they have strong self-efficacy at the end of the program in all of the three modalities without gender difference. It shows that the teacher education program has a positive impact on the development of their confidence in mathematics and teaching mathematics. However, there is variation in the mean score of self-efficacy development of pre-service mathematics teachers across the three modalities.

Thus, from the findings of this study, it can be concluded that the teacher education program in Ethiopia helped pre-service mathematics teachers to have a positive attitude and self-efficacy at the end of 3rd year.

Overall, the above results of attitude and self-efficacy would answer the research questions designed in the study. That is: "Does the pre-service teacher's attitude and self-efficacy towards mathematics and teaching mathematics show significant development in terms of gender and modality?".

Recommendation

Pre-service mathematics showed either agree or strongly agree in attitude and self-efficacy in the three modalities regardless of program type and gender. Therefore firstly, nationwide research should be conducted qualitatively to iden-

tify which part of a teacher education program or factors that have a high impact on the development of pre-service mathematics teacher's positive or negative attitude and self-efficacy so that colleges of teacher education will share the good practices which help them to develop student's positive behavior.

Limitation

The respondents of this study were pre-service mathematics teachers in the three sampled CTEs. Thus 536 participated in the study out of 711. The population was considered to be 536. Hence the sample does not enable to make generalizations but it may show some trends to be studied in a larger sample in the future.

In general, this study is a snapshot with limited data and participation in the three sampled colleges. Therefore, conducting further detailed (explore with further qualitative) studies with similar samples in Ethiopia would provide more explicit findings for pre-service mathematics teacher's professional disposition development.

REFERENCES

Al-Alwan, A. F., & Mahasneh, A. M., 2014. Teachers' self-efficacy as determinant of students' attitudes toward school: A study at the school level. *Review of European Studies,* **6**(1), 171 – 179. http://dx.doi.org/10.5539/res.v6n1p171

Alpacion, N., Camañan, C. T., Gregorio, A., Panlaan, J., & Tudy, R., 2014. Attitude, self-efficacy and students' academic performance in Mathematics. *IAMURE International Journal of Social Sciences.* https://doi. org/10.7718/ijss. v12i1, 920.

Awofala, A. O., 2016. Effect of personalization of instruction on students' motivation to learn mathematics word problems in Nigeria. *Turkish Journal of Computer and Mathematics Education,* **7**(3), 486. https://doi.org/10.16949/turkbilmat.267339

Birhanu, M, A., 2010. *Active learning approaches in mathematics education at universities in Oromia, Ethiopia.* Ph.D. dissertation.

Burley, W. W., Hall, B., Villeme, M., & Brockmeier, L., 1991. A path analysis of the mediating role of efficacy in first-year teachers' experiences, reactions, and plans. *Paper presented at the annual meeting of the American Educational Research Association, Chicago*.

Charalambous, C. & Philippou, G., 2003. Enhancing Preservice teachers' efficacy Beliefs in Mathematics. In: *Proceedings of the 3rd congress of the European Society for Research in Mathematics Education.* Bellaria: ERME.

Coladarci, T., 1992. Teachers' sense of efficacy and commitment to teaching. *The Journal of experimental education,* **60**(4), 323 – 337. Available on: http://www.jstor.org/stable/20152340

Danielson, C., 2007. *Enhancing professional practice: A framework for teaching (2nd. ed.)*. Alexandria, VA: Association for Supervision & Curriculum Development.

Darling-Hammond, L., 1996. What matters most: A competent teacher for every child. *Phi Delta Kappan,* **78**(3), 193.

Darling-Hammond, L., 2006. Constructing 21st-century teacher education. *Journal of teacher education,* **57**(3), 300 – 314. https://doi.org/10.1177/0022487105285962

Demeke, A., 2014. *Factors Affecting Teachers" Work Motivation in Kirkos Sub-City Governmental Primary Schools in Addis Ababa City Government*. Master Thesis in AAU [Unpublished]

Duatepe, A. & Cilesiz, S., 1999. *Developing mathematics attitude scale*. Hacettepe Universitesi Egitim Fakultesi Dergisi, 16-17; 45 – 52.

Dursun, Ö., 2010. *The relationships among preservice teachers' spatial visualization ability, geometry self-efficacy, and spatial anxiety.* Doctoral dissertation for Middle East Technical University, Ankara, Turkey [unpublished].

Ernest, P., 1989. The knowledge, beliefs, and attitudes of the mathematics teacher: A model. *Journal of education for teaching,* **15**(1), 13 – 33.

Evans, E. D., & Tribble, M., 1986. Perceived teaching problems, self-efficacy, and commitment to teaching among preservice teachers. *The Journal of Educational Research,* **80**(2), 81-85. https://doi.org/10.1080/00220671.1986.10885728

Farooq, M. S., & Shah, S. Z. U., 2008. Students' attitude towards Mathematics. *Pakistan Economic and Social Review*, 75 – 83. https://files.eric.ed.gov/fulltext/ED506772.pdf

Fennema, E., & Sherman, J. A., 1976. Fennema-Sherman mathematics attitudes scales: Instruments designed to measure attitudes toward the learning of mathematics by females and males. *Journal for Research in Mathematics Education,* **7**(5), 324 – 326. http://www.jstor.org/stable/748467

Fekede, G, & Tynjälä, P., 2015. Exploring teachers' motivation for teaching and professional development in Ethiopia: voices from the field. *Journal of Studies of Education,* **5**(2). https://doi.org/10.5296/jse.v5i2.7459

Field, A., 2009. *Discovering statistics using SPSS:(and sex and drugs and rock'n'roll)*. London: Sage.

Gavora, P., 2010. Slovak pre-service teacher self-efficacy: Theoretical and research considerations. *The New Educational Review,* **21**(2), 17 – 30.

Gencturk, Y. C., 2012. *Teachers' mathematical knowledge for teaching, instructional practices, and student outcomes*. Champaign, US: The University of Illinois at Urbana-Champaign.

Giles, R. M., Byrd, K. O. & Bendolph, A., 2016. An investigation of elementary preservice teachers' self-efficacy for teaching mathematics. *Cogent Education,* **3**(1), 1160523. https://doi.org/10.1080/2331186X.2016.1160523

Han, S., Liou-Mark, J., Yu, K., & Zeng, S., 2015. Self-efficacy and attitudes towards the mathematics of undergraduates: A US and Taiwan comparison. *Journal of Mathematics Education,* **8**(1), 1 – 15. https://www.educationforatoz.com/images/Han_Spring_2015_.pdf

Hill, D., & Bilgin, A. A., 2018. Pre-Service Primary Teachers' Attitudes towards Mathematics in an Australian University. *Creative Education,* **9**(04), 597. https://doi.org/10.4236/ce.2018.94042

Ilhan, N., & Çiçek, Ö, 2017. The Development of Acid-Base Self-Efficacy Perception Scale and the Investigation of Pre-Service Science Teachers' Self-Efficacy Perceptions on Acid-Base. *Sakarya University Journal of Education,* **7**(1), 123 – 141. https:// doi.org/10.19126/suje.307068

Kahle, D. K., 2008. *How elementary school teacher's mathematical self-efficacy and mathematics teaching self-efficacy relate to conceptually and procedurally oriented teaching practices.* The Ohio State University.

Karjanto, N., 2017. Attitude toward mathematics among the students at Nazarbayev University Foundation Year Programme. *International Journal of Mathematical Education in Science and Technology,* **48**(6), 849-863. http://doi.org/10.1080/0020739X.2017.1285060

Korthagen, F. A., & Kessels, J. P., 1999. Linking theory and practice: Changing the pedagogy of teacher education. *Educational researcher,* **28**(4), 4 – 17. http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.129.8140&rep=rep1&type=pdf

Ma, L., 1999. *Knowing and teaching elementary mathematics: Teachers' understanding of fundamental mathematics in China and the United States*. Mahwah, NJ: Lawrence Erlbaum Associates, Inc.

Majeed, A. A., Darmawan, I. G. N., & Lynch, P., 2013. *A confirmatory factor analysis of attitudes toward mathematics inventory* (ATMI).

Mata, M. d. L., Monteiro, V. & Peixoto, F., 2012. Attitudes towards mathematics: Effects of individual, motivational, and so-

cial support factors. *Child development research*. https://doi.org/10.1155/2012/876028

Memnun, D. S., & Akkaya, R., 2012. Preservice teachers' attitudes towards mathematics in Turkey. *International Journal of Humanities and Social Science,* **2**(9), 90-99. https://www.ijhssnet.com

Ministry of education, 2016. *Evaluating Teacher Training Practices in Ethiopia Across Modalities: Focus on Primary and Pre-primary Future Program*. Addis Ababa.

Morrell, P. D., & Carroll, J. B., 2003. An extended examination of preservice elementary teacher's science teaching self-efficacy. *School Science and Mathematics,* **103**(5), 246 – 251.

Mullis, I. V., Martin, M. O., Foy, P., & Arora, A., 2012. *TIMSS 2011 international results in mathematics*: ERIC.

National Council of Teachers of Mathematics, 1989. *Curriculum and evaluation standards for school mathematics*. Reston, VA: Author

Özgüven, İ. E., 1999. *Psikolojik testler*: PDREM yayınları.

Relich, J., Way, J., & Martin, A., 1994. Attitudes to teaching mathematics: Further development of a measurement instrument. *Mathematics Education Research Journal,* **6**(1), 56-69. http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.588.3966&rep=rep1&type=pdf

Semerci, N., & Semerci, Ç., 2004. Türkiye'de öğretmenlik tutumları. *Fırat Üniversitesi Sosyal Bilimler Dergisi,* **14**(1), 137 – 146.

Stipek, D. J., Givvin, K. B., Salmon, J. M. & MacGyvers, V. L., 2001. Teachers' beliefs and practices related to mathematics instruction. *Teaching and teacher education,* **17**(2), 213 – 226.

Swackhamer, L. E., Koellner, K., Basile, C. & Kimbrough, D., 2009. Increasing the self-efficacy of in-service teachers through content knowledge. *Teacher Education Quarterly,* **36**(2), 63 – 78.

Tabuk, M., 2018. Prospective Primary School Teachers' Attitudes towards Teaching Mathematics. *Journal of Education and Learning,* **7**(4), 225 – 229. https://doi.org/10.5539/jel.v7n4p225

Tepe, D., & Demir, K., 2012. Okul öncesi öğretmenlerinin öz-yeterlik inançları ölçeği. *Abant İzzet Baysal Üniversitesi Eğitim Fakültesi Dergisi*. https://toad.halileksi.net/sites/default/files/pdf/okul-oncesi-ogretmenlerinin-oz-yeterlik-inanclari-olcegi-toad.pdf

Tschannen-Moran, M., & Hoy, A. W., 2001. Teacher efficacy: Capturing an elusive construct. *Teaching and teacher education,* **17**(7), 783 – 805. https://wps.ablongman.com/wps/media/objects/2347/2404137/Megan_Anita.pdf

Unlu, M., & Ertekin, E., 2013. The relationship between mathematics teaching self-efficacy and mathematics self-efficacy. *Procedia-Social and Behavioral Sciences,* **106**, 3041 – 3045.

Uzuntiryaki, E., & Aydın, Y. Ç., 2008. Development and validation of chemistry self-efficacy scale for college students. *Research in Science Education,* **39**(4), 539-551. https://doi.org/10.1007/s11165-008-9093-x

Vygotsky, L., 1978. Interaction between learning and development. *Readings on the development of children,* **23**(3), 34 – 41.

Woolfolk, A. E., Hoy, A. W., Hughes, M., & Walkup, V., 2007. *Psychology in education*: Pearson Education.

Yohannes, G., 2007. *Barriers to teaching and learning mathematics in grade four: a study in one primary school in Addis Ababa, Ethiopia.*

Zeichner, K. G., & Gore, Y., 1990. *Teacher socialization. Handbook of Research on Teacher Education.* New York: MacMillan, 329 – 348.

Zimmerman, B. J., 2000. Self-efficacy: An essential motive to learn. *Contemporary educational psychology,* **25**(1), 82 – 91.

Zuya, H. E., Kwalat, S. K., & Attah, B. G., 2016. Pre-Service Teachers' Mathematics Self-Efficacy and Mathematics Teaching Self-Efficacy. *Journal of Education and Practice,* **7**(14), 93 – 98. https://files.eric.ed.gov/fulltext/EJ1102977.pdf

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