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EXPLORING THE IMPACT OF AGE AND SEX ON UNIVERSITY STUDENTS' ALGEBRA ACHIEVEMENT: A MODERATION ANALYSIS

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Abstract:
A conceptual and meaningful understanding of Algebra is essential for developing other further mathematical concepts required for studies in Geometry, Calculus, Statistics and Probability. Algebra is one of the main mathematical concepts applied mostly in computer science. Since Algebra serves as a link to studying other disciplines in mathematics, understanding the factors that influence students' achievement is crucial for stakeholders and educators in predicting students' general performance. Therefore, using 290 undergraduate preservice mathematics students from a Ghanaian university, a research study was conducted to examine the main effect of age and sex together with their interaction consequence on first-year students' Algebra achievement test scores, which were obtained from students' mid-semester examination in March 2024. A 2×2 NOVA was used as a data analysis technique to examine the impact of sex (male and female) and age on math students' teacher Algebra achievement test. Three primary age groups were formed from the participants: young, middle-aged, and elderly. Age (F (2, 284) = 83.92, p<.05) and sex (F (1,284) = 36.89, p=.001<.05) effects were statistically

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significant. The age group had a large effect size on Algebra performance, while sex had a medium. The interaction of age and sex was also significant (F (2, 284) = 13.18, p=.001<.05) with a small (partial η^2 = .085) effect size. A detailed exploration of the interaction effect revealed that for students less than 30 years old, there was a significant mean difference in Algebra scores between males and females, in favor of males. On the other hand, for 30 – 40 years, there was an insignificant mean difference in Algebra scores between males and females. For students who are above 40 years old, males' and females' Algebra scores were significant statistically in favor of males. The results further show that males outperformed their female counterparts in all three groups and hence, the researchers recommend a change in instructional practices by teachers to close the sex gap, particularly in the Algebra achievement test and mathematics as a whole. Implications and suggestions for expanding this current study have been discussed explicitly.

Keywords: age, Algebra 1, sex, interaction effect, mathematics achievement, preservice mathematics students

1. Introduction

Students who receive sufficient education in mathematics have the skills necessary to handle challenges in their personal, educational, and career pursuits (Boateng *et al.*, 2024). In this way, developing the necessary mathematical skills can help people become more adept at problem-solving, analysis, critical reasoning, and making inferences (Franco-Buriticá *et al.*, 2023; Rico, 2007). Again, mathematics plays a crucial role in various fields of study and professional domains (Koomson *et al.*, 2024). Currently, mathematics is regarded as an indispensable tool for STEM education. Therefore, nations such as Australia, the USA, Japan, China, Korea, and the UK, which had placed much emphasis on mathematics education, are now experiencing rapid socio-economic development in recent times (Valero *et al.*, 2015). Among the various branches of mathematics that are applicable in everyday life, Algebra serves as a critical foundation, underpinning many advanced mathematical concepts and applications. As such, understanding the factors that impact Algebra achievement is of paramount importance, particularly among preservice mathematics students who are poised to become future educators, as their content knowledge in Algebra would be highly required during the teaching-learning process.

The majority of the mathematics curriculum is Algebra embedded (Lau, 2021). According to Çiftçi and Yıldız (2019), Algebra links other learning aspects of mathematics. A fundamental definition of Algebra is a generalised mathematical thinking tool (problem-solving skills, reasoning skills, and representation skills), arithmetic, or a language of mathematics (Kriegler, 2004). Algebra is taught as a thinking tool in educational systems from kindergarten through university, even though it is introduced in the senior high school. Algebraic thinking is a field of mathematical

reasoning that forms the foundation of other areas of mathematics. Algebraic thinking processes are necessary for the application of mathematical knowledge and abilities. Because of this, learner organize their Algebraic learning by connecting it to their arithmetic study (Akkan *et al.*, 2012). According to studies, a lot of students struggle to connect the fundamental ideas of Algebra to the pre-algebraic ideas they learned in elementary school. As a result, it is impossible to attain the desired success (Christou *et al.*, 2007; Sfard & Linchevski, 1994). According to research, the course material, the way it is taught, and the characteristics of the students all affect how well students perform in Algebra (Matthews & Farmer, 2008; Odumosu *et al.*, 2018).

Among these three (course material, instructional practices, and students' characteristics) conditions that hinder students' Algebra achievement, the facilitator's knowledge has been pointed out as the most deterministic factor in students' poor performance (Hill *et al.*, 2005). For instance, a study by Huang and Kulm (2012) with 115 participants from a public university in the USA who enrolled as future mathematics facilitators for middle-grade students expressed a relatively limited Algebra knowledge required for instruction. They identified challenges such as inappropriate quadratic function presentations among participants, partial knowledge in relation to the concept of function, and difficulties in solving both irrational and inequalities of a quadratic function. Because participants in the study could not integrate Algebraic and graphic representations, they found problem-solving very challenging. The findings of Huang and Kulm (2012) may echo the argument of Stephens (2008), who claimed that facilitators' knowledge of Algebra is inadequate. Hence, conducting a rigorous study into preservice mathematics Algebra achievement could serve as a stepping stone for understanding the level of student knowledge in Algebra at the early stages of their professional development as mathematics educators in the near future.

As established earlier, previous research has identified a range of factors that can impact mathematics achievement. Among these, age and sex have emerged as significant variables (Cheema & Kitsantas, 2014; Lindberg *et al.*, 2010; Reilly *et al.*, 2019). Research has indicated that mathematical performance can vary across different age groups. While some studies suggested older students may have more exposure to mathematical concepts and thus perform better in certain areas, others argued that younger students perform better in mathematics as a result of their curiosity to acquire knowledge at a youthful age. A study by Swanson (2004) revealed that older learners did better in mathematics problem-solving activities when phonological processing and working memory were used as predictors than younger learners. In contrast, Gopnik *et al.*, (2015) posited that young students outperform older students when learning strange abstract causal principles. Accordingly, Pellizzari and Billari (2012) studies among undergraduate-level students in Italy from Bocconi University in Milan showed a contradiction, as most literature supports the fact that elderly students perform better academically than young students. Pellizzari and Billari (2012) explained from their findings that combining early learning as well as individual progression over an age range within a cognitive developmental process may cause such an effect on student

performance, thereby making the younger learner outperform the older learner. However, the relationship between age and Algebra achievement, particularly among preservice mathematics students, remains less explored. Developing a coherent understanding of age differences in Algebra achievement also necessitated the study of this research.

Sex is another factor that has been extensively studied in relation to mathematics achievement (Chiu, 2023; Else-Quest *et al.*, 2010; Espinoza & Taut, 2020; Voyer & Voyer, 2014). Existing literature presents mixed findings, with some studies suggesting that males outperform females in mathematics and vice versa, and others report no significant sex differences. For instance, Hyde and Mertz's (2009) study revealed sex equality in mathematics achievement among participants from the USA and other countries as well. To complement the results of Hyde and Mertz (2009), Ajai and Imoko (2015) used a quasi-experimental design (pretest and posttest) among 428 senior high school students with an Algebra Achievement Test as a data collection instrument and found that boys and girls taught through Problem-Based Learning (PBL) in Algebra classes did not differ substantially in retention and achievement scores. They suggested that performance is an orientation functionality, not sex. A comprehensive study by Pargulski and Reynolds (2017) also shows that males outperformed their females in mathematics achievement. Contrary to Xie and Liu's (2023) study, in elementary school, females outperform males in mathematics; however, by junior high school, this sex difference closes or even vanishes, and by senior high school, male students outperform female students in math. Generally, sex difference in mathematics achievements is mostly focused on the general scope of the mathematics content, with little emphasis on the various branches of the subject. There is also limited research that has exploited the impact of sex on the learning of Algebra (McCoy, 2005; Şerife & Yıldız, 2019). Even though this presents a research gap, sex's possible moderating effect on the association between age and algebra achievement has not been fully examined, particularly in teacher training university institutions in Ghana.

Given this context, this present study explores the influence of age and sex on Algebra achievement among preservice mathematics students. Moreover, while the effects of age and sex on mathematics achievement have been studied separately, their interaction has not been thoroughly investigated. Specifically, it seeks to understand whether sex moderates the relationship between age and Algebra scores. Therefore, this study aims to address this problem by exploring the influence of age and sex on Algebra achievement among preservice mathematics students and examining the moderating role of sex in the relationship between age and Algebra scores.

The following research questions were laid down for the study.

1) Do age and sex influence Algebra achievement among preservice mathematics students?
2) To what extent does sex moderate the impact of age on Algebra achievement?

2. Methods and Materials

This research followed a quantitative research approach. This paradigm is based on the philosophy that social reality can be quantified and observed objectively. This approach is suitable as we examine numerical data (mathematics scores) and their relationship with age and sex. A cross-sectional design was considered appropriate as the study gathered data from the students at a single point in time (Lotey *et al.*, 2023), particularly about the Algebra Achievement Test (AAT) from students' mid-semester examination in the year 2024, along with the age and sex of the students.

2.1 Population and Sample

A census was used to collect data from the participants. All things being equal, a total population of 310 undergraduate students was meant to partake in the study since the data was obtained from students' mid-semester examinations. However, the valid data that was used for the analysis was 290, as some data were discarded as a result of student' inability to complete questions on their sex, age, or both. Since participants were given free will to either participate or not in the study, the researchers did not contact the said participant and considered such data as void during the data analysis process.

2.2. Instrument for Data Collection

A lecturer-made test was deployed for collecting data. This test instrument was standardised as it was used to evaluate students' performance during a mid-semester examination. The Algebra Achievement Test (AAT) was made up of three different questions measuring three separate Algebra concepts, along with the age and sex. These three concepts include Set theory, Relation and Function, and Equation and Inequalities. Each topic scored 10 marks, marking a total of 30 marks for the mid-semester examination on Algebra 1. Moreover, the test item was both objective (5 marks for a short answer) and subjective (5 marks for one theory question) in nature. In the university, a mid-semester examination is scheduled for one week, and the duration for all subjects is an hour. The AAT consists 20 of answerable sections, 15 objective, 3 subjective, and 2 items gathering data on students' age and sex. The student's age was divided into three groups (young < 30 years, medium 30 – 40 years, and old > 40 years). The AAT was piloted using a Sandwich student's mid-semester examination. Even though the inter-rating reliability values ranged from 0.71 to 0.8, one lecturer teaching Discrete Mathematics was given to review in order to enhance content validity.

2.3. Data Analysis

The data was analysed via mean [M], standard deviation [SD], and ANOVA. This assisted the researchers in understanding the relationships between age, sex, and Algebra scores. M and SD were utilised to identify the impact of age and sex on undergraduate mathematics students' Algebra Achievement Test. The analysis technique known as moderator analysis enables researchers to examine the direction of the variations in the

moderators' mean impact sizes and the variations in the sub-group differences. Since the second goal of this investigation was to examine whether the differences between the single moderator (sex) were statistically significant, a Post hoc test was employed. A single moderator (sex) variable that was hypothesised to influence the average impact size was identified in the research. According to Kim (2013), formal tests for normality, such as the Shapiro-Wilk and Kolmogorov-Smirnov tests, are suitable for application in small to medium-sized samples ($n < 300$). Therefore, the normality tested for this study was conducted based on the Shapiro-Wilk and Kolmogorov-Smirnov tests since the sample size was $290 < 300$. From Table 1, all the $p > 0.05$ satisfied the normality test assumption.

Table 1: Tests of Normality and Homogeneity of Variances

Tests of Normality and Levene's Test of Equality of Error Variances[b, c]								
Sex	**Age**		**Kolmogorov-Smirnov[a]**			**Shapiro-Wilk**		
			Statistic	**df**	**Sig.**	**Statistic**	**df**	**Sig.**
Males	< 30	ATT	.148	67	.002	.965	67	.084
	30 - 40	ATT	.103	50	.069	.978	50	.265
	> 45	ATT	.098	40	.200*	.973	40	.243
Females	< 30	ATT	.075	58	.200*	.986	58	.486
	30 - 40	ATT	.109	41	.016	.982	41	.294
	> 45	ATT	.069	34	.200*	.992	34	.911

Levene's Test of Equality of Error Variances[b, c]				
	Levene Statistic	**df1**	**df2**	**Sig.**
AAT	7.326	5	284	.369

b. Dependent variable: AAT (Algebra Achievement Test)

c. Design: Intercept + Sex + Age + Sex * Age

3. Results

Table 2 presents descriptive statistics for first-year preservice undergraduate mathematics students' Algebra achievement test scores by sex and age groups (young (< 30); middle (30 – 40); and old (> 40)).

Table 2: Descriptive statistics for Algebra Achievement Test by age group and sex

Sex	**Age**	**N**	**Mean**	**Std. Dev.**
Male	< 30	67	32.24	3.61
Female		58	25.04	3.13
Male	30 – 40	50	22.56	4,49
Female		41	21.73	5.70
Male	> 40	40	21.61	4.72
Female		34	19.50	5.92
Male & Female	< 30	125	28.57	4.95
	30 – 40	91	22.09	5.19
	> 40	74	20.36	5.53
Total		**290**		

It was revealed that the highest mean score for male and female participants was in the young age group ($M = 28.57$; $SD = 4.95$). This is followed by the middle-aged group ($M = 22.09$; $SD = 5.19$) and subsequently the old age group ($M = 20.36$; $SD = 5.53$) at last. Furthermore, Table 1 depicts that the young age group had a total student participate of 125 (male = 67; female = 58). The majority of the students were from the young age group. The middle age group had the second highest participant of 91 (male = 50; female = 41). Additionally, the old age group had the lowest participant of 74 (male = 40; female = 34). In all, the male participants in this current study were 157 and that of female was 133.

A 2×2 ANOVA was conducted to investigate the impact of sex (male and female) and age on the Algebra 1 achievement test. The sex impact $F(1, 284) = 36.89, p < .05$, and age group $F(2, 284) = 83.92, p < .05$ were statistically significant. The effect size for sex was average (partial eta-squared $= .115$) and that of age was large (partial eta-squared $= .371$). The sex and age interaction were also significant statistically, $F(2, 284) = 13.18, p < .05$ with a small (partial $\eta^2 = .085$) effect size. The R-squared value of .46 indicates that approximately 46% of the variability in participants' AAT achievement can be explained by sex and age group. In other words, sex and age group together account for about 46% of the differences in AAT scores among first-year preservice mathematics students (see Table 3).

Table 3: Tests of Between-Subjects Effects

Dependent Variable: AAT						
Source	**Type III Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**	**Partial Eta Squared**
Corrected Model	5334.17	5	1066.83	48.65	.001	.461
Intercept	159801.48	1	159801.48	7287.49	.001	.962
Sex	809.03	1	809.03	36.89	.001	.115
Age	3680.53	2	1840.26	83.92	.001	.371
Sex * Age	577.84	2	288.92	13.18	.001	.085
Error	6227.61	284	21.93			
Total	178986.00	290				
Corrected Total	11561.78	289				

R Squared = .46 (Adjusted R Squared = .452)

With Table 4, a detailed examination of the interaction effect revealed that for the less than 30 age group, there was a significant mean difference in AAT scores between boys and girls in favor of boys. A similar result was found in the age group 30 – 40 for boys and girls, but it was insignificant. The age groups greater than 40, boys and girls, differ significantly also in favor of boys (see descriptive statistics in Table 4). However, the mean difference for the age group 30 – 40 was relatively small as compared to the older age groups (< 30 and > 40).

Table 4: A multiple comparison of Algebra scores by sex across categories of age groups

Comparison				
Sex	**Age**	**Mean Difference**	**Std. Error**	**Sig[b, *]**
Male vrs Female	< 30	7.21	.89	.00*
Male vrs Female	30 – 40	.84	.98	.40
Male vrs Female	> 40	2.11	1.02	.04*

*. The mean difference is significant at the .05 level

b. Adjustment for multiple comparisons: Bonferroni.

As depicted in Table 5, males, aged less than 30, have a statistically significantly higher Algebra score than both the 30 – 40 and greater the 40. Moreover, the largest mean difference for the male age group was found between students less than 30 years old and more than 40 years old.

Table 5: A multiple comparison of Algebra scores by age group across categories of sex

Comparison				
Sex	**Age**	**Mean Difference**	**Std. Error**	**Sig[b, *]**
Male	< 30 vrs 30 – 40	9.68	.97	.000*
	< 30 vrs > 40	10.63	1.01	.000*
	30 – 40 vrs > 40	.95	1.07	1.000
Female	< 30 vrs 30 – 40	3.31	.91	.001*
	< 30 vrs > 40	5.54	.90	.000*
	30 – 40 vrs > 40	2.23	.92	.050*

*. Significant level .05.

b. Adjustment for multiple comparisons (Bonferroni).

This means that students performed better at a younger age in Algebra than at middle and/or older ages. Even though the mean difference between male students (30 – 40 vrs > 40) was .95, it was insignificant. This implies that male students' age groups labelled as middle and old achievement in AAT do not differ (see Figure 1). However, for females, the mean difference across all age groups was statistically significant. Additionally, the largest mean difference for females was identified between younger age and older age (< 30 vrs > 40), and the least was between middle and older age.

As depicted in Figure 1, there was a large decline in students' AAT scores for male students from the young to middle age group as compared to female students from the young to the middle age group. The line graph further shows a small estimated marginal means of AAT for males in the middle and the older age group. The female student age group was slightly inclined, as their estimated marginal means of AAT scores declined steadily. The mean scores for boys and girls in the middle age group were close to each other as compared to the two age groups (young and old).

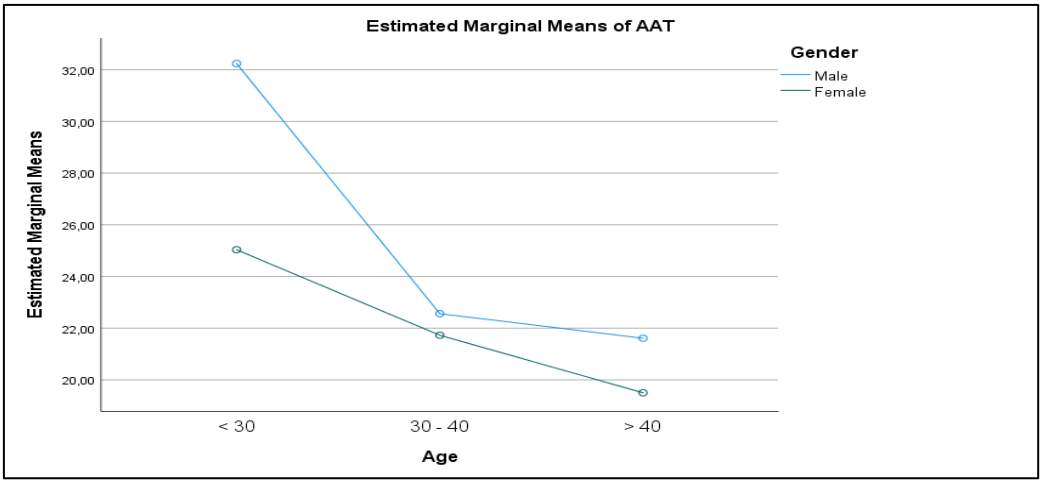

Figure 1: A line graph showing the interaction effect

Since there was a significant main impact in the age group, the researchers also performed a Post Hoc Test to investigate where the difference occurred. However, sex was not included in the Post Hoc Test even though the main effect was significant. This exclusion was done for the sex because it had only two groups (male and female), which is not applicable in the Post Hoc Test analysis. As the homogeneity of variances assumption (see Table 1) was satisfied and the sample was more than 50, the Scheffe test was adopted by researchers as an appropriate measure for the analysis. The Scheffe test is the most flexible post hoc test, as well as the most conservative, and produces the widest confidence intervals. A considerable mean difference exists between the three age groups (see Table 6).

Table 6: A Post Hoc Test (Scheffe) between the combined age group for male and female

Post Hoc Tests (Scheffe)			
Age	**Mean Difference**	**Std. Error**	**Sig**
< 30 vrs 30 – 40	6.47	.662	.000
< 30 vrs > 40	6.47	.662	.000
30 – 40 vrs > 40	1.73	.698	.047

4. Discussions and Implications

4.1. Impact of Age on Algebra Achievement

The findings show a significant influence of age on preservice mathematics students' Algebra Achievement Test scores. Within the three-age group used in this study, the young age group had the highest mean score *(M = 28.57; SD = 4.94)* which suggests that both male and female participants who are young outperformed the other two age groups (middle (*M = 22.10; SD = 5.19*) and old age group (*M = 20.36; SD = 5.53*)). This means that the young students had the highest scores, which collectively led to the highest mean scores. This result is supported by the discovery that there was a significant mean difference $(F(2, 284) = 83.92,\ p < .05)$ between the two groups and that eta squared $(\eta^2 = .371)$ showed a large effect size. The Scheffe Post Hoc Test (see Table 5)

showed that the mean difference (6.47) for groups (< 30 vrs 30 – 40 and < 30 vrs > 40) was the same and significant. Collectively, males and females in the young age group outperformed their counterparts (middle and old age). The findings from this study concur with other similar studies (Jabor *et al.*, 2011; Nyatsikor, 2024; Pellizzari & Billari, 2012). From the results, the researchers concluded that as students age increases, their mathematics achievement in Algebra diminishes, hence the teaching-learning of Algebra must be more aligned to meet the needs of the middle and old-age group in order to increase their conceptual understanding of Algebra which could subsequently increase their achievement thereby serving as a precursor for further studies in other mathematics subjects (Geometry, Statistics and Probability, Calculus).

In general, Roberts and Stott's (2015) study in the UK with 460 students at the tertiary level affirmed the findings of this study and further concluded with a general assertion that young age groups obtain higher first-class degree honors than older age groups due to an outstanding performance in academics. This study's result, however, contradicts the findings of Abubakar & Oguguo (2011) and Navarro *et al.*, (2015). A study by Josiah and Olubunmi Adejoke (2014) with a sample size of 150 mathematics student facilitators from Nigeria in Federal Colleges of Education (Ogun State and Lagos) studying MAT 111 (Algebra) revealed age as an insignificant predictor of participants' achievement in Algebra. However, a further Post Hoc analysis test from the study of Josiah and Olubunmi Adejoke (2014) showed that mathematics trainee students between 15 and 20 years received the highest mean score, while those 31 years and above received the lowest mean scores. The divergent findings from the works of Abubakar and Oguguo (2011), Navarro *et al.*, (2015) as well as Josiah and Olubunmi Adejoke, (2014) could be attributed to the different instructional strategies adopted by various facilitators. Also, teacher's belief about teaching could affect the study findings. Again, student's early exposure to strong algebraic concept can lead to the discrepancy of the study's findings. An implication from this study suggests that early intervention and targeted instruction can be adopted to enhance middle and old-age-group students' algebraic thinking as well as promote peer tutoring among students where more knowledgeable young ones can support vulnerable ones (middle and/or old-age-group). This could lead to the development of more complex algebraic skills at an earlier stage in the professional development of mathematics facilitators. Additionally, the results of the study could influence educational policies, particularly those related to mathematics education. Policymakers might consider implementing strategies that have been shown to benefit younger students, as the school system is generally dominated by young students in recent times.

4.2. Impact of Sex on Algebra Achievement

The study further showed that the sex of preservice mathematics students influences their AAT score significantly in favour of boys. In all three age groups (young, middle, and old), the male participants sampled for the study outperformed the female participants, which concords with other previous findings (Pargulski & Reynolds, 2017).

The male participant's performance was statistically significant ($F(1, 284) = 36.89,\ p = .001 < .05$) with a mean difference of 3.384 and a medium effect size ($\eta^2 = .115$). Problem-based learning, as suggested by Ajai and Imoko, (2015) can be deployed by lecturers as an effective method to overcome sex biases in mathematics and improve student performance. In support of the findings of this study, Cook, (2018) examines sex disparities in adult numeracy skills across 20 OECD countries, questioning if educational empowerment of women reduces these differences and the findings indicate that while education equalisation has decreased sex gaps in numeracy in many countries, women's educational advances have not always led to reduced numeracy disparities.

In contradiction to the findings of this study Şerife & Yıldız (2019) examined the impact of sex on algebra achievement using TIMSS data and adopted a meta-analysis of TIMSS results from 1995 to 2015, involving over 1.2 million participants. Şerife & Yıldız's (2019) key findings showed that the impact of sex on algebraic performance is minimal yet significant, with females generally outperforming males. Şerife & Yıldız (2019) complement their finding by reporting that the effect of sex varies by national culture, with horizontal-individualist cultures showing a greater sex difference in favor of females. Even though the findings of Jabor *et al.*, (2011) revealed that girls outperformed boys significantly in mathematics GPA scores, the effect size was small *(Cohen's d; d = .24)* as compared to the medium effect size established from this study. The results of this study do not concur with that of Saleh and Rahman (2016). The difference in Saleh and Rahman, (2016) result and this study could be ascribed to potential influence of classroom dynamics, teacher expectations, and social perceptions of gender and mathematics. In Ghana, most mathematics related courses are male dominate and most society regard mathematics for boys than girls. An additional implication from the results of the research is that teachers could prioritize sex-sensitive teaching. That is, lecturers in the study area and other educators should be aware of the sex differences in algebra achievement and adapt their teaching methods accordingly. For instance, this study shows that boys perform better in algebra than girls. Hence, teachers should use teaching strategies (see Arroyo *et al.*, 2013) that are known to benefit girls to help them improve. Introvert female students can be motivated to leverage recent AIs for individualised learning. Teachers can be trained to accept and use digital tools in mathematics education (Bandoh *et al.*, 2024; Lotey *et al.*, 2023, 2025). This could help close the gender gap.

4.3. The Interaction Effects of Age and Sex on Algebra Achievement

The uniqueness of this research was based on the interaction of age and sex to explore its effect on preservice mathematics students' Algebra achievement as numerous studies have particularly focused on either the main effects of age (Thoren *et al.*, 2016; Ünal, 2019), sex (Cook, 2018; Pargulski & Reynolds, 2017; Şerife & Yıldız, 2019) or both (Jabor *et al.*, 2011; Josiah & Olubunmi Adejoke, 2014) in Algebra. This interaction (age and sex) from this study was statistically significant ($F(2, 284) = 13.18,\ p = .001 < .05$). Although this is considered a small effect size, it is nonetheless statistically significant. The interaction between age and sex means that the effect of one independent variable (e.g., sex) on the

outcome of the dependent variable (AAT) depends on the level of the other independent variable (e.g., age). For instance, the difference in outcomes between males and females might change as they get older. A detailed exploration of the interaction effect revealed that for students less than 30 years old, there was a significant mean difference in Algebra scores between males and females, in favor of males. On the other hand, for 30 – 40 years, there was an insignificant difference in mean Algebra scores between males and females. For students who are above 40 years old, male and female Algebra scores were statistically significant in favor of males.

The finding aligns with Haist *et al.* (2000). Haist *et al.* (2000) research aimed to examine the influence of age and sex on medical school performance, specifically on academic performance (AP) and academic difficulty (AD) among first-year medical students in the USA. Their result showed a statistically significant interaction between age and sex. However, the results from the Douglas *et al.* (2020) study contradict the findings of this current research. Douglas *et al.* (2020) study was also conducted among two universities, one in Australia with a sample size of 367 and the other participants from the UK with 2,163 a sample size. The study used undergraduate students to investigate how age and sex interact to influence academic achievement and learning styles. The quantitative analysis deployed for the study showed that while older women tend to adopt deeper learning approaches compared to other demographic groups, which positively impacts their academic performance, the interaction effect of sex and age was insignificant. The implications for the significant interaction effect of age and sex from this study are that (1) if the effect of sex on achievement changes with age, educators might need to differentiate their instruction for older and younger students. For example, teaching strategies that work well for young boys might not be as effective for older boys, and (2) lecturers could benefit from professional development programs that help them understand how age and sex interactions might affect student performance. This could enable them to better tailor their teaching strategies to meet students' diverse needs.

5. Conclusions and Suggestions for Further Studies

This study explores the main effect of age and sex together with their interaction effect on preservice mathematics achievement in Algebra 1 based on students' results from a mid-semester examination in March 2024 from a university in Ghana. A significant and large effect size was established for age, medium effect sizes for sex, and a small effect for the interaction of age and sex. The study further revealed that the male participants outperformed their female counterparts in all three age groups. Among the three age groups, the younger age group had the highest mean scores in both boys' and girls' Algebra 1 achievement test. The finding from this study highlights the importance of inclusive education and the need for further research on demographic influences (sex and age) in mathematics teacher training. Education policymakers (or lecturers) could use this information to formulate policies that aim to reduce the sex gap in Algebra 1

achievement. This could include policies on teacher training, curriculum design, and resource allocation.

Future studies could examine other demographic information, such as the socioeconomic background of students and students' marital status, as they can also contribute significantly to students' performance in mathematics. Other first-year courses, such as Trigonometry and Geometry 1 could be examined to completely understand and predict the general performance of undergraduate preservice mathematics students in the university. Similar studies can be conducted in other teacher training institutions across the country to enhance the generalisation of these current findings.

Conflict of Interest Statement

No potential conflict of interest was reported by the author(s).

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