ASEAN Journal of Science and Engineering Education

Journal homepage: http://ejournal.upi.edu/index.php/AJSEE/

Examining Sources of Mathematics Self-Efficacy Beliefs of Senior Secondary School Students

*Adeneye Olarewaju A. Awofala**

University of Lagos, Nigeria
Correspondence: E-mail: aawofala@unilag.edu.ng

ABSTRACTS

Except people have confidence that they can produce desired results they have little motivation to act. Self-referent thought plays a significant part in the psychological working of humans. People's conception of their efficacy is most powerful in their everyday life and the self-efficacy of a person has been recognized as a vital element for executing tasks successfully. While many studies have shown the predictive power of self-efficacy, fewer efforts have examined the sources underlying self-efficacy beliefs. Sources of self-efficacy in mathematics scale was a multi-dimensional construct comprising: mastery experience; vicarious experience; social persuasions; and physiological and affective states. Senior secondary school students had a moderate level of sources of self-efficacy in mathematics. Gender differences in sources of self-efficacy in mathematics among senior secondary school students were significant and in favor of the male students. However, future studies in Nigeria should investigate the confirmatory factor analytic structure of the sources of self-efficacy in mathematics scale to generalize the findings of this study.

ARTICLE INFO

Article History:
Submitted/Received 22 Jul 2022
First revised 26 Aug 2022
Accepted 31 Aug 2022
First available online 01 Sep 2022
Publication date 01 Dec 2023

Keyword:
Gender,
Mathematics,
Senior secondary school students,
Sources of self-efficacy.

1. INTRODUCTION

Except people have confidence that they can produce desired results they have little motivation to act. Self-referent thought plays a significant part in the psychological working of humans. People's conception of their efficacy is most powerful in their everyday life and the self-efficacy of a person has been recognized as a vital element for executing tasks successfully. Self-efficacy, introduced by psychologist Albert Bandura (Bandura, 1977), is a type of personal cognition described as people's judgments of their capabilities to organize and execute courses of action required to attain designated types of performance.

Self-efficacy is one's self-judgments of personal capabilities to initiate and successfully carry out specified tasks at designated levels, expend greater effort, and persevere in the face of adversity (Akinsola & Awofala, 2009). Self-efficacy can be conceptualized in two dimensions: "personal self-efficacy" and "outcome expectancy". Personal self-efficacy is the judgment about the individual's values and beliefs in terms of personal competencies affecting an assigned responsibility. Outcome expectancy is a judgment about the individual's belief in a performance to be realized in a specific task. Sensing efficacious aids a person to disburse extra strength, and to act in a proper mode, which may eventually turn out to be essential to sustain great success (Sahil & Hashim, 2011). Individuals form their self-efficacy beliefs by interpreting information from four sources: mastery experience, vicarious experience, social persuasions, and physiological or affective states.

Mastery experiences refer to the experience's individuals gain from their previous attainments. Once the students complete an academic task, they interpret and evaluate the results obtained, and judgments of competence are created or revised based on those interpretations (Usher & Pajares, 2009). The mastery experience to be the most powerful source as it is interpreted result of one's previous attainments. These experiences prove powerful when individuals overcome obstacles or succeed on challenging tasks, especially those that are difficult for others as successful performances in a domain have lasting effects on one's self-efficacy (Usher & Pajares, 2009). A student who accomplished a task in mathematics and was successful will be confident to perform a similar and challenging task in the nearest future. Most individuals do not quickly dismiss their experiences of mastery (or of failure) (Usher & Pajares, 2009). To have an irrepressible sense of self-efficacy is a function of experience in asphyxiating impediments through effort and determination.

Vicarious experiences come from our observation of people around us, especially people we consider role models. Seeing people similar to ourselves succeed through their sustained effort raises our beliefs that we too possess the capabilities to master the activities needed for success in that area. Since there are no absolute measures of proficiency (Usher & Pajares, 2009), students gauge their capabilities and make judgments concerning the performance of others which include classmates, peers, and adults. More so, students engage in self-comparison of their current and past performances either intellectually or by evaluating their performances and this is capable of altering their self-efficacy.

The social persuasions that students get from influential people in their lives such as parents, teachers, managers, or coaches can strengthen their beliefs that they have what it takes to succeed and these serve as a third source of self-efficacy. Persuading students that they possess the capabilities to master certain activities may boost their confidence and ginger them to put in the effort to succeed and sustain it when problems arise. Negative social persuasions may decrease and undermine self-efficacy faster than positive social persuasions

DOI: http://dx.doi.org/10.17509/xxxx.xxxx
p- ISSN 2775-6793 e- ISSN 2775-6815

meant to increase and sustain students' self-confidence and effort most especially for youngsters who are in their formative years.

The fourth source of self-efficacy beliefs is informed by students' emotional and physiological states which may influence how a student feels about his/her abilities. These physiological states can be in the form of stress, depression, tension, fatigue, anxiety, and mood which affect students' self-efficacy beliefs. Depression, for instance, can reduce confidence in our ability while stress reactions or tension are construed as symbols of susceptibility to pitiable or poor performance.

However, positive emotional reactions to school-related tasks can boost our self-assurance in our skills for success. High anxiety can reduce self-efficacy and students with high anxiety will experience the feeling of dread and uneasiness when going to a mathematics class for instance and might interpret their worry as a lack of skill in mathematics. A student that is confident and feels no anxiety will experience a sense of excitement that can foster a great sense of self-efficacy. It is thus, very important that we increase students' physical and emotional well-being and reduce their negative emotional states to reinforce their self-efficacy beliefs.

Clarifying the latent structure of hypothesized four sources of self-efficacy has been an issue of research in the recent past. Lent *et al*. (1996) tested four possible structures of sources of self-efficacy with high school and college students. For college students, Bandura's model of four interpretable sources of self-efficacy belief showed the best fit for the data. However, results varied marginally with the high school students, with a five-factor model showing a better fit for the high school data. In the high school model, the effect of social persuasions from peers was detached from social persuasions from adults.

The authors guessed that high school students may be subtler to variances in contribution from peers and adults. Britner and Pajares (2006) conducted exploratory factor analysis (EFA) to identify the latent constructs underlying the sources of self-efficacy items on each scale with 319 middle school students. Findings revealed four interpretable factor structures with items on each scale loaded on one factor. Factor loadings for the mastery experience items ranged from .60 to .81; for the vicarious experience from .47 to .72; for the social persuasions from .55 to .85; and for the physiological states from .66 to .88.

Usher and Pajares (2009) conducted a study (in three phases) that involved developing and validating items with which to assess Bandura's theorized sources of self-efficacy among middle school mathematics students. Results from the first phase (N = 1111) were used to develop and refine items for subsequent use. In Phase 2 of the study (N = 824), a 39-item, four-factor exploratory model fit best, and Items were revised to strengthen psychometric properties. In Phase 3 (N = 803), a 24-item, four-factor confirmatory factor model fit best and concluded that this final model was invariant across gender and ethnicity.

Gender difference in sources of self-efficacy is a subject of intense research in the past decade in which mixed findings have been found. Some researchers have found gender differences in the sources of self-efficacy among middle school, high school, and college students, with females reporting stronger vicarious experiences and social persuasions than do males (Anderson & Betz, 2001; Lent *et al*., 1996) but lower mastery experience than males (Britner & Pajares, 2006). Others, however, have failed to find significant gender differences in the sources of self-efficacy (Lent *et al*., 1991; Matsui *et al.,* 1990).

In Nigeria, the need for self-efficacy beliefs is anchored on the low interest coupled with the low performance of students in mathematics. Evidence suggests that students' performance in mathematics in both internal and external examinations in Nigeria is at low

DOI: http://dx.doi.org/10.17509/xxxx.xxxx
p- ISSN 2775-6793 e- ISSN 2775-6815

ebb and students show low motivation and dwindling interest in mathematics (Awofalaa & Falolu, 2017).

This low performance in mathematics has not only led to frustration and high mathematics anxiety in students but has promoted students' negative attitudes toward mathematics (Awofala & Akinoso, 2017).

Given the background above, it is pertinent to note that in Nigeria no prior study had established the factorial structure of the sources of self-efficacy in the mathematics scale let alone determine if the sources of self-efficacy in mathematics differ as a function of gender. The only published study that relates to the present study in Nigeria is that conducted by Arigbabu and Oludipe (2010) which showed that the perceived efficacy beliefs of prospective Nigerian science teachers were high and that there was no significant influence of gender on prospective science teachers' self-efficacy beliefs.

The objectives of the current study were threefold. First, the study determined the level of sources of mathematics self-efficacy among senior secondary school students in Nigeria. Second, the study sought to determine the latent structure of hypothesized four sources of self-efficacy using the sources of mathematics self-efficacy scale adopted from Usher and Pajares (2009). Third, because gender differences are typically reported in studies of academic self-efficacy beliefs, this study investigated whether the sources of mathematics self-efficacy differ as a function of gender. Specifically, in this study, the following research questions were addressed:

1) RQ1. What is the level of the sources of mathematics self-efficacy among Nigerian senior secondary school students?
2) RQ2. What is the factor structure of the sources of mathematics self-efficacy scale among Nigerian senior secondary school students?
3) RQ3. Do male and female senior secondary school students differ in sources of mathematics self-efficacy?

2. METHODS

The study made use of a quantitative research method within the blueprint of the descriptive survey design of an ex-post facto type. This is because the existing status of the independent variables was only determined during data collection without any manipulation of the variables by the researchers.

2.1. Research Design

The target population for the study comprised public senior secondary school year three mathematics students in education Districts II and III of Lagos State, Nigeria. The multi-stage sampling technique was used. First, simple random sampling was used to select educational Districts II and III out of the six educational districts in Lagos State.

Second, purposive sampling was used to select schools to participate based on three conditions: (i) schools that have qualified mathematics teachers (i.e graduates) who have been teaching in the school for at least three years.

The three years was the researchers' decision to ensure some degree of teachers' cognate experience (ii) schools that have been presenting candidates in public examinations such as the Senior School Certificate Examinations (SSCE) and National Examinations Council (NECO) in mathematics for at least four years consistently.

DOI: http://dx.doi.org/10.17509/xxxx.xxxx
p- ISSN 2775-6793 e- ISSN 2775-6815

The minimum of four years was the researchers' decision to ascertain whether the schools have been presenting candidates in mathematics at external examinations, and (iii) whether schools should be public or government owned and coeducational.

2.2. Population, Sample, and Sampling Technique

The target population for the study comprised public senior secondary school year three mathematics students in education Districts II and III of Lagos State, Nigeria. The multi-stage sampling technique was used. First, simple random sampling was used to select educational Districts II and III out of the six educational districts in Lagos State. Second, purposive sampling was used to select schools to participate based on three conditions: (i) schools that have qualified mathematics teachers (i.e graduates) who have been teaching in the school for at least three years.

The three years was the researchers' decision to ensure some degree of teachers' cognate experience (ii) schools that have been presenting candidates in public examinations such as the Senior School Certificate Examinations (SSCE) and National Examinations Council (NECO) in mathematics for at least four years consistently. The minimum of four years was the researchers' decision to ascertain whether the schools have been presenting candidates in mathematics at external examinations, and (iii) whether schools should be public or government owned and coeducational.

Based on the aforementioned criteria, 15 schools in education District II and 10 schools in education District III met the criteria. Thereafter, 12 schools were randomly selected from the 15 schools in education District II and eight schools were randomly selected from the 10 schools in education District III for the convenience of the researchers. Each of the schools has three streams for mathematics and these were used for the study. A total of one thousand five hundred consisting of 800 males and 700 female's Senior Secondary year three mathematics students were involved in the study. Their ages ranged from 15 years to 21 years with a mean age of 18 years 3 months (SD=2 years and 2 months).

2.3. Instrument

For data collection, one instrument tagged the sources of self-efficacy in the mathematics scale was used for this study. The Sources of Self-Efficacy in Mathematics Scale (SSEMS) is a 24-item questionnaire adapted from Usher and Pajares (2009). The SSEMS contained statements on the mastery experience, vicarious experience, social persuasions, and physiological state.

Table 1 showed the number of items for each dimension of the sources of self-efficacy on the mathematics scale. These items were graded on a modified five-point Likert scale: (0 undecideds, 1 strongly disagree, 2 disagree, 3 agree, and 4 strongly agree). The reliability coefficient (Cronbach Alpha) has been calculated using a sample group of 200 students from one senior secondary school not part of the study schools in education District II of Lagos State, Nigeria.

The reliability value for SSEMS as a whole was 0.982. The number of items and reliability value for each dimension of the SSEMS is as follows: mastery experience (6 items, α = .921), vicarious experience (6 items, α = 0.936), social persuasions (6 items, α = 0.928), and physiological state (6 items, α = 0.914). The six items in each of the four subscales of SEMS showed adequate internal consistency reliabilities, with Cronbach's alpha coefficients above the cut-off points of .80 recommended by Henson (2001).

DOI: http://dx.doi.org/10.17509/xxxx.xxxx
p- ISSN 2775-6793 e- ISSN 2775-6815

Table 1. Dimensions of sources of self-efficacy in mathematics scale.

S/No	Sources of Self-Efficacy in Mathematics Scale (SSEMS)	Number of items
1	Mastery experience	6
2	Vicarious experience	6
3	Social persuasions	6
4	Physiological state	6

2.4. Procedure for Data Collection

The researchers together with 10 research assistants personally administered the research instrument to the sample in a regularly scheduled class period. The participants were told that their participation was voluntary and that their responses would be treated with the utmost confidentiality.

2.5. Final Clarification Basin

Data collected were analysed with the descriptive statistics of frequency count, percentage, mean and standard deviation, and inferential statistics of independent samples t-test and factor analysis at a 0.05 level of significance.

3. RESULTS AND DISCUSSION

3.1. Research Question One: What is the level of the sources of mathematics self-efficacy among senior secondary school students?

Tables 2-5 show the overall sources of mathematics self-efficacy among senior secondary school students. The actual numbers and percentages for responses to each statement were shown in the table. The percentages were in parenthesis. **Tables 2-5** show that the senior secondary school students in the present study had a moderate level of sources of mathematics self-efficacy (Mean=2.509, SD=1.268).

Concerning mastery experience in mathematics (Mean=2.606, SD=1.256), 77% agreed/strongly agreed that: I make excellent grades on mathematics tests (item 1), 60% agreed/strongly agreed that: I have always been successful with mathematics (item 2), more than 75% disagreed/strongly disagreed that: even when I study very hard, I do poorly in mathematics (item 3), more than 80% agreed/strongly agreed that: I got good grades in mathematics on my last report card (item 4), 70.6% agreed/ strongly agreed that: I do well on mathematics assignments (item 5), 55% agreed/strongly agreed that: I do well on even the most difficult mathematics assignments (item 6).

Concerning vicarious experience in mathematics (Mean=2.913, SD=1.315) 77% agreed/strongly agreed that: seeing adults do well in math pushes me to do better (item 7), 78.3% agreed/strongly agreed that: when I see how my math teacher solves a problem.

I can picture myself solving the problem in the same way (item 8), 79.6% agreed/strongly agreed that: seeing kids do better than me in math pushes me to do better (item 9), 60% agreed/strongly agreed that: when I see how another student solves a math problem, I can see myself solving the problem in the same way (item 10), 77% agreed/strongly agreed that: I imagine myself working through challenging math problems successfully (item 11), 78.3% agreed/strongly agreed: that I compete with myself in math (item 12).

DOI: http://dx.doi.org/10.17509/xxxx.xxxx
p- ISSN 2775-6793 e- ISSN 2775-6815

Table 2. Senior secondary school students' sources of self-efficacy in mastery experience in math.

No	Items	SA/A	SD/D	U	M	STD	FL
1	I make excellent grades on math tests	1155 (77.0)	90 (6.0)	255 (17.0)	2.777	1.376	0.663
2	I have always been successful with math	900 (60.0)	510 (34.0)	90 (6.0)	2.833	1.204	0.778
3	Even when I study very hard, I do poorly in math.	236 (15.7)	1155 (77.0)	109 (7.3)	1.690	0.907	0.766
4	I got good grades in math on my last report card.	1240 (82.7)	200 (13.4)	60 (4.0)	3.250	1.041	0.796
5	I do well on math assignments	1060 (70.6)	165 (11.0)	275 (18.3)	2.700	1.476	0.451
6	I do well on even the most difficult math assignments	825 (55.0)	324 (21.6)	350 (23.3)	2.383	1.529	0.835
		Sub-total			2.606	1.256	

* Reverse-scored item; FL=Factor Loading; Low Level: 0.00-1.99; Moderate Level: 2.00-2.99; High Level: 3.00-4.00

Concerning social persuasions in mathematics (Mean=2.526, SD=1.349) 55% agreed/strongly agreed that: my math teachers have told me that I am good at learning math (item 13), 57.3% agreed/strongly agreed that: people have told me that I have a talent for math (item 14), 58.7% disagree/strongly disagreed that: adults in my family have told me what a good math student I am (item 15).

68.4% agreed/strongly agreed that: I have been praised for my ability in math (item 16), 56.3% agreed/strongly agreed that: other students have told me that I'm good at learning math (item 17), 66.4% agreed/strongly agreed that: my classmates like to work with me in math because they think I'm good at it (item 18). Concerning the physiological state in mathematics (Mean=1.989, SD=1.151), 51.3% disagreed/strongly disagreed that: just being in math class makes me feel stressed and nervous (item 19).

52.3% disagreed/strongly disagreed that: doing math work takes all of my energy (item 20), 62.3% disagreed/strongly disagreed that: I start to feel stressed-out as soon as I begin my math work (item 21), 61% disagreed/strongly disagreed that: my mind goes blank and I am unable to think clearly when doing math work (item 22), 60% disagreed/strongly disagreed that: I get depressed when I think about learning math (item 23), 74.7% disagreed/strongly disagreed that: my whole body becomes tense when I have to do math (item 24).

DOI: http://dx.doi.org/10.17509/xxxx.xxxx
p- ISSN 2775-6793 e- ISSN 2775-6815

Table 3. Senior secondary school students' sources of self-efficacy in vicarious experience in math.

No	Items	SA/A	SD/D	U	M	STD	FL
1	Seeing adults do well in math pushes me to do better.	1155 (77.0)	165 (11.0)	180 (12.0)	2.920	1.388	0.774
2	When I see how my math teacher solves a problem, I can picture myself solving the problem in my own way.	1175 (78.3)	145 (9.7)	180 (12.0)	2.897	1.313	0.655
3	Seeing kids do better than me in math pushes me to do better	1195 (79.6)	125 (8.3)	180 (12.0)	2.977	1.387	0.833
4	When I see how another student solves a math problem, I can see myself solving the problem in the same way.	900 (60.0)	365 (24.3)	235 (15.7)	2.603	1.421	0.700
5	I imagine myself working through challenges math problems successfully.	1320 (88.0)	125 (8.3)	55 (3.7)	3.310	1.032	0.903
6	I compete with myself in math	1095 (73.0)	185 (12.3)	220 (14.7)	2.770	1.350	0.399
	Sub-total				2.913	1.315	

* Reverse-scored item; FL=Factor Loading; Low Level: 0.00-1.99; Moderate Level: 2.00-2.99; High Level: 3.00-4.00

Table 4. Senior secondary school students' sources of social persuasions in math.

No	Items	SA/A	SD/D	U	M	STD	FL
1	My math teachers have told me that I am good at learning math.	825 (55.0)	400 (26.7)	275 (18.3)	2.397	1.456	0.859
2	People have told me that I have a talent for math.	860 (57.3)	400 (26.7)	240 (16.0)	2.420	1.355	0.741
3	Adults in my family have told me what a good math student I am	881 (58.7)	454 (30.3)	165 (11.0)	2.593	1.249	0.862
4	I have been praised for my math ability.	1025 (68.4)	345 (23.0)	130 (8.7)	2.857	1.241	0.557
5	Other students have told me that I'm good at learning math	845 (56.3)	291 (19.4)	364 (24.3)	2.230	1.516	0.788
6	My classmates like to work with me in mathematics because they think I'm good at it.	996 (66.4)	324 (21.6)	180 (12.0)	2.660	1.274	0.791
	Sub-total				2.913	1.315	

* Reverse-scored item; FL=Factor Loading; Low Level: 0.00-1.99; Moderate Level: 2.00-2.99; High Level: 3.00-4.00

DOI: http://dx.doi.org/10.17509/xxxx.xxxx
p- ISSN 2775-6793 e- ISSN 2775-6815

Table 5. Senior secondary school students' sources of physiological state in math.

No	Items	SA/A	SD/D	U	M	STD	FL
1	Just being in math class makes me feel stressed and nervous*	495 (33.0)	770 (51.3)	235 (15.7)	1.997	1.274	0.802
2	Doing math work takes all of my energy.	525 (35.0)	785 (52.3)	190 (12.7)	2.157	1.162	0.767
3	I start to feel stressed out as soon as I begin my math work*	360 (24.0)	935 (62.3)	205 (13.7)	1.943	1.118	0.794
4	My mind goes blank and I am unable to think clearly when doing math work*.	345 (23.0)	915 (61.0)	240 (16.0)	1.740	1.060	0.725
5	I get depressed when I think about learning math*	512 (34.1)	900 (60.0)	88 (5.9)	2.057	1.270	0.794
6	My whole body becomes tense when I have to do math*	345 (23.0)	1121 (74.7)	34 (2.3)	2.037	1.022	0.884
	Sub-total				**1.989**	**1.151**	
	Total				**2.509**	**1.268**	

* Reverse-scored item; FL=Factor Loading; Low Level: 0.00-1.99; Moderate Level: 2.00-2.99; High Level: 3.00-4.00

3.2. Research Question Two: What is the factor structure of the sources of the mathematics self-efficacy scale among Nigerian senior secondary school students?

The Sources of Mathematics Self-efficacy Scale (SSEMS) was adopted from Usher and Pajares (2009) with information regarding its psychometric properties in which four interpretable factor structures were achieved. However, the SSEMS was developed in a setting with different cultural background from Nigeria, the base of the current study. Thus, it is wise that the factor analytic structure is re-ascertained. Therefore, this study subjected the 24 items SSEMS to principal components factor analyses (PCA) with varimax rotation to extract its common factors.

The Sources of Mathematics Self-efficacy Scale (SSEMS) was adopted from Usher and Pajares (2009) with information regarding its psychometric properties in which four interpretable factor structures were achieved. However, the SSEMS was developed in a setting with different cultural background from Nigeria, the base of the current study. Thus, it is wise that the factor analytic structure is re-ascertained. Therefore, this study subjected the 24 items SSEMS to principal components factor analyses (PCA) with varimax rotation to extract its common factors.

The data screening processes for the SSEMS were carried out and showed no missing values for the 1500 participants. Subsequently, further screening showed no concern about normality, linearity, multicollinearity, and singularity. For example, scale scores were normally distributed with skewness and kurtosis values within acceptable ranges (e.g. skewness ranged from -0.42 to 0.66, kurtosis ranged from -1.08 to 0.52) using absolute cut-off values of 3.0 for skewness and 8.0 for kurtosis.

Initial inspection of the correlation matrix of the 24 items revealed that the correlations when taken overall were statistically significant as indicated by Bartlett's test of sphericity, $\chi 2$

DOI: http://dx.doi.org/10.17509/xxxx.xxxx
p- ISSN 2775-6793 e- ISSN 2775-6815

= 1.745E3; df=276; p<.001 which tests the null hypothesis that the correlation matrix is an identity matrix. The Kaiser-Meyer-Olkin measure of sampling adequacy (MSA) fell within the acceptable range (values of 0.60 and above) with a value of 0.85.

Each of the variables also exceeded the threshold value (0.60) of MSA which ranged from 0.72 to 0.94. Finally, most of the partial correlations were small as indicated by the anti-image correlation matrix. These measures all led to the conclusion that the set of 24 items of SSEMS was appropriate for PCA.

The initial pre-rotation resulted in four factors with eigenvalues greater than 1 (Kaiser, 1960), accounting for approximately 43.79%, and based on its pattern of factor loadings, this unrotated factor model was theoretically less meaningful and as such was difficult to interpret. Therefore, the analysis proceeded to rotate the factor matrix orthogonally to achieve a simple and theoretically more meaningful solution. Varimax rotation was used for the orthogonal solution. By rotating three factors, the total percentage of variance accounted for remained at 43.79%.

An examination of Cattell's (1966) scree test produced a four-factor solution (**Figure 1**). This seemed to support the original theory on which the instrument is based which had proposed four factors. For interpretational clarity, a salient loading of 0.40 was selected as one that is sufficiently high to assume the existence of an item-factor relationship. The first factor, which accounted for 23.66% of the variance (eigen value=5.68), was labelled Mastery Experience in mathematics and this factor included six items.

The second factor, Vicarious Experience in mathematics had six items and accounted for 7.62% of the variance (eigenvalue=1.83). The third factor, Physiological State in mathematics had six items and accounted for 7.04% of the variance (eigenvalue=1.69). The fourth factor, Social Persuasion in mathematics had six items and accounted for 5.47% of the variance (eigenvalue=1.31). In this study, all the communalities for the factor analysis satisfied the minimum requirement of being larger than 0.50. These ranged from 0.53 to 0.87. Figure 1 below is the Scree plot which graphs the eigenvalue against the component number and is suggestive of a four-component model.

Table 2 displays the factor loadings for the orthogonal four-factor model of the SSMS. All items loaded 0.50 and above on their primary factor and none of the secondary loadings exceeded 0.30. The items identified that loaded significantly on factors 1 to 4 were tested for internal reliability.

Cronbach's alpha coefficients of 0.84, 0.81, 0.85 and 0.78 were found for factors 1, 2, 3, and 4 respectively. Since the sources of the self-efficacy scale were separated into 4 latent factors identified to possess a minimum of 1.0 eigenvalues, statistically, significantly reliable, and non-overlapping subscales based on these 4 factors were used in subsequent data analyses which were outside the scope of the present study. The following models were obtained:

$F_1=0.66a_{11}+0.78a_{12}+0.77a_{13}+0.80a_{14}+0.45a_{15}+0.84a_{16}$

$F_2=0.77a_{21}+0.66a_{22}+0.83a_{23}+0.70a_{24}+0.90a_{25}+0.40a_{26}$

$F_3=0.86a_{31}+0.74a_{32}+0.86a_{33}+0.56a_{34}+0.79a_{35}+0.79a_{36}$

$F_4=0.80a_{41}+0.77a_{42}+0.79a_{43}+0.73a_{44}+0.79a_{45}+0.88a_{46}$

where a_{ij} are the items that loaded significantly high on factors of *i*, *i*, and *j* are unique for each model because no item indicates a factorial complexity of two or more.

DOI: http://dx.doi.org/10.17509/xxxx.xxxx
p- ISSN 2775-6793 e- ISSN 2775-6815

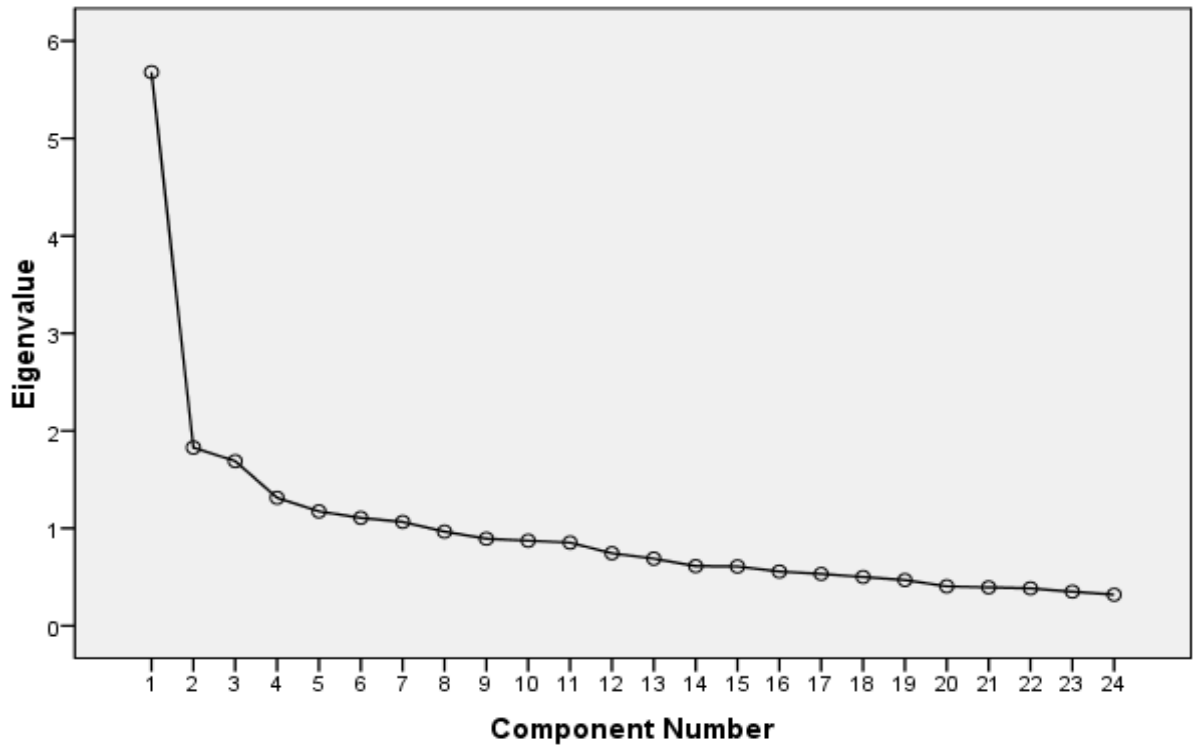

Figure 1. Eigenvalue versus the component number.

3.3. Research Question Three: What is the factor structure of the sources of the mathematics self-efficacy scale among Nigerian senior secondary school students?

Table 6 shows the descriptive statistics of mean and standard deviation and t-test values on senior secondary school students' sources of self-efficacy in mathematics according to gender. Concerning the aggregate sources of self-efficacy score, the female group recorded a lower mean score (M=59.43, SD=12.43) than their male counterparts (M=60.86, SD=13.65).

However, this difference in mean score was statistically significant (t1498=-2.12, p=0.035). Table 6 shows that the male senior secondary school students recorded a lower mean score (M=15.34, SD=4.15) in mastery experience than their female counterparts (M=15.96, SD=3.64) and this difference was statistically significant (t1498=3.09, p=0.002). In Table 3, the female senior secondary school students recorded a lower mean score (M=16.64, SD=5.49) in vicarious experience than their male counterparts (M=18.21, SD=5.09).

The difference was statistically significant (t1498=-5.77, p=0.000). Concerning the social persuasion factor, the female senior secondary school students recorded a lower mean score (M=14.60, SD=4.12) than their male counterparts (M=15.64, SD=5.48). However, this difference in mean score was statistically significant (t1498=-3.30, p=0.001).

Table 6 reveals that male senior secondary school students recorded a lower mean score (M=11.67, SD=3.92) in physiological states than their female counterparts (M=12.23, SD=4.12). This difference in mean score was statistically significant (t1498=2.69, p=0.007). Thus, it was concluded that gender had a significant influence on senior secondary school students' aggregate sources of self-efficacy in mathematics, and even at the sources of self-efficacy subscale levels.

DOI: http://dx.doi.org/10.17509/xxxx.xxxx
p- ISSN 2775-6793 e- ISSN 2775-6815

Table 6. Independent samples t-test analysis of senior secondary school students' sources of self-efficacy in mathematics according to gender.

Variable	Gender	N	M	SD	Df	t	p
Mastery experience in math	Female	700	15.96	3.64	1498	3.09*	.002
	Male	800	15.34	4.15			
Vicarious experience in math	Female	700	16.64	5.49	1498	5.77*	.000
	Male	800	18.21	5.09			
Social persuasions in math	Female	700	14.60	4.12	1498	3.30*	.001
	Male	800	15.64	5.48			
Physiological states in math	Female	700	12.23	4.12	1498	2.69*	.007
	Male	800	11.67	3.92			
Sources of math self-efficacy	Female	700	59.43	12.43	1498	2.12*	0.35
	Male	800	13.65	13.65			

*Significance at p<.01

The results of the present study have shown three main findings. These findings relate to establishing the factor structure of the sources of self-efficacy in mathematics scale with senior secondary school students, determining the level of sources of self-efficacy in mathematics among senior secondary school students, and determining whether differences existed between male and female senior secondary school students in sources of self-efficacy in mathematics.

The results of the present study showed that sources of self-efficacy in mathematics are a multi-dimensional construct. The exploratory factor analysis using the principal components analyses revealed a four-factor structure underlying the scale. The four interpretable factor structures coincided with the factor structure determined by the original developers of the scale (Usher & Pajares, 2009) and are subsequently labelled: Mastery experience (with six items), Vicarious experience (with six items), Social persuasions (with six items), and Physiological state (with six items) and each subscale had adequate internal consistency reliability.

The senior secondary school students in the present study had moderate sources of self-efficacy in mathematics (Mean=2.509, SD= 1.268). This suggests that these students have a combination of both low and high sources of self-efficacy beliefs in mathematics. This was in support of the finding in Turkey in which Azar (2010) showed that the self-efficacy of in-service and pre-service science teachers was neither low nor high. Shkullaku (2013) showed that Albanian university students recorded a moderate level of self-efficacy while in Nigeria Arigbabu and Oludipe (2010) revealed a high level of teaching efficacy beliefs among pre-service science teachers.

In addition, findings from the United Kingdom particularly England revealed that the level of self-efficacy beliefs among primary school students was very low (Webb-Williams, 2014). This was contrary to the findings from the United States which showed that the level of self-efficacy among the population was very high (Britner & Pajares, 2006; Usher & Pajares, 2009). These differences in findings might be a result of differences in strategies used to promote and engender mathematics self-efficacy in students. Self-efficacy in Nigeria is not a topical issue of research but in the United States and other developed countries, it is. PISA (2012) revealed that countries that showed a low level of mathematics anxiety for instance Portugal and Iceland had increased mathematics self-efficacy with attendant positive educational policies and programs. Such countries also showed a strong relationship between mathematics self-efficacy and mathematics performance.

DOI: http://dx.doi.org/10.17509/xxxx.xxxx
p- ISSN 2775-6793 e- ISSN 2775-6815

The results of the present study showed that gender was a factor in senior secondary school students' sources of self-efficacy in mathematics. The male and female senior secondary school students recorded different mean scores in sources of self-efficacy in mathematics. Thus, gender differences in sources of self-efficacy in mathematics as shown in this study were significant.

The implication of the present study finding regarding gender is that gender differences in sources of self-efficacy in mathematics are very important. Thus gender-based differences may be due to the individual's perception of their abilities, socio-cultural practices, and sex role stereotyping (Recber *et al*., 2018; Schiefele & Csikszentmihalyli, 1995) that males are better in mathematics than females. In the present study, the females recorded higher mastery experiences than males, lower vicarious experiences than males, lower social persuasions than males, and higher physiological states than males. This result partially supported the result of Britner and Pajares (2006) in which male students showed higher mastery experience but lower physiological states than female students.

In the literature, three outcomes of research on gender disparities in mathematics self-efficacy beliefs are outlined. First, some studies indicated significant gender differences in mathematics self-efficacy beliefs in favor of males (Peters, 2013; Louis & Mistele, 2012; Pajares & Miller, 1994; Shkullaku, 2013). Second, some studies showed significant gender differences in mathematics self-efficacy beliefs in favor of females (Pajares & Valiante, 1999; Britner & Pajares, 2001). Third, some studies exhibit no significant effect of gender on mathematics self-efficacy beliefs (Isiksal & Askar, 2005; Arigbabu & Oludipe, 2010; Kiran & Sungur, 2012).

The research carried out in the US has shown some evidence for gender differences in self-efficacy supporting males (Louis & Mistele, 2012; Pajares & Miller, 1994), and a recent meta-analysis (Huang, 2013) found small but significant gender effects across 187 studies with a small difference supporting males. However, in some studies, females have been seen to display higher self-efficacy beliefs than males.

Britner and Pajares (2001) indicated that females had higher self-efficacy beliefs and attainment in science than males and Pajares *et al*. (1999) examined gender differences and self-efficacy for writing and reported that females had a stronger self-efficacy for self-regulated learning together with higher attainment. Huang (2013) provided support for gender differences in self-efficacy beliefs in support of females. Recber *et al.* (2018) found that boys reported significantly higher self-efficacy in mathematics than girls in Turkey. This is contrary to the findings of this study in which males showed significantly higher self-efficacy beliefs than females. Kiran and Sungur (2012) examined gender differences in science self-efficacy and strategy use of 1932 middle school students. The findings revealed no gender difference regarding science self-efficacy and strategy use.

Isiksal and Askar (2005) investigated the effect of dynamic geometry software on 7th-grade students' mathematics achievement and mathematics self-efficacy beliefs. The findings indicated no significant mean difference in gain scores of females and males regarding mathematics achievement and mathematics self-efficacy beliefs. These conflicting findings regarding self-efficacy beliefs have been reported, thus further investigation is needed to determine the direction of any significant difference. While it is noted that self-efficacy research is at its climax in the US (Web-Williams, 2014) and other developed countries, it is underexplored in Africa and particularly Nigeria despite being an important concept in school learning.

DOI: http://dx.doi.org/10.17509/xxxx.xxxx
p- ISSN 2775-6793 e- ISSN 2775-6815

4. CONCLUSION

In light of these findings, it is concluded that more studies are needed with different grade levels to gain a deeper understanding of the socio-cultural factors and affective variables that could widen gender gaps related to sources of mathematics self-efficacy. More so, comprehensive research investigations should be conducted to understand how socio-cultural factors, previous knowledge, and demographic variables could affect the development of sources of self-efficacy in mathematics of senior secondary school students. Examining the ins and outs that can produce disparities in sources of self-efficacy in mathematics, investigating how sources of mathematics self-efficacy develop across the senior secondary school years, and what factors enhance its development could produce significant inferences for the educational field. However, it was thus, recommended that future studies in Nigeria and elsewhere should investigate the confirmatory factor analytic structure of the sources of self-efficacy in mathematics scale to generalize the findings of this study.

5. ACKNOWLEDGMENT

The author thanked all the students, teachers, and principals of the schools that participated in the study.

6. AUTHORS' NOTE

The authors declare that there is no conflict of interest regarding the publication of this article. Authors confirmed that the paper was free of plagiarism.

7. REFERENCES

Akinsola, M. K., and Awofala, A. O. A. (2009). Effect of personalization of instruction on students' achievement and self-efficacy in mathematics word problems. *International Journal of Mathematical Education in Science and Technology, 40*(3), 389-404.

Anderson, S.L., and Betz, N.E. (2001). Sources of social self-efficacy expectations: Their measurement and relation to career development. *Journal of Vocational Behaviour, 58*, 98–117.

Arigbabu, A. A. and Oludipe, D. I. (2010). Perceived efficacy beliefs of prospective Nigerian science teachers. *Journal of Science Education and Technology, 19*, 27–31.

Awofala, A. O. A. and Akinoso, S. O. (2017). Assessment of psychometric properties of mathematics anxiety questionnaire by preservice teachers in south-west, Nigeria. *ABACUS: The Journal of the Mathematical Association of Nigeria*, *42*(1), 355-369.

Awofala, A. O. A. and Falolu, O. S. (2017). Motivation to learn mathematics as correlates of pre-service teachers' performance in mathematics. *ABACUS: The Journal of the Mathematical Association of Nigeria*, *42*(1), 370-390.

Azar, A. (2010). In-service and pre-service secondary science teachers' self-efficacy beliefs about science teaching. *Educational Research and Reviews*, 5(4), 175-188.

DOI: http://dx.doi.org/10.17509/xxxx.xxxx
p- ISSN 2775-6793 e- ISSN 2775-6815

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioural change. *Psychological Review, 84*, 191–215.

Britner, S. L. and Pajares, F. (2006). Sources of science self-efficacy beliefs of middle school students. *Journal of Research in Science Teaching, 43*(5), 485–499.

Britner, S. L., and Pajares, F. (2001). Self-efficacy beliefs, motivation, race, and gender in middle school science. *Journal of Women and Minorities in Science and Engineering*, 7, 271–285.

Cattell, R.B. (1966). The screen test for the number of factors. *Multivariate Behavioural Research, 1*, 245–276.

Henson, R. K. (2001). Understanding internal consistency reliability estimates: A conceptual primer on coefficient alpha. *Measurement and Evaluation in Counselling and Development, 34*, 177–189.

Huang, C. (2013). Gender differences in academic self-efficacy: a meta-analysis. *European Journal of Psychology of Education, 28*(1), 1-35.

Isiksal, M., and Askar, P. (2005). The effect of spreadsheet and dynamic geometry software on the achievement and self-efficacy of 7th-grade students. *Educational Research, 47*(3), 333-350.

Kaiser, H. F. (1960). The application of electronic computers to factor analysis. *Educational and Psychological Measurement, 20*, 141-151.

Kiran, D., and Sungur, S. (2012). Middle school students' science self-efficacy and its sources: Examination of gender difference. *Journal of Science Education and Technology, 21*(5), 619-630.

Lent, R., Lopez, F., and Bieschke, K. (1991). Mathematics self-efficacy sources and relation to science-based career choice. *Journal of Counselling Psychology, 38*(4), 424-430.

Lent, R.W., Lopez, F.G., Brown, S.D., and Gore, P.A. (1996). Latent structure of the sources of mathematics self-efficacy. *Journal of Vocational Behaviour, 49*, 292–308.

Louis, R. A., and Mistele, J. M. (2012). The differences in scores and self-efficacy by student gender in mathematics and science. *International Journal of Science and Mathematics Education, 10*(5), 1163-1190.

Matsui, T., Matsui, K., and Ohnishi, R. (1990). Mechanisms underlying math self-efficacy learning of college students. *Journal of Vocational Behaviour, 37*, 225–238.

Pajares, F., and Miller, D. (1994). Role of self-efficacy and self-concept beliefs in mathematical problem solving: A path analysis. *Journal of Educational Psychology*, *86*, 193-203.

Pajares, F., and Valiante, G. (1999). Grade level and gender differences in the writing self-beliefs of middle school students. *Contemporary Educational Psychology, 24*, 390-405.

Pajares, F., Miller, M.D., and Johnson, M.J. (1999). Gender differences in writing self-beliefs of elementary school students. *Journal of Educational Psychology, 91*, 50–61.

DOI: http://dx.doi.org/10.17509/xxxx.xxxx
p- ISSN 2775-6793 e- ISSN 2775-6815

Peters, M. L. (2013). Examining the relationships among classroom climate, self-efficacy, and achievement in undergraduate mathematics: A multi-level analysis. *International Journal of Science and Mathematics Education, 11*(2), 459-480.

Recber, S., Isiksal, M., and Koç, Y. (2018). Investigating self- efficacy, anxiety, attitudes and mathematics achievement regarding gender and school type. *Anales de Psicología, 34*(1), 41-51.

Sahil, S. A. S., and Hashim, R. A. (2011). The roles of social support in promoting adolescents' classroom cognitive engagement through academic self-efficacy. *Malaysian Journal of Learning and Instruction, 8,* 49-69.

Schiefele, U., and M. Csikszentmihalyi (1995), Motivation and ability as factors in mathematics experience and achievement. *Journal for Research in Mathematics Education, 26*(2), 163-181.

Shkullaku, R. (2013). The relationship between self–efficacy and academic performance in the context of gender among Albanian students. *European Academic Research, 1*(4), 467-478.

Usher, E. L., and Pajares, F. (2009). Sources of self-efficacy in mathematics: A validation study. *Contemporary Educational Psychology, 34*(1), 89-101.

Usher, E., and Pajares, F. (2006). Sources of academic and self-regulatory efficacy beliefs of entering middle school students. *Contemporary Educational Psychology, 31,* 125–141.

Webb-Williams, J. (2014). Gender differences in school children's self-efficacy beliefs: Students' and teachers' perspectives. *Educational Research and Reviews*, *9*(3), 75-82.

DOI: http://dx.doi.org/10.17509/xxxx.xxxx
p- ISSN 2775-6793 e- ISSN 2775-6815