


Classroom Assessment Literacy Levels of Mathematics Teachers in Ghanaian Senior High Schools

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ABSTRACT

The mathematics teacher's ability to assess and integrate assessment data into instructions is a function of their assessment literacy. While the teacher's assessment literacy level is a determinant of quality of mathematics education delivery, research in the domain is limited. The study employed a descriptive survey design to explore perceived levels of assessment literacy of mathematics teachers in implementing classroom assessment within the school based assessment framework. A 35-item classroom assessment inventory was adopted, modified and administered to a purposive sample of 96 mathematics teachers from eleven Senior High Schools in Ghana. Seven other items were included to further collect data on their self-efficacy beliefs about their assessment literacy. Data were analyzed using descriptive statistics, Mann Whitney U test and correlation analysis. The result shows that majority of the participants did not attain the required assessment literacy standards for quality assessment in mathematics classroom. Moreover, there was a mismatch between participants' assessment literacy and their self-efficacy beliefs in assessment in mathematics education even when gender and teacher experience were controlled. The study recommends that institutions training mathematics teachers or providing professional development should accentuate assessment literacy development to ensure standard assessment practices and quality instruction in mathematics at senior high schools. The assessment inventory used in this study could be adapted for use in college of education in Ghana to measure mathematics teachers' literacies in assessing students.

Keywords: assessment literacy, mathematics teachers, self-efficacy beliefs, senior high schools

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INTRODUCTION

Classroom assessment forms an integral part of mathematics instructions because of its role in providing summative and formative evidences needed for making educational decisions, offering feedback on students' progresses, judging instructional effectiveness and curricular adequacy as well as informing policy practices (Siegel & Wissehr, 2011; Tan et al., 2017). However, in view of the changing role of assessment and the inability of some teachers to assess their students satisfactorily, providing such evidences has remained a challenge over the years (Herrington et al., 1997; Kim & Lee, 2021).

In the 21st Century, the role of classroom assessment has shifted from summative agenda of gathering evidences of overall measure of achievement of students, to a more supportive role of formative assessment where students' achievement leads to action plans, for both the teacher and students (Larsari, 2021; Ministry of Education, 2018a; Tan et al., 2017). This formative assessment, described in the Ghanaian curriculum documents and other countries as School Based Assessment (SBA), has placed enormous responsibility on the mathematics teacher (Awoniyi, 2016).

The SBA framework requires mathematics teachers to continuously and realistically measure, evaluate, document and communicate academic readiness and knowledge acquisition levels of students relative to specific learning benchmarks (Awoniyi, 2016; Ministry of Education, 2018a). The expectation of the SBA is that mathematics teachers would apply multiple and alternative authentic ways of assessing the quality of students' learning.

To be able to apply such ways of assessment within the SBA expectation, mathematics teachers' assessment literacy in its implementation is an important factor (Stiggins, 1999). That is, mathematics teachers should be knowledgeable and skilled in choosing, developing and administering appropriate assessment tasks to students. They should also be skilled in applying multiple alternative pathways in scoring and interpreting learning outcomes for pedagogical decisions.

Assessment literacy has been defined by many authors in different ways based on the purpose of assessment. While some authors focused on the knowledge and skills educators use to identify and design assessment for various purposes (Xu & Brown, 2016), other authors framed assessment literacy in terms of assessment principles, knowledge and skills (Tan et al., 2017; Stiggins, 1995). In this study however, assessment literacy entails mathematics teachers' knowledge

of the content and learning outcomes to be assessed, purpose and ways of assessing students, and skills of applying quality instruments to assess students' performance (Koh & Velayutham, 2009; Stiggins, 1995). For inferences and instructional adjustments as required by SBA, it is assumed that mathematics teachers should demonstrate high level of assessment literacy standard and self-efficacy for classroom practice (Xu & Brown, 2016).

Assessment Literacy Frameworks and Standards

In recent times, assessment literacy has attracted the attention of researchers because it empowers the mathematics teacher to effectively implement the mathematics curriculum (Kim & Lee, 2021; Lian & Yew 2020; Xu & Brown, 2016). However, few studies that exist (Huang & He, 2016; Larsari, 2021; Siegel & Wissehr, 2011; Popham, 2004) suggest that teachers with no or little assessment literacy produce unreliable assessment data that adversely affect pedagogical and policy decisions. While Huang and He (2016) stressed that limited assessment literacy produces inaccurate assessment of learning process, Popham (2004) identified the consequences of assessment illiteracy such as professional suicide and unaccountable learning relapse about the success of an education system. Despite these consequences, available studies continue to portray novice and experienced teachers who do not feel adequately prepared to effectively assess their students (Huang & He, 2016; Siegel & Wissehr, 2011).

Tan et al. (2017) noted that proper assessment literacy development is deeply rooted in teacher training and professional development. Teachers, during their training and professional development sessions, are often introduced to or updated on three key components of assessment literacy namely principles, skills and knowledge of assessment. The principles, skills and knowledge entail identifying and choosing effective assessment methods, using assessment to maximize learning, interpreting and applying assessment outcomes and integrating assessment in decision making as well as the purpose of assessment (Abell & Siegel, 2011). Despite this, there is limited evidence regarding how teachers imbibe and apply these principles, skills and knowledge effectively in their assessment practices (Tan et al., 2017).

There are three purposes of assessment which relate to supply of formative or summative evidences. These are assessment *of* learning, assessment *for* learning and assessment *as* learning (Earl, 2013). Assessment of learning is summative. It is regarded as an accountability measure from tests conducted at the end of a learning cycle to determine the extent to which learning has occurred within the period. However, assessment for learning and assessment as learning are formative evidences taken constantly during the learning process to modify instructions and improve learning respectively. To achieve these assessment purposes, teachers need to be well-equipped with assessment literacy to function effectively (Kim & Lee, 2021; Lian et al., 2014; Yamtim & Wongwanich, 2014). This suggests the demand to measure teachers' level of assessment literacy.

Research into how teachers' assessment literacy is measured has been ongoing prior to the 1990s. However, the American Federation of Teachers, the National Council on Measurement in Education and the National Education Association (AFT, NCME, NEA) (1990) were the first to develop assessment standards for measuring teachers' assessment literacy. These standards are stated as follows:

Standard	Indicators
Standard 1:	Teachers should be skilled in choosing appropriate assessment methods for instructional decision making.
Standard 2:	Teachers should be skilled in developing appropriate assessment tasks, methods and tools for making decisions about instruction.
Standard 3:	Teachers should be skilled in administering, scoring and interpreting assessment outcomes.
Standard 4:	Teachers should be skilled in using assessment outcomes to make decisions about students, to plan for instruction, to develop curriculum and improve the school system.
Standard 5:	Teachers should be skilled in developing valid grading procedures for assessing students' achievement.
Standard 6:	Teachers should be skilled in communicating assessment outcomes with students, parents, educator, etc.
Standard 7:	Teachers should be skilled in recognizing unethical, illegal, and otherwise inappropriate assessment methods and uses of assessment information.

These standards were to help define the criteria for teacher assessment competence referred to in this study as teachers' assessment literacy level. These standards as noted by Yamtim and Wongwanich (2014) relate assessment to instruction such that effective instruction cannot occur without quality assessment of students' learning. These standards are also considered in the measure of mathematics teachers' assessment literacy levels for this present study.

Perceived Self-Efficacy Beliefs in Assessment Literacy

Self-efficacy beliefs theory states that individuals have certain beliefs and thoughts about their own competences and capabilities to achieve certain tasks (Bandura, 1977). This suggests that the mathematics teacher's self-efficacy beliefs about their own level of knowledge, skills and abilities propel their action in curriculum implementation. This further suggests that teachers' assessment literacy is well underpinned by their self-efficacy beliefs regarding assessment and its role in mathematics teaching and learning (Sbai, 2018). In this study, self-efficacy beliefs of mathematics teachers' own assessment literacy is a key construct that is measured perceptually.

Although previous studies about assessment literacy have focused on the use of assessment scenarios and realistic assessment tasks, few studies explored assessment literacy using self-efficacy beliefs of teachers. Sbai (2018) for example explored the teachers' self-efficacy belief in their own assessment literacy and found that participants were likely to implement sound assessment in their classrooms. Other related studies showed that teachers who rated themselves low in their self-efficacy beliefs demonstrated low motivation to complete instructional tasks (Zee & Koomen, 2016). Therefore, understanding the self-efficacy beliefs of mathematics teachers about their own assessment literacy is important as it could reveal the likely assessment principles, skills and knowledge applied by mathematics teachers. It would also help to determine how teacher education and professional development can incorporate teachers' belief system into assessment literacy development programmes.

Studies on Assessment Literacy of Teachers

The issue of inadequate assessment literacy is not new in education, though less researched in mathematics education. Over decades, there has been debate in the literature about teachers' assessment practices with some researchers indicating that many preservice, novice and experienced teachers do not possess essential capacity necessary to successfully fulfil their assessment duties (Koh & Velayutham, 2009; Yamtim & Wongwanich, 2014). A study by Suah and Ong (2012) indicated that in-service teachers use traditional types of assessment. Their assessment practices differed between language teachers, science and mathematics teachers, primary school teachers and secondary school teachers and experienced teachers with inexperienced teachers.

Siegel and Wissehr (2011) explored ways in which pre-service teachers included assessment into their teaching and their perceived role of assessment in teaching and learning. Their study concluded that pre-service teachers were often not sure about alternative assessment practices. The study suggests that teacher education programmes do not place emphasis on pre-service teachers' assessment literacy as teachers seem not well prepared to select and implement variety of appropriate assessments as learning. AlKharusi (2011) investigated teachers' self-perceived skills as a function of gender and teaching experience and found that there were significant differences with regards to teaching experience and in-service training.

Koh and Velayutham (2009) investigated how prolonged professional development sessions improve teachers' assessment literacy and found that teachers' assessment tasks and quality of students' work increased substantially for all subjects, except Mathematics where the improvement was only slightly. The slight improvement in Mathematics teachers' skills in assessment tasks was attributed to the nature of the subject. The result points to the complexity and challenging nature of developing assessment literacy of mathematics teachers compared to other subject area teachers.

Recently, Lian and Yew (2020) assessed preservice teachers' level of assessment literacy prior to their teaching practicum using super-item test and concluded that majority of the samples were stuck at low levels and did not perform well in selecting and constructing assessment tasks. Sbai (2018) explored K-12 teachers' perception of their own assessment literacy and obstacles that hinder them from conducting effective assessment for their students. The study concluded that teachers have high perception of their assessment literacy but lack training on assessment literacy. Arguing from theoretical lens, Lian et al. (2014) maintained that assessment literacy should focus more on practical issues of validity, reliability, transparency and fairness as well as information usage.

From literature reviewed (Larsari, 2021; Zee & Koomen, 2016), many teachers appear ill-prepared to develop, administer and interpret assessment. They are less skilled and experience difficulty in developing authentic assessments (Siegel & Wissehr, 2011). However, in Ghana and with respective mathematics teachers at the senior high school, research on assessment literacy is very rare. This study therefore contributes to the limited literature on assessment literacy of mathematics teachers in the context of secondary education.

Statement of the Problem

Available literature from many countries reveals that not much is done on assessment literacy of mathematics teachers at senior high schools (Yamtim & Wongwanich, 2014). One concern that remains

unclear is whether the present crop of mathematics teachers' assessment literacies are meeting the 21st century necessities of making mathematics a socio-cultural activity, a way of thinking and a way of communicating problem solving processes and solutions.

In Ghana, the recent emphasis on SBA requires a set of skills and competences from mathematics teachers for effective assessment. These skills and competences are particularly crucial following the increasing class sizes resulting from the free senior high school policy intended to improve access to secondary education. With increasing class enrolments, an understanding of mathematics teachers' assessment literacies is imperative for the effective implementation of the mathematics curriculum (Ministry of Education, 2018a) and for the realization of Ghana Education Strategic Plan 2018-2030 of making Ghana a mathematics learning nation (Ministry of Education, 2018b). However, there is currently a dearth of data on Ghanaian mathematics teachers' assessment literacy. This study was designed to fill this void by exploring the assessment literacy levels and beliefs of Senior High School mathematics teachers in Ghana.

Research Questions

The study sought to answer the following research questions.

1. What are the assessment literacy levels of senior high school mathematics teachers?
2. What are the self-efficacy beliefs of senior high school mathematics teachers regarding their own assessment literacy?
3. Are there any relationships between the assessment literacy and self-efficacy beliefs of senior high school mathematics teachers about their own assessment literacy?

Research Hypothesis

Didactically, it is necessary that regardless of gender or years of experience, an assessment literate mathematics teacher should be skilled in choosing assessment methods, designing suitable assessment, making accurate judgment and communicating assessment results appropriately. This however remains conjectural as research is still inclusive about difference in assessment literacy between gender and between teaching experiences (Bandebe & Olutawayo, 2013). Therefore, to effectively answer the research questions, the following research hypotheses were tested.

- Ho1: There is no significant gender difference in participants' assessment literacy levels.
- Ho2: There is no difference in participants' assessment literacy levels by level of experience in teaching.
- Ho3: There is no significant relationship between assessment literacy and self-efficacy beliefs of mathematics teachers about their own assessment literacy.

METHODOLOGY

Design of the Study

The study was a descriptive research. Kothari (2004) presents descriptive research as a fact-finding enquiry for describing the state of affairs of a phenomenon. In this study, the descriptive design was adopted to enable the researcher obtain data on the state of affairs of mathematics teachers' assessment literacy and self-efficacy beliefs in practice.

Table 1. Distribution of characteristics of participants in the study

Gender	Highest qualification			Type of teacher	
	Bachelor	Master	Novice	Experienced	
Male	74 (77.1%)	8 (8.3%)	14 (14.6%)	68 (70.8%)	
Female	12 (12.5%)	2 (2.1%)	2 (2.1%)	12 (12.5%)	
Total	86 (89.6%)	10 (10.4%)	16 (16.7%)	80 (83.3%)	

Scenario #4: Mr Adongo is a mathematics teachers in a senior high school experienced in issues of classroom assessment. He is often asked to respond to mathematics departmental questions on best practices for evaluating student learning in mathematics.

22. Ms Assibi, also a mathematics teacher, asks what type of assessment is best for evaluating senior high school form one students' writing skills in mathematics. Which of the following methods is likely to provide the best response to her question?

- Selected response methods
- True/false statement
- Completion items

23. One of the mathematics teachers is designing her tests to make greater use of "story problem" as a way to check students' mathematics understanding. She consulted Adongo to see what if any concerns she should be aware of when designing story-based test.

- Make sure that the reading level is grade appropriate
- Avoid scenarios more familiar to concern groups over others
- Check for clarity of sentence construction
- Incorporate scenarios used during instruction

Figure 1. Sample items**Table 2.** Item content and numbers used to measure each assessment literacy standard

Item content	Item #
skills in choosing appropriate assessment methods	1, 8, 15, 22 and 29
Skills in developing appropriate assessment tasks/methods	2, 9, 16, 23 and 30
Skills to administering, scoring and interpreting results of external and teacher-produced assessment methods	3, 10, 17, 24, and 31
Skills in appropriate use of assessment results to make instructional decisions.	4, 11, 18, 25, and 32
skills in developing valid grading procedures	5, 12, 19, 26, and 33
Skills in appropriate communication of assessment results	6, 13, 20, 27, and 34
Skills in recognizing unethical use of assessment information	7, 14, 21, 28 and 35

Participants

Purposive sampling technique was used to select eleven (11) senior high schools in the northern regions of Ghana. Ninety-six (96) professional mathematics teachers comprising 82 males and 14 females who volunteered to participate in the study were selected from the eleven senior high schools. The distribution of the characteristics of participants is presented in **Table 1**.

As shown in **Table 1**, the majority of male participants had bachelor degree while a few had master degree in mathematics education. Also, the majority (70.8%) of the males and a few (12.5%) of the females were experienced teachers with between five and 25 years of teaching mathematics at senior high schools in Ghana. The rest of participants (16.7%) were novice teachers with less than five years of teaching experience. With such high proportion of experienced teachers, it is expected that many participants would exhibit high literacy standards in classroom assessments.

Research Instrument and Administration

Classroom assessment literacy inventory questionnaire developed by Mertler (2002, 2004) was adapted for data collection to measure seven assessment literacy standards. The reported psychometrics properties in terms of reliability ($r_{KR20} = .75$), item difficulty value (.212 - .992), the mean item difficulty (.681) and discrimination index (.32) (Mertler, 2004) and its frequent use in studies in different countries, make the instrument reliable. The instrument contains 35 content-based items formulated from assessment scenarios. The scenarios with their associated items were modified. The items were structured in four multiple choices (see sample in **Figure 1**).

Table 2 shown the item content and item numbers measuring each of the seven assessment literacy standards.

Seven items parallel to the seven standards were included to measure the mathematics teachers' self-efficacy in their own assessment literacy. These items were structured on a scale of 0 to 4, where 0 and 4 signified lowest and highest self-efficacy levels respectively. Participants' demographic characteristics were also included in the inventory. The entire instrument was critically examined and reviewed for face and content validities, and later rated for consistency by two mathematics educators and five teachers from a senior high school in the Central Region of Ghana. Inter-rater consistency of 91.5% was achieved between the educators and teachers.

The inventory was administered to participants in the eleven selected senior high schools in the Northern Regions of Ghana. The researcher visited the selected schools at different days to interact and administer the inventory questionnaire. Participants completed and returned the inventory to the researcher each day of the visits. This ensured 100% return rate.

Ethical Considerations

To gain access to schools for data collection, a consent letter was submitted to the Municipal Directors of Education in-charge of the selected senior high schools for approval. When approval was granted, the directors wrote to heads of the selected senior high schools to enable the researcher meet participants. Participants were informed of the purpose of the study and the inventory questionnaire was administered to those who consented. Participants were assured of their confidentiality and given the opportunity to opt out at any point of the study.

Data Analysis Procedure

The data collected from the study instrument were cleaned up, coded and keyed into SPSS software to produce a data file for

Table 3. Descriptive statistics of participants' assessment literacy scores (min=11, max=25, N=96)

Mathematics teachers' assessment literacy in ...	Mean	SD	Criterion	%
<input type="checkbox"/> Standard 1: choosing assessment methods	2.6	.29	high	50.0
<input type="checkbox"/> Standard 2: developing assessment tasks	3.1	.40	high	68.8
<input type="checkbox"/> Standard 3: administering, scoring and interpreting results	2.3	.23	low	39.6
<input type="checkbox"/> Standard 4: assessment decision making	2.8	.17	high	58.3
<input type="checkbox"/> Standard 5: developing valid grading procedures	2.2	.09	low	41.7
<input type="checkbox"/> Standard 6: communicating assessment results	2.4	.16	low	45.8
<input type="checkbox"/> Standard 7: recognizing unethical, misuse of assessment results	2.3	.15	low	36.7
<input type="checkbox"/> Overall score of seven literacy standards	17.5	.46	low	48.7

Table 4. Mann Whitney U test of gender difference in participants' assessment literacy levels

	Choosing assessment methods	Developing assessment tasks	Administering, scoring and interpreting results	Assessment decision making	Developing valid assessment procedures	Communicating assessment results	Recognizing unethical misuse of assessment
Male mean rank	52.1	48.5	49.6	48.7	52.2	47.5	47.2
Female mean rank	50.0	48.3	42.2	47.2	26.7	54.3	39.5
Mann-Whitney U	441.0	570.5	485.5	556.0	269.0	493.0	448.5
P-values (2-tailed)	.152	.970	.344	.845	.001	.383	.295

Grouping Variable: gender

Table 5. Mann Whitney U test of difference in participants' assessment literacy levels by teaching experience

	Choosing assessment methods	Developing assessment tasks	Administering, scoring and interpreting results	Assessment decision making	Developing valid assessment procedures	Communicating assessment results	Recognizing unethical misuse of assessment
Novice	56.3	53.3	52.1	56.1	45.8	45.4	39.2
Experience	46.9	47.5	47.8	46.9	49.1	49.1	47.5
Mann-Whitney U	514.5	562.5	582.5	519.0	596.0	590.0	490.5
p-values (2-tailed)	.200	.427	.560	.214	.655	.610	.230

Grouping Variable: level of experience of teachers (novice and experienced)

descriptive and inferential analyses. The responses of participants were summed separately to reflect each assessment standard. The sum for each standard ranged from 0 to 5 where 5 represented the highest level. The mean scores with standard deviations were computed to ascertain participants' literacy on each assessment standard. For this study, a participant is counted as having attained high assessment literacy standard if he/she scored above the mean of 2.5 (Mertler, 2002). Mann Whitney U tests were conducted to test if there are differences in assessment literacies of participants by gender and by level of experience in teaching at .05 significance levels. For self-efficacy beliefs, a participant is counted as having attained high self-efficacy beliefs if he/she scored above the mean of 2.0. Also, Spearman rank correlation analysis was performed to determine the correlation between assessment literacy and self-efficacy beliefs at .05 significance level.

RESULTS

Level of Assessment Literacy of Mathematics Teachers

One of the focus of the study was to determine participants' level of assessment literacy. The result of descriptive analysis of participants' responses to the inventory questionnaire based on the seven literacy standards framework (Mertler, 2002) is presented in **Table 3**.

On aggregate, participants' overall scores ranged from 11 to 25 and this yielded an overall mean score of 17.5 (SD=.46) out of the expected total score of 35. As shown in **Table 3**, the mean scores for the seven assessment literacies ranged from 2.2 (SD=.10) in developing valid grading procedures to 3.1 (SD=.40) in developing assessment tasks. An examination of all the mean scores shows that apart from the literacies

in choosing assessment methods (2.6), developing assessment tasks (3.1) and assessment decision making (2.8), the mean scores of the rest of the literacies fell below the criterion mean score of 2.5.

Detailed analysis of participants who attained the cut-off mean score of 2.5 or higher in each assessment literacy standards revealed that about one-half (½) of the participants attained assessment standard 1, 2 and 4, and more than one-half (½) of participants did not attained the rest of the standards. The overall results show that averagely only 49% of participants attained the standard assessment literacy in mathematics.

Further analysis was performed to test research hypothesis 1 (Ho1) regarding gender difference in participants' assessment literacy levels. The analysis involved Mann Whitney U test at .05 significance level to determine if the mean ranks of participants' assessment literacy levels differ statistically by gender. The result is presented in **Table 4**.

Table 4 shows that, except for literacy in developing valid assessment procedures which differ significantly by gender ($U = 269.0, p = .001, z = -3.276, N = 96$), the rest of the mean ranks did not differ significantly between male and female participants. Since p-value for only one literacy standard was statistically significant, further analysis was done to determine its effect size. The effect size (η^2) computed was .334, signifying that 33.4% of the variability in the mean ranks for participants' literacy in developing valid assessment procedures is accounted for by gender.

For research hypothesis 2 (Ho2), Mann Whitney U test was also conducted to determine if the mean ranks of assessment literacy levels differ statistically by participants' teaching experience. The result is presented in **Table 5**.

Table 6. Frequency counts and percentages of participants' self-efficacy beliefs ratings of their assessment literacy levels

Mathematics teachers' self-efficacy beliefs rating in ...	Mean	SD	Criterion	%
<input type="checkbox"/> choosing appropriate assessment methods to measure mathematics learning outcomes	2.9	.78	high	65.7
<input type="checkbox"/> developing classroom assessment tasks in line with the lesson objectives	2.9	.69	high	79.9
<input type="checkbox"/> administering, scoring and interpreting scores of students	2.9	.77	high	64.6
<input type="checkbox"/> using students results to make instructional decisions	3.0	.70	high	77.1
<input type="checkbox"/> developing suitable grading procedures for classifying students' achievement	2.9	.68	high	73.0
<input type="checkbox"/> communicating assessment results to students, parents, educators, etc.	2.6	.84	high	66.3
<input type="checkbox"/> recognizing unethical, illegal use of assessment results	2.7	.73	high	58.3

NB: Cut-off criterion (mean below 2.0 is low and mean above 2.00 is high)

% are those with high self-efficacy beliefs about their assessment literacy

Table 7. Mean ranks of self-efficacy beliefs by gender and by teaching experience

Gender	Male mean rank	Female mean rank	Mann-Whitney U	P-values (2-tailed)
	49.4	43.2	500.0	.438
Teaching experience	Novice	Experienced	Mann-Whitney U	P-values (2-tailed)
	5.5	3.5	4.0	.237

Table 8. Bivariate correlation coefficients of participants' self-efficacy ratings and assessment literacy scores (N=96)

Literacy	SE1	SE2	SE3	SE4	SE5	SE6	SE7
Standard 1	.139 (.345)	-.068 (.646)	-.026 (.862)	-.024 (.873)	-.245 (.093)	-.317* (.028)	-.005 (.974)
Standard 2	.087 (.558)	-.009 (.953)	-.101 (.493)	.002 (.991)	-.218 (.137)	.227 (.120)	.040 (.788)
Standard 3	.125 (.396)	.309* (.033)	.178 (.226)	.180 (.221)	.058 (.697)	.438** (.002)	.005 (.971)
Standard 4	-.011 (.942)	.160 (.276)	.088 (.553)	.094 (.525)	.063 (.671)	.017 (.907)	.052 (.727)
Standard 5	-.199 (.176)	.024 (.869)	-.081 (.585)	.012 (.935)	-.059 (.689)	.106 (.475)	.009 (.952)
Standard 6	.063 (.670)	.011 (.941)	-.180 (.220)	.222 (.130)	.108 (.463)	-.077 (.602)	.067 (.649)
Standard 7	-.015 (.923)	-.041 (.784)	-.259 (.078)	-.044 (.771)	-.294* (.045)	.034 (.820)	-.077 (.605)

NB: SE=Self-Efficacy beliefs rating at each standard of assessment literacy

Parenthesis are significant values (p-values)

Table 5 shows that the mean ranks of participants' assessment literacy levels in all seven assessment standards did not differ significantly between novice and experienced teachers at .05 significance level. Participants with five to 25 years of teaching experience did not differ in their assessment literacy from those with less than five years teaching experience.

Mathematics Teachers' Self-efficacy Beliefs of their Assessment Literacy

Another focus in this study was to determine participants' ratings of their self-efficacy beliefs about their assessment literacy levels on the scale 0 to 4. Participants' ratings were analysed using mean with standard deviation and percentages and presented in **Table 6**.

An examination of all the mean scores with their standard deviations in **Table 6** shows that participants' level of self-efficacy beliefs was higher than the cut-off mean value of 2.0. Specifically, more than 70% of the participants rated themselves high (i.e., above 2.0) in their self-efficacy beliefs in developing assessment task, using students' results to make decisions and developing grading procedures in mathematics. Similarly, up to two-thirds ($\frac{2}{3}$) of the participants rated themselves high in choosing assessment methods and in administering, scoring, and interpreting results. Overall, the highest self-efficacy belief was in choosing appropriate assessment methods and lowest was in recognizing unethical, illegal, and inappropriate use of assessment results.

Even though not explicitly hypothesized earlier, Mann Whitney U test was conducted to determine if the mean ranks of self-efficacy beliefs differ statistically by participants' gender and by teaching experience. The result is presented in **Table 7**.

Table 5 shows mean rank for male of 49.4 and female of 43.2 in self-efficacy which yielded Mann-Whitney U value of 500.0 with p-value of .438. The result shows no significant difference in participants' self-efficacy beliefs about their own assessment. Similarly, mean ranks for novice 5.5 and experienced teachers of 3.5 in self-efficacy beliefs which yielded Mann-Whitney U value of 4.0 with p-value of .237. The result shows no significant difference in participants' self-efficacy beliefs by teaching experience.

Relationship between Self-Efficacy Belief and Assessment Literacy

The study was also to determine the relationship between participants' assessment literacy and self-efficacy beliefs of their assessment literacy. Participants' scores and ratings were analysed using Spearman rank bivariate correlation. The results of the correlations with their corresponding p-values at .05 significant level are as presented in **Table 8**.

As shown in **Table 8**, the matrix of Spearman rank correlation coefficients particularly along the leading diagonal shows weak correlations between participants' assessment literacies and the corresponding self-efficacy beliefs for all seven standards.

Research hypothesis 3 (Ho3) tested any statistically significant relationship between assessment literacy and self-efficacy beliefs of mathematics teachers about their own assessment literacy. From **Table 8**, all correlation coefficients indicated that except in four cases, no statistically significant relationships occurred at .05 level between assessment literacy and self-efficacy beliefs of participants. The partial correlation analysis between the overall scores of assessment literacy and overall ratings of self-efficacy beliefs controlling for gender and teaching experience were computed as shown in **Table 9**.

Table 9. Partial correlations of participants' assessment literacy and self-efficacy controlled by gender and by experience in teaching

Control Variables		Self-efficacy ratings	
Gender of teachers (male, female)	Overall score of seven levels	Correlation	.006
		Sign (2-tailed)	.956
Teaching experience (novice, experienced)	Overall score of seven levels	Correlation	-.063
		Sign (2-tailed)	.549
		df	91

As shown in **Table 9**, when gender and by experience in teaching were controlled, the correlation between participants' assessment literacy and self-efficacy belief were still weak and statistically insignificant. These results suggest that the assessment literacy of female and male mathematics teachers differ from their self-efficacy beliefs. Similarly, whether experienced or novice in teaching, the participants' assessment literacy does not relate to their self-efficacy beliefs.

DISCUSSION OF FINDINGS

This study explored the levels of assessment literacy of mathematics teachers in senior high schools and whether these levels relate to their self-efficacy beliefs. The study identified four main findings discussed as follows.

First, the study found that participants' assessment literacies were lower than the standard literacy levels for implementing effective assessment practices in the mathematics classroom. Particularly, up to one-half of the participants did not reach the required standard of assessment literacy. Among the seven assessment literacies examined, participants' highest literacy was in developing assessment methods and lowest literacy was in developing valid grading procedures. This finding suggests that participants seem inadequately exposed to standard assessment recommended under the SBA in Ghana or by AFT, NCME and NEA (1990). It therefore means this crop of mathematics teachers is likely to exhibit difficulties in identifying *what, why* and *how to* assess in mathematics classroom at senior high schools in Ghana. The finding is consistent with previous studies (Santos & Cai, 2016; Beziat & Coleman, 2015) which identified illiteracy in assessment as a factor influencing the implementation of SBA. Other studies on assessment literacy (Larsari, 2021; Lian & Yew, 2020; Mahmud, 2020; Tan et al., 2017) also noted that teachers with little assessment literacies tend to assess students unsatisfactorily and produce unreliable assessment data that negatively affect pedagogical and policy decisions. The finding, perhaps, reflects concerns among Ghanaians about the trustworthiness of SBA data produced by teachers towards candidates' final scores of the national senior secondary certificate examinations. In Ghana, there have been reform efforts by the Ghana Education Service to improve the quality of SBA data and improved classroom assessment practices towards assessment *for* and *as* learning where the teacher plays central role (Ministry of Education, 2018b). However, it remains unclear how mathematics teachers imbibe these assessment practices. The present evidence suggests that even though such reform agenda are clearly defined in curriculum documents, the mathematics teacher's assessment literacies, beliefs and practices are yet to yields the desire change. Perhaps, such desire change might occur if we re-examine critically the role teacher training and professional development sessions play in bridging the gap between mathematics teachers' literacy levels and intended assessment agenda.

Second, it was found that except literacy standard on developing valid grading procedures where 33.4% of the variability in the mean ranks is accounted for by gender, there were no differences in participants' assessment literacy levels by gender and by level of teaching experience. The finding implies that both novice and experienced mathematics teachers, regardless of their gender orientation, appear ill-prepared to carry out assessment *for* and *as* learning as enshrined in the SBA. If mathematics teachers in service for more than five years tend to exhibit comparably low assessment literacies as novice teachers, it might be due partly to deficiency in their continuous professional growth in assessment. Tan et al. (2017) admitted that most workshops aimed at upgrading mathematics teachers' professional practices usually overlook the skillset and challenges in classroom assessment. In fact, where such workshops are based on assessment literacy, they appear erratic and do not equip participants with requisite skills to perform quality SBA. The issue of low assessment literacy could also be attributed to failure of teacher training institutions to emphasise assessment literacy when developing teachers' mathematical knowledge for teaching (Huang & He, 2016; Larsari, 2021). In Ghana, very little attention is often given to mathematics teachers' assessment literacies during initial teacher training and professional development sessions. It has been observed that most teachers in Ghana have limited knowledge on how to set cognitively demanding tasks, check reliability/validity of assessment tools or develop suitable grading procedures (Ministry of Education, 2018b). This tends to limit the mathematics teachers' assessment skills and thus corroborates public worries in Ghana that assessment data produced by mathematics teachers in SBA could not reflect the true potentials of students. This leads to erroneous conclusions on students' performance in mathematics (Awoniyi, 2016; Ministry of Education, 2018b). According to Awoniyi (2016), such erroneous conclusions affect the quality of mathematics education. This is confirmed by Mahmud (2020) who identified that mathematics teachers' lack classroom assessment literacy affects their ability to ask higher level questions that stimulates students' mathematical thinking skills.

Third, it was found that participants' perceived self-efficacy beliefs were generally high with the highest self-efficacy belief being in choosing appropriate assessment methods and lowest being in recognizing unethical, illegal and inappropriate use of assessment results. Specifically, it was found that both male and female mathematics teachers, irrespective of their teaching experiences, rated themselves high in their self-efficacy beliefs to choose, develop and implement assessment tasks/methods as well as make instructional decisions or communicate students' learning outcomes ethically. As acknowledged in literature, self-efficacy belief is a key indicator of how mathematics teachers implement effective classroom assessment (Kim & Lee, 2021; Lian & Yew, 2020; Sbai, 2018). Therefore, evidence of the high self-efficacy beliefs in this study suggests that the mathematics teachers feel they possess sufficient skills and are competent in implementing effective classroom assessment in mathematics.

Four, the study found that the relationships between participants' assessment literacies and their self-efficacy beliefs were generally weak and statistically insignificant even if gender or teaching experience were controlled. In particular, the weakest correlation occurred between developing classroom assessment tasks, and administering, scoring and interpreting assessment results. While the finding shows that the mathematics teachers believe they can implement SBA, it is surprising that their beliefs were inconsistent with their standard skillsets in assessment. This inconsistency casts doubt about whether these mathematics teachers' beliefs have any influence on their assessment practices in the mathematics classroom. It might as well be that what they think as competencies in assessment is at variant with the universally recommended assessment literacies. The gap between their self-efficacy beliefs and assessment literacies therefore needs to be addressed to prevent observable pitfalls in assessment practices at the senior high schools in Ghana.

CONCLUSION

This study concludes that the assessment literacy levels of mathematics teachers in this study, irrespective of their gender or teaching experience, generally fell below the standards required to implement SBA in mathematics classroom at the senior high schools. Furthermore, the assessment literacy levels of the mathematics teachers are not consistent with their self-efficacy beliefs. The implication is that the mathematics teachers are likely to struggle with the SBA reform agenda which aims at increasing students' mathematical thinking and making Ghana a mathematics learning nation (Ministry of Education, 2018a). For effective SBA, the mathematics teachers' assessment literacy has to be given the attention and priority it deserves by stakeholders. The study therefore makes the following recommendations for policy practice and research.

- Ghana Education Service and teacher professional development bodies should organize continuous in-service training on assessment literacy for practicing mathematics teachers to upgrade their assessment literacies to cope with current trends and demands of classroom assessment.
- Teacher education institutions should apply the assessment literacy standards recommended by AFT, NCME and NEA (1990) in the training of preservice mathematics teachers. The assessment inventory used in this study could be adapted for use in teacher training institutions in Ghana.
- Workshops focusing on assessment literacy should be organized to update and upgrade both novice and experienced mathematics teachers' knowledge, skills and belief system about classroom assessment.
- Researchers and educators need to develop valid instruments for use in teacher training institutions to measure assessment literacy of preservice mathematics teachers before they are certificated for practice.

Limitation of the Study

The main limitation of this study is the use of mathematics classroom assessment scenarios to gather data on participants' assessment literacies. While such assessment scenarios are reliable, they do not always accurately measure the actual skills in practice. Also, the use of questionnaire to obtain participants' self-efficacy beliefs might

not necessarily reflect their actual practices. Therefore, future studies should examine the assessment tasks and documents generated by mathematics teachers and use interviews or observations to authenticate their true skillsets and beliefs in assessment.

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