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Three Ghanaian Preservice teachers' knowledge and understanding of assessment literacy: Implications for teaching and learning of mathematics

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ABSTRACT This article offers an analysis of preservice mathematics teachers' knowledge and understanding of assessment literacy. We draw from Abell and Siegel's (2011) notion of assessment literacy to explain the salient component of assessment literacy among the preservice teachers who participated in this study. Semi-structured and group interviews were used to generate data from three second-year preservice teachers enrolled in a Diploma in Education program. Data were analyzed using thematic analysis.

While the findings revealed that preservice teachers perceive assessment as an ongoing process aimed at gathering information about students' learning, their knowledge is grounded more on summative assessment. Furthermore, it was noted that preservice teachers view assessment as generic and not specific to mathematics teaching. In terms of conducting assessments, preservice teachers concede that time aligns with purpose and that administering assessments is solely the instructor's responsibility. Based on the findings, we concluded that preservice mathematics teachers have limited knowledge and understanding of assessment literacy. Thus, it is recommended that teacher educators pay particular attention to the evolution of preservice mathematics teachers' conception of assessment literacy. It is also recommended that preservice mathematics teachers' classroom assessment practices be investigated to ascertain how their assessment knowledge informs their classroom practices

KEYWORDS *Preservice teachers, Assessment literacy, Mathematics, Teaching and learning*

Introduction

The advancement of teacher assessment literacy is critical to improving teaching and learning. For example, Wang, Wang, and Huang (2008) posit that teacher assessment literacy is essential to the success of teaching. Of the same view, DeLuca et al. (2013) and White (2009) feel that teachers' assessment literacy enhances the quality of student learning and student learning motivation. Advocating the same point, in 2015, the Government of Ghana launched a program called Transforming Teacher Education and Learning, with technical and financial support from the Government of the United Kingdom. The program aimed to transform the delivery of preservice

teacher education in Ghana by improving the quality of teaching at the teacher training colleges. This reform saw the creation of two policy documents: 1) the National Teachers Standard for preservice teachers and 2) the National Teacher Education Curriculum Framework to guide teacher educators, in-service teachers, preservice teachers, and other stakeholders in the education sector. The reform brought about a restructuring of the content and the assessment regime of the teacher training colleges. Some of the major issues relating to assessment contained in these policy documents are as follows:

- 1) Teacher educators need to prepare preservice teachers to be assessment literate so that they understand and apply the principles and procedures for sound

classroom assessment of learning (summative) and assessment for learning (formative) and

- 2) Preservice teachers need to know how to use the information from their assessments to support learning (National Council of Assessment and Curriculum (NaCCA), 2018).

The policy calls for preservice teachers to have assessment literacy and to be able to use assessment information to support learning. Therefore, colleges of education need to harness and develop preservice teachers to become assessment literate to ensure they have the knowledge and assessment skills required to be effective when they become in-service teachers. While Ghana's reform policies and framework prioritized the advancement of assessment literacy, a review of the literature has shown that limited research has been carried out on understanding the knowledge of assessment literacy among teacher educators, preservice teachers, and teachers in Ghana, especially in mathematics.

It is no secret that education in Ghana is in crisis (Merku, 2019) and that this crisis is strongly pronounced in mathematics (Asare & Nti, 2014; Merku, 2019). Within these parameters, this study aims to understand preservice mathematics teachers' (PsMTs) knowledge of assessment literacy. Focusing on PsMTs is prompted by the fact that the reform program in Ghana emphasizes advancing assessment literacy among preservice teachers. We believe that one's knowledge of assessment informs one's practice in the classroom. As prospective teachers, PsMTs' assessment knowledge will inform their practices when they become in-service teachers. Understanding how they conceptualize assessment literacy would assist in restructuring reforms to advance their knowledge and practice. Therefore, this case study explored the knowledge and understanding of assessment literacy of three second-year Ghanaian PsMTs in the College of Education. To explore this phenomenon, we asked the following research question: How is assessment literacy conceptualized by some preservice mathematics teachers in the [blinded] in Ghana? Conceptualization in this study refers to preservice teachers' understanding of the meaning of assessment, which informs why assessment is to be carried out (purpose of assessment), and the means of doing so (assessment strategies).

Teachers' assessment literacy

Assessment literacy has been defined from different standpoints. Mellati and Khademi (2018) note that assessment literacy is the:

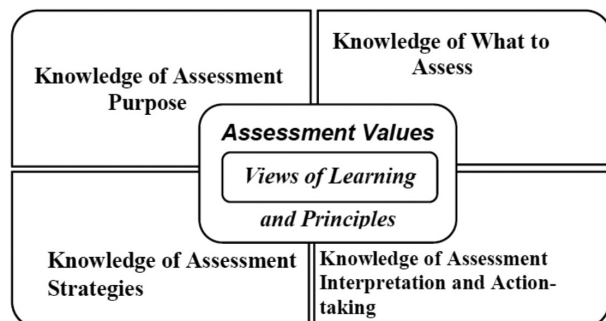
Possession of knowledge about the basic principles of assessment and evaluation practices, which includes terminology of assessment concepts such as test, measurement, ... and the use of assessment methodology and techniques in the classroom ... familiarity with an alternative to traditional measurement of learning. (p. 1)

Assessment literacy defines the knowledge and skills one needs to investigate what students know and can do, interpret the results of assessment, and use assessment results to decide how to improve learning (Abell & Siegel, 2011). Popham (2011) contends that "assessment literacy consists of an individual's understanding of the fundamental assessment concepts and procedures deemed likely to influence educational decisions" (p. 265). Stiggins (1999) developed a framework for assessment literacy and proposed seven assessment competencies that teachers need to possess: 1) Connecting assessment to the purpose, 2) Clarifying achievement expectations, 3) Applying proper assessment methods, 4) Developing quality assessment exercises and scoring criteria and sampling appropriately, 5) Avoiding bias in assessment, 6) Communicating effectively about students' achievements, and 7) Using assessment as an instructional intervention. Similarly, Siegel and Wissehr (2011) developed a framework that includes principles, tools, and assessment purposes to explore preservice teachers' assessment literacy. The common aspect among these frameworks is that assessment literacy should advance learning and that knowledge and assessment practices are intertwined. In this study, assessment literacy is defined as the beliefs and knowledge of assessment, based on the framework of Abell and Siegel (2011), because it articulates the key components of assessment literacy, as illustrated in Figure 1.

Abell and Siegel's model considers the various types of assessment knowledge the teacher needs and the

Figure 1

A model for teacher assessment literacy (adapted from Abell & Siegel, 2011, p. 212)



required skills to enhance teaching and learning. In the center of the model are teachers' views of learning, which support the assessment values and principles needed for teaching (Abell & Siegel, 2011). The values and principles interact with four categories of teachers' assessment knowledge: assessment purposes, assessment strategies, assessment interpretation and action-taking, and what to assess. What is emphasized in this framework is the purpose of assessment, meaning that when carrying out an assessment, it is important to consider the purpose for doing so.

The model illustrates the key elements an assessment-literate teacher needs, including a detailed understanding of assessment strategies, which are tools or instruments for gathering evidence of teachers' pedagogy and students' learning. Teachers need to be knowledgeable about formal and informal assessment strategies because they are linked to the type of assessment task that a teacher designs and implements, which in turn reflects their knowledge of assessment purposes and their assessment values (Abell & Siegel, 2011). Knowledge of what to assess refers to teachers' knowledge of mathematics content as concepts and processes. Teachers need to know what, when, how, and why to assess and what to do with assessment data (Abell & Siegel, 2011). These authors explain that a critical component of assessment literacy is what teachers know about interpreting and acting on assessment data. This implies that knowledge of assessment interpretation is about making sense of evidence gathered from assessment, which is born out of teachers' knowledge of the purpose of assessment.

Assessment literacy includes knowing how to use assessment data to help students learn or using evidence from assessments to modify instructional plans. For example, a teacher might use informal questioning as an assessment strategy in a mathematics class when teaching numbers and numerals to learn about students' misconceptions. A teacher might give a formative quiz that asks whether a number with three digits is bigger than a number with two digits, which works in some situations (328 is bigger than 35) but not in the case of numbers with decimals (3.28 is not bigger than 3.5). Based on information generated from the example, the teacher will learn whether another example is needed or if students are ready to move on to a new concept. Teachers' interpretation of assessment as to whether further examples are required or if the teacher needs to modify his/her pedagogy will result from the meaning they make of the assessment data.

Context of the study

This study focused on preservice mathematics teachers in the Central Region of Ghana enrolled in a three-year Diploma in Basic Education program. A total of 18 PsMTs in their second year of study were invited to participate; however, only three (two males and a female) agreed to participate. Data presented here were collected from these three PsMTs. The three PsMTs who participated in this study had been exposed to assessment both as students and students' teachers in micro-teaching (practice teaching that student teachers engage in on campus) and had been exposed to observing teachers teaching and assessing in neighboring schools. An in-depth case study was used to deeply explore PsMTs' assessment knowledge; hence, the three participants were deemed adequate and appropriate. Respondents ages ranged from 17 – 20 years.

Data collection and analysis

Data were collected using individual semi-structured interviews and a group interview. Semi-structured interviews encourage participants to narrate rather than being restricted in terms of what they should discuss. It also allows researchers to probe to understand the studied phenomenon in depth. In this article, the phenomenon being studied was assessment literacy, and therefore, we focus on PsMTs' knowledge and understanding of assessment literacy. Thus, individual and group interviews were deemed appropriate as they allowed PsMTs to narrate their knowledge and understanding of assessment literacy. Moreover, group interviews assisted the researcher in unearthing the dynamics and synergy in PsMTs' knowledge and understanding of assessment. To ensure the trustworthiness of the data collected, the interviews were recorded. This was done to ensure that the real voices and ideas of the participants were captured. Pseudonym IDs were used to protect the identity of the participants (PsMT1, PsMT2, and PsMT3). The numbers allocated have no meaning in terms of performance or order.

To understand PsMTs' knowledge and understanding of assessment literacy and to stay close to the data, the interview data were first transcribed and then segmented (first-level coding) line by line. They were used to generate codes, as shown in Abell and Siegel's (2011) assessment literacy model (Figure 2). The codes can be found in Table 1.

Figure 2

Example of first-level coding of an extract of an interview transcript from one of the participants

How do you understand assessment?

Assessment, as in education, is trying to *determine how best students have followed instruction (Evaluating learning)*. So, assessment could be done through quizzes, interviews, and written papers. That is why we have the **formal and informal way of assessing students (Strategies)**

Table 1

Codes generated from participants' verbatim responses

Evaluating learning	Teachers' responsibility	Formal assessment method
Evaluating of learning	Curriculum planners responsible for assessing students	Informal assessment method
Gathering information	Assessing students	Assessment type
Finding information	No specific time Assessment occurs during instruction.	Written-test, interviews Different techniques

In the second analysis phase, a constant comparative method was used, and codes carrying the same meaning were collapsed to identify broader categories, (Glaser & Strauss, 2017). Collapsed codes and broader categories are illustrated in Table 2 below.

Table 2

Collapsed categories to arrive at broader categories

Collapsed codes	Categories	Broader categories aligned to the framework
Gathering information and finding information	Evidence gathering	Knowledge of the purpose of assessment
Evaluating learning; evaluating of learning	Assessing student learning	
Teacher responsibility; assessing students Curriculum planners responsible for assessing students; Assessment occurs during instruction; No specific time	Assessment Implementation	Decision making action taking
Assessment type; Written test, interviews; Different techniques formal assessment method; Informal assessment method	Assessment methods/ techniques	Knowledge of assessment strategies

Findings of the study

To answer the research question about preservice mathematics teachers' conception of assessment literacy, the findings are presented using categories that emerged from the data, which we then align to key constructs drawn from the framework guiding the study.

To ascertain preservice mathematics teachers' knowledge of the purpose of assessment, they were asked to narrate their understanding of assessment:

Researcher: What do you consider to be the purpose of assessment?

PsMT3: Gathering information which is educational[ly] important about students so that you can make decisions about them either to intensify the program that they are undergoing or to provide certain remedies to those facing difficulties.

PsMT2: Assessment is to find out information about students for decisions and other purposes.

PsMT1: To find out how best students have followed the instructions.

PsMT1's views contrasted with those of the other two participants, as this preservice teacher regarded assessment as a means of evaluating students' understanding.

To probe further during the group interview to narrow the discussion to classroom mathematics, the preservice mathematics teachers were asked to narrate their conceptions of

assessing mathematics. While all narrated a generic view, PsMT3 went further:

Researcher: What do you consider to be the purpose of assessment, particularly in mathematics teaching?

PsMT3: Mathematics is an integrated subject, so the purpose of assessment is to find out what students know before teaching a topic and after. For example, multiplication builds from addition, so I need to know if they can add whole numbers and use that knowledge to teach multiplication.

PsMT1: I am not sure if it's any different in mathematics; my understanding is that we assess so that we evaluate student learning.

PsMT2: Like in all other subjects, the purpose of assessment is to see if learners have learnt what was taught.

The preservice mathematics teachers conceive assessment as a means to either gather information about the program and students or to evaluate students to ascertain what they know about the topic, thus foregrounding assessment as summative. This positional view contradicts the NaCCA (2018) of Ghana, which emphasizes the importance of both formative and summative assessments. While PsMT3 emphasizes assessing before and after teaching and the need to assess, as alluded to in Abell and Siegel's (2011) framework, none of the preservice mathematics teachers mentioned assessment in learning. This suggests that they do not consider assessment to serve the purpose of ascertaining knowledge and skills while learning occurs.

Preservice mathematics teachers' knowledge and understanding of assessment modes

By modes of assessment, we refer to assessment methods (types or techniques) and timing to administer assessment. Participants shared their views on the forms in which mathematics learning is/can be assessed:

Researcher: What are the modes or techniques through which assessment can be done?

PsMT1: I will say it is only written tests.

PsMT2: We can have tests and anything that will help you to collect information about students.

Thus, PsMT2 added that modes of assessment are any means that offer individuals the opportunity to gather information on student learning. When probed further about other modes of assessment, PsMT2 cited interviews as one of the techniques but was unable to explain how these could be used in assessing learning, suggesting that it is not a method of which she has in-depth knowledge. However, as noted in the above response, PsMT2 emphasized gathering student

learning and testing as the common mode of assessment, suggesting that she considers assessment to be summative-driven.

In contrast, PsMT3 stated that assessment could be formal or informal and went on to cite examples of these methods:

PsMT3: ... could be done in two forms, either formal or informal. The informal ones are not structured or organized, like quizzes, exercises, and sometimes observations, but the formal assessments are mostly organized and structured, like the end-of-semester examination that we take.

When probing further to articulate the types of assessment adopted in mathematics classrooms, PsMT1 and PsMT2 could not differentiate between types of assessment and techniques used in the mathematics classroom. While PsMT3 mentioned formative and summative assessment, the emphasis was on assessment used for progression purposes:

Researcher: Which mode of assessment and techniques are used in mathematics classrooms? Also, what is the purpose of those modes and techniques in mathematics?

PsMT3: There are two types of assessment, formative and summative, and the techniques used are either tests, assignments, or projects and investigations. Yes, there are other techniques like question and answer, but those are not used for assessing the depth of the content learnt.

PsMT1: As I have said above, assessing is about evaluating students so things like tests and examinations are used to evaluate students.

PsMT2: To gather information about students, we use tests, assignments, examinations, and so on.

It was noted that PsMT3 knows about informal assessment modes but does not believe it enhances learning. While the NaCCA (2018) policy emphasizes assessment for progression, it also emphasizes the importance of informal assessment. However, the preservice mathematics teachers did not mention baseline or diagnostic assessment, suggesting that the conception of assessment is geared towards assessing for progression purposes. Moreover, while knowledgeable about generic forms of assessment, they could not articulate them in relation to mathematics.

Sharing their conception of the timing for administering assessment, they had the following to say:

Researcher: In your understanding, when is assessment carried out?

PsMT3: During the course of study or at the end of the study. So, if it is during the course of study,

then it becomes a formative assessment. Then, if it is at the end of the course of the study, it becomes a summative assessment. For example, in mathematics, at the end of each lesson, one can administer homework, and at the end of the term, students write examinations.

PsMT2: It is carried out from the beginning to the end of instruction ...

PsMT1: Normally, at the end, but these days, I have to know that the assessment does not have a specific time. We are assessed at any time ...

Therefore, according to PsMT3, the time of assessment is aligned with the purpose. PsMT1 and PsMT2 hold the same view and argue that it forms part of teaching and learning. Although PsMT1's conception seems grounded on evaluating learning, the above response shows that new experiences influenced her conception. We based this on her saying that she understands that assessment has no specific time. What is evident in the preservice teachers' responses is that their beliefs influence their conception of timing regarding the purpose of assessment. However, as we noticed in the case of PsMT1, new experiences ignite new conceptions, suggesting that when exposed to new experiences, they are open to changing their conception.

Preservice mathematics teachers' knowledge of decision-making and action-taking in assessment

Narrating their conceptions about decision-makers in assessing, two of the preservice mathematics teachers remarked that assessment is the responsibility of teachers:

Researcher: In your understanding, who are the role players when it comes to assessment or assessing?

PsMT1: In my own view, teachers are the key role players because they assess the learners, or those who instruct are the assessors.

Similarly, PsMT3 argued that assessment is done by teachers, further stating that head teachers, as well as the curriculum planning division, can also engage in the assessment process.

While holding a similar view, PsMT2 believes that assessing is the responsibility of teachers and peers:

PsMT2: Assessors are those who collect information concerning the students to make value judgments or other decisions. In this case, assessors are teachers, or it can be a student assessing another student.

Although she considers peers as assessors, her response indicates that her conception of assessment is that of learning and places more emphasis on assessors

collecting information to make judgments, with limited attention as to how this contributes to learning.

The preservice mathematics teachers' responses show that of the three, only one mentioned peer assessment, suggesting they mostly hold a narrow view of assessment, as they do not consider students as important in the assessment process. All participants echoed that it is the teacher's responsibility because the purpose is to collect information about students or learning. This contradicts scholars such as Bansilal et al. (2011) and Kanjee and Mthembu (2015), who emphasize that assessment is a cyclic process of knowing and informing teachers and learners about the learning process.

Discussion

This study aimed to examine preservice mathematics teachers' knowledge and understanding of assessment literacy. Based on the data from the interviews, preservice mathematics teachers' assessment literacy was categorized into three areas: knowledge of the purpose of assessment, knowledge of modes of assessment, and knowledge of decision makers and action taking in assessment. The standpoint held by the three preservice mathematics teachers reflects assessment as being of learning, contradictory to DeLuca et al.'s (2013) findings in a study conducted in Canada. Their findings revealed that preservice teachers consider building conversations, praxis activities, modeling and critical reflection, and planning of teaching and learning as key components of assessment. This contrasts with the Ghana preservice mathematics teachers in this study, who consider gathering information about students and evaluating students as key assessment components. However, the participants' conceptions in this study coincide with Volante and Fazio's (2007) findings in a study conducted with preservice teachers enrolled in a four-year program in Canada. Their findings revealed that preservice teachers mostly conceive of assessment as summative, meaning that it is mainly considered to be used for evaluation purposes.

The emphasis on assessment being summative was further evident in the conceptions of assessment techniques or strategies held by the participants, as all foreground the use of tests as the main assessment technique. This finding concurs with those of Yilmaz-Tuzun (2008), who conducted a study with 166 preservice teachers in three Midwestern Universities in the US. Yilmaz-Tuzun (2008) argues that preservice mathematics teachers have a limited collection of assessment strategies they choose from. Therefore, they mostly

employ questioning and traditional paper and pencil assessment strategies to evaluate students' learning, even though they are aware of other assessment methods. The findings reveal aspects similar to contexts in other parts of the world. Moreover, the findings have educational implications for the Ghanaian education context, which is, in the transformation stage, to ensure the transformation as stipulated in the policy is translated to practice for the development of the preservice mathematics teachers' assessment literacy.

Implications for mathematics classroom teaching

Drawing from the preservice mathematics teachers' views, it could be argued that the generic view of their purpose of assessment is problematic, especially for mathematics teaching. For example, none of the preservice mathematics teachers foreground assessment in learning, while in mathematics classrooms, it is critical that teaching and assessment are constantly intertwined, as posited by Siegler and Wissehr (2011). However, preservice mathematics teachers mostly consider assessment to evaluate learning, i.e., summative assessment. However, summative assessment is important, especially for benchmarking, and since learning is continuous, assessment should also be continuous. Considering that assessment is used to evaluate learning means that feedback only happens after, which does not inform or enhance the learning process. This contradicts the call by Bansilal et al. (2011), which is that feedback should be continuous and aim at informing learning. Mathematics teaching is anchored in both the process and product. Therefore, focusing on one means that holistic teaching is not taking place.

Limitations

This exploratory study involves three preservice mathematics teachers and does not claim to provide findings representative of all preservice mathematics teachers in Ghana. While having only three participants is considered a limitation, the data generated provided an in-depth understanding of the preservice mathematics teachers' conceptualization of assessment. The use of only interviews can be considered a limitation. However, the study focuses on preservice mathematics teachers' conceptions, not practices. Thus, interviews were deemed most suitable to help us answer our research question.

Conclusion

The findings showed that Ghana's preservice mathematics teachers' conception of assessment is that of learning, which focuses on evaluating students and is driven by testing, with teachers having the most important role in the process of assessing. This conception contradicts Ghana's policy documents on assessment, which aim to transform assessment practices in schools and emphasize assessment for learning, assessment in learning, and assessment of learning (NaCCA, 2018).

Based on the findings of this study, we conclude that Ghana's preservice mathematics teachers need exposure to multiple modes of assessment during their teacher training to influence their conception such that it is not one-dimensional but encompasses both formative and summative assessment. As Siegel and Wissehr (2011) mooted, knowledge about a variety of assessment types allows teachers to select the most appropriate and effective instrument to meet their relevant learning needs, exposing preservice mathematics teachers to multiple forms of assessment that are necessary to advance their conception of assessment literacy. As suggested by Kanjee and Mthembu (2015), the development of assessment literacy should be an integral part of teacher training because it influences the quality of teaching in schools.

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