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Connecting knowledge and practice: Mathematics teacher educators' knowledge and use of formative feedback in Ghana

Justice Enu

Department of Teacher Education, Faculty of Educational Studies, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana
jenu@knust.edu.gh
https://orcid.org/0000-0002-3426-9599

Annatoria Zanele Ngcobo

Department of Mathematics Education, School of Education, University of KwaZulu-Natal, Durban, South Africa
ngcoboA2@ukzn.ac.za
https://orcid.org/0000-0002-3460-8757

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Abstract

The feedback aspects of formative assessment are an indispensable tool for improving teaching and learning. In this study, we report on findings about mathematics teacher educators' conceptions of feedback and how their conceptions translate into practice when conducting assessments in mathematics modules. In our qualitative study, underpinned by an interpretive paradigm, data were generated through semi-structured interviews, lecture observations, and textual analysis of students' scripts from six mathematics teacher educators purposely selected across three teacher colleges. Findings revealed that the teacher educators' knowledge and practices of feedback are foregrounded on providing corrective measures to students' weaknesses. This means when giving feedback, mathematics teacher educators focus on how well students can solve the task at hand—with limited attention to helping students regulate their own learning. We argue for the need to revise current policy to expose teacher educators to best practices and to engage with relevant literature on formative assessment and effective feedback.

Keywords: effective feedback, knowledge, mathematics teacher educators, practices

Introduction

This paper reports on a section of a doctoral study (Enu, 2021), which explored Ghanaian mathematics teacher educators' (MTE) understanding and practices of formative assessment.

Ghana, like most other countries, incorporated the principles of formative assessment into its curriculum policies and classroom practices, following good international practices. Formative assessment in the Ghanaian curriculum aims to improve learning and to shape and direct the teaching and learning process (National Council for Curriculum and Assessment [NaCCA], 2018). Ghanaian policy on assessment values the incorporation of diagnostic assessment based on various information sources (e.g., portfolios, teachers' observations, conversation, etc.). Furthermore, it emphasises giving verbal or written feedback that identifies strengths and challenges and demands instructors to continually evaluate students' understanding and adjust their instruction to meet the needs of the students. It involves giving no grades or scores, and record keeping that is primarily anecdotal and descriptive—and occurs throughout the learning process (NaCCA, 2018). With the intention to inform and improve teaching and learning at all levels of education in the country, the Ghanaian assessment policy stipulated the following to guide teacher educators, in-service teachers, pre-service teachers, and other stakeholders in the education sector:

- Observations during in-class activities.
- Homework and exercises as a review of class discussions and signal for future teaching and learning activities.
- Reflection journals that are reviewed periodically during the semester or term.
- Question and answer sessions, both formal (planned) and informal (spontaneous).
- Progress review meetings between the instructor and student at various points in the semester or term.
- In-class activities where students informally present their results. (NaCCA, 2018, p. 34)

When teacher educators in Ghana plan their daily instruction, they are required to make effective use of feedback—effective in the way that it indicates the strengths and weaknesses of a piece of work, which is considered central to formative assessment. It is noted that the Ghanaian assessment policy does not consider assessment and feedback as two different entities but, rather, considers feedback to be a formative assessment in its nature. The aim, as stipulated in the Ghanaian policy, is that assessment should not be considered as only an end-of-activity that checks if learning expectations have been met; rather, the prime aim should be about improving learning. As stated by Buabeng et al. (2020), the Ghanaian policy framework puts more emphasis on formative assessment and effective feedback as a means to support and improve teaching and learning.

Although assessment policies in Ghana emphasise the inclusion of formative assessment to ensure effective feedback, Oduro-Okyireh et al. (2015) have argued that assessment practices

in Ghana have predominantly been examination oriented with the emphasis placed on the student's grade. Mereku (2014) also posited that the curriculum in Ghanaian teacher training colleges lacks the flexibility of incorporating challenging school-based assessment tasks. This identified gap between policy and practices in Ghanaian education is a cause for concern. In the policy, principles and guidelines for best practices are outlined; however, for effective implementation, it requires that those expected to implement it have sound knowledge of the policy guiding principles. Buabeng et al. (2020) argued that conscious efforts are needed to link policy to practice to improve education. Noting the gap between policy and practice in Ghanaian education and recommendations for improving teacher qualification, we explored mathematics teacher educators' (MTE) knowledge and use of feedback to improve teaching and learning in mathematics classrooms.

Mathematics globally, is a subject deemed difficult for learners at school as well as for students at the university to understand and therefore, teachers and teacher educators are always encouraged to make use of effective instructional strategies to improve teaching and learning. Ghana is among the many countries performing poorly in mathematics (Akyeampong & Stephens, 2002; Butakor et al., 2017). Enu et al. (2015) posited that teacher educators' instructional practices are among the factors influencing student performance in mathematics. Yin (2019), on the other hand, argued that to provide pre-service teachers with maximum support to practicalise their knowledge, they should be exposed to best practices that connect policy to practice. Our argument is that because the Ghanaian assessment policy framework advocates for formative assessment and effective feedback as the means to support and to improve teaching, these practices should be demonstrated in the classroom. We further argue that MTEs have the responsibility to model best practices to pre-service mathematics teachers to assist them in developing both the subject matter knowledge and the expertise to identify and address the learning needs of their students. However, for the MTE to model best practices in teaching, they should have sound knowledge of these practices and be able to implement them in their own teaching. Literature suggests that pre-service teachers tend to replicate how they have been taught because their practice is influenced by the teaching they have been exposed to (Erawan, 2011; Hine, 2018; Merisi & Pillay, 2020). This statement implies that pre-service teachers' experiences of their learning (whether at the school level or at the tertiary level) influence their teaching schema. It is against this backdrop that we deemed it necessary to explore MTEs' knowledge and use of feedback. With this in mind, we asked the following questions:

1. What is Ghanaian mathematics teacher educators' knowledge of formative feedback?
2. How do they use and provide feedback in the classroom?

In this study, we explore MTEs' knowledge and use of feedback in three teacher colleges in Ghana. Given that teacher educators are tasked with the responsibility of modelling best practices for pre-service teachers, we consider their knowledge and practices to be critical towards transforming teacher education in Ghana. We begin by reviewing the literature that shaped our argument and then discuss the framework underpinning the study. Next, we explain the methodology of the study before discussing the findings and implications of the

study to teacher education practices. We conclude by summarising the findings and making recommendations based on the findings of the study.

Literature review

Formative assessment is currently a widespread term in the education sector and is considered one of the key strategies in enhancing students' achievement. Emerging studies have indicated that the practice of formative assessment is well understood and implemented in countries like the United Kingdom, Australia, New Zealand, and many more (Black & Wiliam, 1998; Cowie & Bell, 1999; McMillan, 2007b). Wiliam and Thompson (2007) proposed a framework for the implementation of formative assessment in the classroom that comprises the application of five key strategies: (i) clarifying and sharing of learning intentions and criteria for success, (ii) engineering effective classroom discussion, questions, and learning tasks that elicit evidence of learning, (iii) providing feedback that moves learners forward, (iv) activating students as owners of their own learning, and (v) activating students as instructional resources for one another. These five strategies are useful in directing the instructional processes to answer three critical questions: 1) "Where am I going?" 2) "Where am I now?" and 3) "How can I close the gap?" (Chappuis, 2015).

Regarding the use of feedback as an instructional strategy to improve teaching and learning, Heritage (2010) observed that assessment needs to provide actionable information (feedback) for both teachers and students. Supovitz (2012) extended the argument and posited that feedback reflects a student's development towards the goals of learning, and can address thinking processes and misconceptions. As purported by Gibbs and Simpson (2004), feedback needs to be linked with the assessment task or criteria, and it should be on what needs to be done to encourage students to believe that they can improve. This means that feedback should relate to the learning goals and the success criteria to ensure its effectiveness.

Whereas teacher educators need to use feedback information to shape and adjust their instruction, students use feedback information to improve their learning. Feedback is therefore information that can be used to guide both teaching and learning (Halverson, 2010). Feedback given as part of formative assessment draws attention to existing gaps in students' desired goals and current knowledge and thus enables students to engage in a continuous self-assessment loop (Fluckiger et al., 2010; Trumbull & Lash, 2013). Alves de Lima (2008) opined that feedback is constructive if the information provided emphasises students' strengths and weaknesses. Thus, feedback is crucial in formative assessment, and teacher educators play an essential role in its implementation. Review studies on feedback by Hattie and Timperley (2007) suggested that feedback answers three major questions:

- Where am I going? (What are the goals?).
- How am I going? (What progress is being made towards the goals?).
- Where to next? (What activities need to be undertaken to make better progress?).

Drawing from the above literature it can be argued that giving feedback is part of formative assessment and considered an effective tool to improve teaching and learning. It is therefore within these parameters that we decided to explore teacher educators' conceptions and practices of feedback in mathematics pedagogy. It is crucial to understand how they effectively use feedback in the teaching and learning of mathematics.

Teacher education in Ghana

Every country aims to bequeath to her citizenry quality education in which teachers play an important role. Adegoke (2003) averred that education is a condition for development, and that the teacher is the ultimate definer of its reality. Ghana's quest to become an industrialised country depends greatly on the quality of its citizens, who are the product of its education system (Buabeng et al., 2020). According to the Ghanaian Ministry of Education (MOE, 2012), the country's vision of the tertiary teacher education programme is to train teachers capable of providing quality education. Teacher training colleges (now called colleges of education) in Ghana offer two streams of teacher education programmes: a 3-year diploma in education and a 4-year bachelor of education (BEd) programme. Following in the footsteps of countries like South Africa, and as part of educational reforms to improve teacher education, the BEd programme began to replace the 3-year Diploma in Education in 2018. Examinations for the diploma qualification are conducted and moderated by the University of Cape Coast's Institute of Education (IOE). For the past 50 years, the IOE has had sole responsibility for examining and certifying trainee teachers. However, as part of reforms to boost teacher education, Ghana's 46 public colleges have been affiliated to five of the country's public universities (the University of Cape Coast; the University of Education, Winneba; the University of Ghana; Kwame Nkrumah University of Science and Technology; and the University for Development Studies) to facilitate mentorship and to ensure that the teacher colleges offer the quality teacher education that the country desires.

Unlike other countries such as South Africa, which did away with teacher colleges altogether and mandated the universities to train the country's teachers, Ghana still allows its teacher colleges to play a major role in the education and training of pre-service teachers; thus, the assessment policy used in teacher colleges is more or less the same with assessment policy used in schools. Although teacher colleges play a major role in the education and training of pre-service teachers, their activities (in particular their examination and certification process) are facilitated and regulated by the affiliate universities. However, Asare and Nti (2014) have raised concerns about the practices in teacher colleges in Ghana as not promoting effective learning and improve teaching and learning. In his study, Mereku (2019) noted that assessment practices in Ghana are summative driven, which contradicts the principles of assessment policy.

Formative assessment: Knowledge and practices

Teacher educators play a significant role in the preparation of pre-service teachers in becoming assessment literate and able to practise after their training. However, they themselves need to have a sound understanding of formative assessment to implement it

effectively. Cassim (2010) noted that one's knowledge of assessment informs one's classroom practices. In a study conducted with in-service teachers, Yao (2015) observed that teachers consider assessment a means to an end. However, Kumator (2017) opined that assessment that supports students' learning should not occur as the end product of instruction; instead, it needs to occur prior to learning, during learning, and after learning—and this is what governs the principles of formative assessment. Vandeyar and Killen (2007) concluded, based on the findings of their study on instructors' conceptions and practices of assessment, that there is a need for instructors to be trained in the pedagogy of assessment because they cannot use assessment strategies which they do not understand or lack the skills to implement. Extending the argument, Bennett (2011) posited that for effective implementation of formative assessment, there should be a theory of action that revolves around one big idea. The big idea that needs to be considered during the implementation is students and thus, the practices should be directed towards meeting students' needs and enhancing teaching and learning (Educational Testing Service, 2010).

Mathematics teacher educators' feedback practices

In their study about the characteristics of feedback that MTEs provide to pre-service mathematics teachers, Kastberg et al. (2020) found that MTEs' feedback practice is characterised by redirecting pre-service teachers to pay attention to procedural aspects of learning mathematics—and does not guide pre-service teachers towards becoming self-regulators of their learning. The authors further argued that MTEs should be an instantiation of practice and provide pre-service teachers with information about their learning (Kastberg et al., 2020). In other words, in a mathematics classroom setting, feedback should aim to enhance students' understanding of the taught concepts. Extending the debate, Shaughnessy et al. (2015) posited that, other than focusing on pre-service teachers' skills to solve mathematics, feedback given should focus on enactment of practice. This means effective feedback given to pre-service mathematics teachers should go beyond addressing the procedural knowledge gaps and further, pay attention to developing specialised content knowledge. In Ghana, although there are limited studies exploring the practices of formative assessment and effective feedback, scholars like Oduro-Okyireh et al.'s (2015) findings showed that although assessment policy advocates for formative assessment with an emphasis on effective feedback to enhance learning, such practices are not demonstrated in the classroom. Buabeng et al. (2020) believed that Ghana's education systems are responding well to issues related to developing an understanding of the teaching; however, challenges still prevail in matters relating to the development of subject matter knowledge. Ghana is known for poor performance in mathematics; thus, the improvement of mathematics subject matter knowledge is of utmost importance.

A plethora of literature on teachers' knowledge and feedback practices has focused primarily on pre-service teachers and in-service teachers. For example, Lema and Maro's (2016) study of in-service secondary school teachers in Tanzania found that the teachers knew little about using feedback in the teaching and learning of mathematics. However, there is a paucity of research on teacher educators who prepare and train pre-service teachers to become

mathematics teachers. Secondly, formative assessments are discipline-specific, and specific issues arise concerning the formative assessment of mathematics. Havnes et al. (2012) argued that the nature of mathematics as a discipline affects the provision of feedback to students. Similarly, Bennett (2011) found that teachers' understanding of the discipline often frames their instructional decisions. Despite this discipline specificity concerning formative assessment, there is scant research on the feedback aspect of formative assessment within specific disciplines (Coffey et al., 2011). Taking into account the identified gap between what the Ghanaian assessment policy stipulates about formative feedback, and practices of feedback, as well as the limited research done to understand teacher educators' knowledge and practices of providing feedback, in this study we paid particular attention to MTE's knowledge and use of feedback in their classrooms.

Framework for the study

In general, researchers agree on the importance of formative assessment and the opportunities constructive feedback offers students in moving their learning forward (Bansilal et al., 2010; Black & Wiliam, 1998; Hattie & Timperley, 2007; Heritage, 2011). Research has also shown that feedback is significant and should not be seen in isolation from other instructional activities (Enu, 2021). As mentioned earlier, feedback answers three questions: "Where am I going? (What are the goals of learning?)" "How am I going? (What progress is being made towards the goal?)" and "Where to next? (What activities need to be undertaken to make better progress?)." According to Hattie and Timperley (2007), these questions are referred to as feedback questions. An attribute that emerges from the questions is that feedback is always aligned to the intended learning goal. This is because it informs students where they are in their learning and what they need to do next. The notion that feedback is an important aspect of formative assessment gives credence to two conditions for effective feedback as proposed by (Sadler, 1989). First, Sadler (1989) posited that feedback must identify gaps between the desired goal of learning and the student's present status in relation to achieving that goal; secondly, feedback must provide an opportunity for students to take steps in closing gaps in their learning and understanding.

In this study, we were interested in teacher educators' knowledge and use of feedback because their knowledge of feedback is essential in identifying learning gaps between the desired goal of learning and the present state of their students' learning. And, their feedback practices would provide evidence as to whether the kind of feedback they give offers their students the opportunity to modify and close gaps in their learning or not. Therefore, we were guided by the framework for effective feedback that Hattie and Timperley (2007) highlighted; the model shows the purpose of feedback and how it can be utilised in clarifying learning discrepancies or understanding. The authors explained in their model how feedback comments might be related to the three feedback questions on four different levels: task, process, self-regulation, and self-feedback (Hattie & Timperley, 2007). Hattie and Timperley (2007, p. 90) also stated that "the level at which feedback is directed influences its effectiveness." In the following, we describe these four levels briefly.

Task level

Feedback at the task level explains how well a task is understood and performed and may include directions to acquire more, different, or correct information. Hattie and Timperley (2007) remarked that this kind of feedback is called corrective feedback or knowledge of result and is akin to correctness, neatness, or other criteria related to task accomplishment.

Process level

A deep understanding of learning involves the construction of meaning. Therefore, the second level of the model is aimed at processing information or learning processes requiring understanding. This gives insightful information to the individual to improve their work.

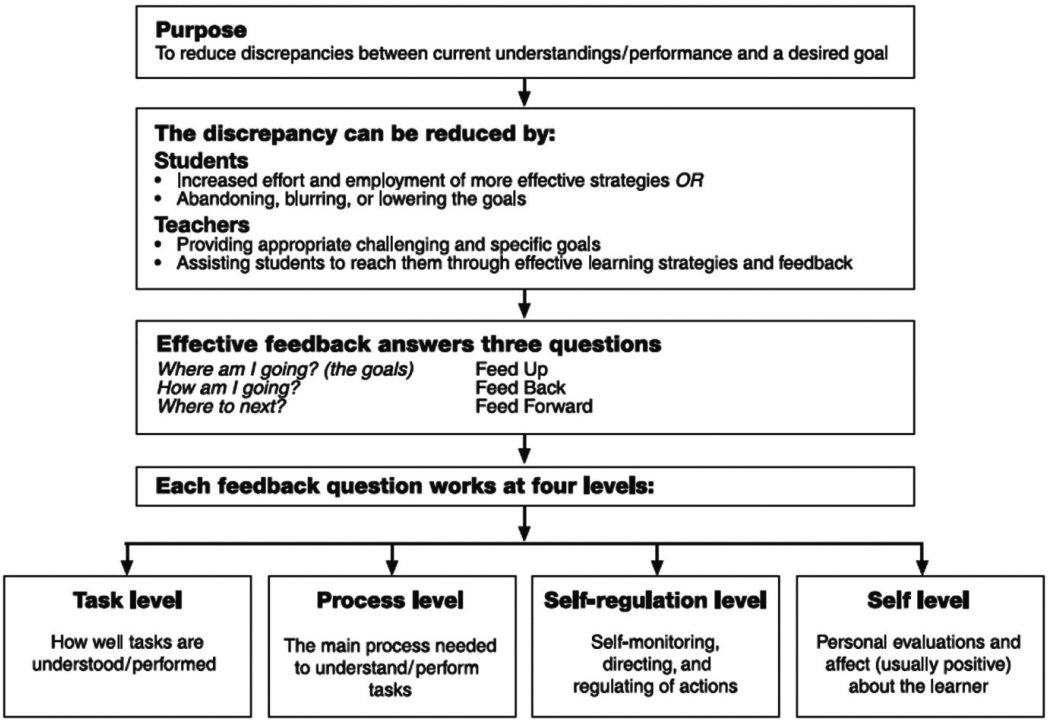
Self-regulation

Self-regulation involves an interplay between commitment, control, and confidence. It addresses how students monitor, direct, and regulate actions towards the learning goal (Hattie & Timperley, 2007). This is powerful in selecting and interpreting information in ways that provide feedback.

Self-feedback

Feedback about oneself is the least effective among the four feedback levels highlighted by Hattie and Timperley (2007). It usually contains little task-related information and is rarely converted into more engagement or commitment to the learning goal. Figure 1 illustrates the feedback model.

Figure 1
Model of feedback to enhance learning (Hattie & Timperley, 2007, p. 87)



Methodology

This paper reports on a qualitative study exploring MTEs' knowledge and use of feedback in mathematics teaching and learning. A qualitative approach was used because it allowed the voices of the participants to be heard and thus facilitated a diverse range of responses (Flick, 2016). The data presented in this study were generated in three ways. The researchers interviewed the MTEs to understand their knowledge of and use of "feedback" concerning formative assessment. Using interviews was considered the best way to capture people's understanding of the phenomena. Instead of closed interviews, semi-structured interviews were conducted to allow the participants to express their conceptions without being restricted to yes/no answers, and to allow the researchers to probe certain responses further. In addition, presentations of lecturers by each participant were also observed three times, for at least one and a half hours. After each observed presentation, there was a follow-up debriefing to discuss any questions or ideas that arose from the observation. Three of the participants were teaching first-year students, whereas the other three were teaching students in the second year of their teacher training. The average class size for presentations observed was 39 students. Participants were observed teaching different mathematics concepts such as integers, binary operation, statistics and probability, fractions, trigonometry, set problems, relations, and functions. Finally, the researchers analysed students' assessment scripts and looked for evidence on the nature of teacher educators' feedback on students' written work. A total of eight marked scripts (assignment and mid-semester quiz papers) were reviewed. The scripts were mathematics scripts with questions on binary operations, percentages, statistics and probability, ratio, and proportion. The data generated from the interviews were triangulated with the classroom observations data and document analysis to explore teacher educators' understanding and use of feedback in mathematics pedagogy.

Sampling

Purposive sampling was used to select three teacher colleges. The selected colleges were in close proximity to each other, and run a homogenous curriculum. They were mentored and affiliated under one public university in Ghana's Central Region. Based on the recommendation of the heads of department, two teacher educators from each selected teacher college who had taught at the colleges for at least two years, who had experience in teaching in the diploma programme, and had transitioned to teaching in the new BEd programme were invited to participate in the study. The rationale for selecting two participants from each college was to ensure that each college was represented in case a participant withdrew from the study. In total, six teacher educators were involved in the study: Sekyi and Emily (from Roberkeyta College), Wilson and Fordjour (from Oswald College), and Anani and Peprah (from PhilNeri College). Pseudonyms were used to protect the identity of the teacher educators and colleges.

Data analysis

For this study, inductive and deductive data analysis were adopted. The deductive part was guided by Hattie and Timperley's (2007) model. The inductive data analysis involved four phases (McMillan & Schumacher, 2014): identifying patterns, categorising and ordering data, refining patterns through determining the trustworthiness of the data, and synthesising themes. The authors first worked separately in each phase, analysing the data, generating codes, and creating their categories. In refining the themes, the authors then met to present their coding before working together to elaborate on, collapse, or distinguish between similar codes. These themes provided a picture of the teacher educators' understanding and implementation of feedback in mathematics pedagogy. The final phase involved synthesising the themes, which were arranged to align with the research questions.

Findings and discussion

We used data generated from the interviews to respond to Research Question 1: "What is Ghanaian mathematics teacher educators' knowledge of formative feedback?" The interview transcripts were read and segmented, and responses that reveal teachers' knowledge were selected. The interview excerpts that illustrate teachers' feedback knowledge are presented below.

Mathematics teacher educators' knowledge of effective feedback

In a conversion with Anani, it transpired that he considered feedback as means to inform students about their weaknesses and for students to know what they did right or wrong. The excerpts below are extracted from the interview with Anani:

> It is about providing information to students on their shortfalls to be able to make a correction and move forward.

He went on to say:

> Without giving feedback, students will not know whether the assignment is done right or wrong or they have done the right quiz.

Of the same view as Anani, Sekyi emphasised that effective feedback is about informing students about their weaknesses, hoping that they will understand that they need to improve:

> If you are working on an activity and you have been made to see that there is something amiss with what you are doing. Then certainly, as a human being, you need to improve.

On the other hand, Emily was of the view that feedback should be about improving teaching rather than learning. This was illustrated in the excerpt below:

> If you teach and assess [give a quiz], and maybe 75% of the students are getting below half of the total marks, then it means there is something wrong. So, as a teacher, I have to re-strategise by using a different strategy or method.

In response to follow up questions to get more clarity on her about her knowledge of feedback Emily said:

> Feedback allows me as the teacher educator to reflect and modify my teaching strategies because when my students have not done well, it means they did not understand. It also tells me where they have gaps.

Of the same view, Wilson had this to say:

> If I assess [give an exercise] and the outcome tells me that a particular understanding or concept has not been formed well, it helps me to quickly devise a means to help them [the students].

Fordjour extended the argument to include that he considered feedback to guide his methodology:

> It gives you some information about your methodology and shows the way the students perceive your lesson. You try to assess yourself about your method.

Fordjour went on to say:

> When students do not do well it gives something to reflect on and plan how to improve.

Peprah believed that feedback is a way to inform students about their strengths and about opportunities to improve:

> Feedback is about telling students what they have done well and what needs to be improved upon.

All the participants were of the view that effective feedback is about improving teaching and learning. However, there were contradictory views on where the emphasis should be based. Situating this within the perspective of the framework, we conclude that participants' knowledge of feedback corresponds to two levels of Hattie and Timperley's (2007) framework. For example, Anani and Sekyi considered feedback as informing students about their knowledge gaps, which Hattie and Timperley (2007) termed as corrective feedback that places emphasis on helping students understand the task. As mentioned by Anani, feedback should be given so that corrective measures can be implemented. Both Anani and Sekyi emphasised that feedback should help students see what they have done right or wrong and that, by helping students identify their shortfall, they will be able to correct them and move forward. Although Emily, Wilson, and Fordjour's knowledge of feedback coincided with Anani and Sekyi, their knowledge goes beyond it being a corrective measure to encompass

construction of meaning, which Hattie and Timperley (2007) referred to as process level. For example, all three emphasised that feedback should not only correct learning it should also inform teaching to help students construct meaning of the taught concept by revising the instructional strategies.

In his study, Bennett (2011) opined that one's knowledge of formative assessment should be driven by one big idea: meeting students' needs driven by the overarching goal to enhance teaching and learning. In the present study, Anani and Sekyi's knowledge targets students' needs; however, their focus is on providing immediate corrective measures with limited attention to future goals and addressing gaps. In addition, their knowledge focuses on students' weaknesses, not the strengths, as emphasised by Alves de Lima (2008). Extending the argument by Alves de Lima (2008), Heritage (2010) posited that feedback should be seen as a means to provide actionable information for students and teachers. Our findings revealed that the other four participants considered feedback beyond attending to learning needs, but only to provide actionable information for the instructors. The participants in this study's knowledge of feedback is at the task level with limited attention to helping students engage in a self-regulatory level of their learning. Black and Wiliam (2009) emphasised that beyond moving learning forward, feedback should activate students as owners of their own learning, and activate students as instructional resources for one another. For the participants of this study, it appears that the main aim is to move the teaching and move learning forward because Anani talks about making and correction and move the learning forward, and Sekyi talks about identifying what is amiss and working towards improving that; Emily and Fordjour emphasise identifying shortfalls and re-strategising and Peprah emphasises that attention should not only be directed to weaknesses but also the strengths as well as opportunities for improvement. The findings of this study revealed that the overarching aim of giving feedback is to correct learning and improve teaching, and not activating students as owners of their learning and resources for others—in other words, self-regulation and self-feedback (Hattie & Timperley, 2007).

Mathematics teacher educators' feedback practices

To respond to Research Question 2: "How do MTE's use and provide feedback in the classroom?", we use data generated from classroom observation and document analysis. During the classroom observations, the mathematics teacher educators were teaching mathematics to first-year or second-year students. During the teaching and learning process, it was observed that while teaching mathematics, teacher educators provided oral feedback to their students. This feedback sometimes consisted of instructions guiding students on how they could correct their responses. At other times, the feedback aimed at giving students instructions about the steps to follow to get the correct answer or complete the required task. For example, Wilson used the question and answer approach to establish students' knowledge of binomial theorem. While introducing year-two students to Pascal's triangle, Wilson kept on correcting and reminding them of the steps to follow, as illustrated in the example below:

Use the Pascal triangle to write down the binomial expansion of $(3x - 2)^5$.

Coefficient for expansion with index 5 is always given as: 1 5 10 10 5 1

$$(3x-2)^5 = 1(3x)^5 + 5(3x)^4(-2) + 10(3x)^3(-2)^2 + 10(3x)^2(-2)^3 + 5(3x)(-2)^4 + 1(-2)^5$$

$$= 243x^5 - 810x^4 + 1080x^3 - 720x^2 + 240x - 32.$$

He followed up with a series of examples and assessment tasks to assess students' understanding of the concept. With a different group of first-year students, Fordjour used question and answer to elicit students' understanding. The kind of feedback provided was telling the student whether they were right or wrong in answering the question, as illustrated in the response captured during the observation:

> Fordjour: What is the question looking for specifically?
>
> Student: I think we are to calculate the angles.
>
> Fordjour: Good, then how do we go about it?
>
> Student: Because we are to calculate the angles, we have first to draw a right-angle triangle then calculate the angles using the trigonometric ratio.

Fordjour responded by telling the student they were wrong and asking the class how the question could be solved.

Fordjour's practice was dominated by telling the student which answers or steps were wrong or correct. Where the answer was wrong, corrective procedures were demonstrated on the board for students to copy into their exercise books. Thereafter, additional examples to practise what was explained were provided for students. Both Fordjour and Wilson's practices focused on ensuring students understood the task and guiding them to perform corrective procedures to find the correct solution—with limited attention to helping them construct meaning. According to Hattie and Timperley (2007), feedback that focuses on whether the work is correct or incorrect (corrective feedback) is at the task level.

On the other hand, Peprah gave feedback by doing corrections on the board for the whole class. Every time students seem not to follow the methods or the instructions; she would redo the example on the board for all the students, and also ask students to assist each other (Table 1).

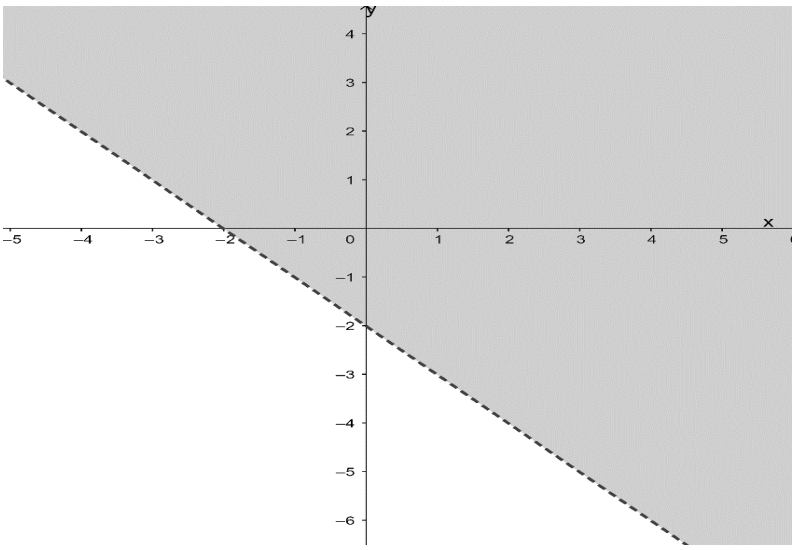
She continually used the same strategy every time students failed to find the correct answer. Beyond doing the examples on the board, she also engaged individual students to explain their thought process while solving the task. Similar examples that students needed to do followed such activity so that she would be able to see if they understood the method.

Table 1
Peprah's instructive example during classroom observation (Source: Enu, 2021, p. 157)

Example of a task	Classroom practices by MTE providing the solution	Type of feedback
Given that, $n\,((H\ \cup F \cup V)) = 87, n\,(H) = 43,\ n(F) = 42, and\ n\,(V) = 47$ Find $n\,(H \cap F \cap V) = x$, if $n(H\ \cap F\,) = 15\ and\ n\,(\,F\ \cap V\,) = 21.$	Peprah: Using the law $n\,(H\ \cup F \cup V) = n(H) + n\,(F) + n\,(V) - n\,(H \cap F) - n(F \cap V) + n\,(H \cap F \cap V)$ 87 = 43 + 42 + 47 – 15 – 21 + $\Rightarrow\ n\,(H \cap F \cap V) = 87 - 79 = 8.$	Corrective feedback and guiding students to construct meaning.

Adopting the same strategy with his first-year students, Sekyi started by checking students' solutions to the task, asking them what they did and why before doing corrections on the board as illustrated in Table 2.

Table 2
Sekyi's instructive example during classroom observation (Source: Enu, 2021, p. 143)

Example of task	Classroom practices by MTE providing the solution	Type of feedback
Sketching the graph for the inequality $x + y > -2$		Corrective feedback, guiding students towards meaning making and guiding them towards self-regulation.

The same process was repeated in various activities that he did with his students. He also engaged students in classroom activities to test their understanding; for example, "Plot the graph of the inequality $x + y \leq 4$ and shade the required region." While students were working on the task, Sekyi moved around the lecture hall, observing and providing verbal feedback. Other than providing verbal feedback, he moved from desk to desk to mark students' individual responses. In some cases, he would pair students to assist each other; mainly pairing those with a correct response to those with an incorrect response. After attending to each student, he engaged the students in a whole-class discussion. He called on

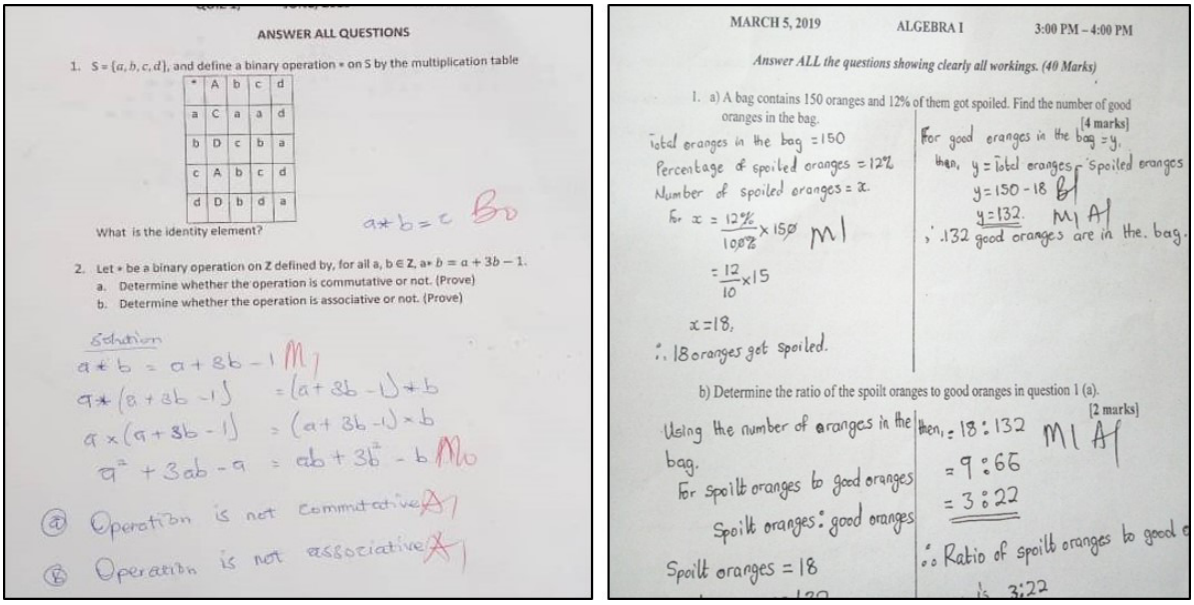
those who had the correct answers to explain the processes to the entire class. As the discussion progressed, he pointed out to students who had the wrong answer as to where they went wrong and explained the appropriate method to get the correct answer. Exploring Peprah's and Sekyi's practices showed that their practices of giving feedback focused more on helping students construct meaning of the taught concepts. Whereas Emily and Anani also adopted the whole-class discussion strategy, there was limited engagement encouraged from the side of the students. Similar to Wilson and Fordjour, their focus was on explaining procedures needed to acquire the correct answer, which Hattie and Timperley (2007) referred to as corrective feedback (grounded on the task level).

The findings revealed that most of the MTE's practices of feedback involved providing students with corrective strategies to complete the tasks. Instead of focusing on individual attention to students' weaknesses, most MTE's opted for whole-class feedback to respond to students' difficulties. Although, two MTE's made attempt to engage individual students' thought processes, the dominant practice was to point out students' weaknesses and guide them towards correcting it so that they could produce the expected answer. Although there was evidence of providing feedback that attended to students' weaknesses, limited attention was given to outlining the goals to students so that they could know where they were going—and allowing students to establish their progress and let them figure out what they need to do to make better progress as purported by Hattie and Timperley (2007) and Chappuis (2015). What transpired during the observations supported Shute's (2008) conception of feedback as information given to the student to alter their mindset with the sole purpose of improving learning. In contrast with Bansilal et al.'s (2010) purpose of feedback that is multi-directional, the findings showed that the dominant practices among the MTE's was unidirectional process that focused on the teacher educator giving feedback for corrective purposes with limited attention given to students to construct meaning or engage in self-regulatory learning or self-feedback which, according to Hattie and Timperley (2007), should target three aspects: feed up, feedback and feed forward.

From the students' point of view, the formative assessment on a written task or script asks questions like: "What knowledge or skills do I aim to develop?", "How close am I now?" and "What do I need to do next?" (Brookhart, 2017, p. 1). The answer to "How close am I now?" indicates where the students are in the learning process relative to where they started. Therefore, formative assessment should focus primarily on what the students have learned instead of what the teacher has taught. Chappuis (2015) argued that this question could be answered when students understood the learning goals through descriptive feedback. In view of this, a document analysis in the form of students' written work was analysed to identify how teacher educators provide feedback when marking assessment tasks. The study established that all six participants use three annotations when marking students' work: M—a method mark, A—an accuracy mark, and B—a mark for the correct result independent of the method mark. The most dominant form of feedback was the use of these annotations, followed by summing up the correct answers to produce the total mark, which was then written on the top corner of the script. Figure 2 presents evidence that the type of feedback given in students' written work does not explicitly articulate students' weaknesses (the type

of mistake they made), their strengths (what was good about their work), and what they could/should do to improve. Although the teacher educators indicated what is wrong, and allocated method marks, the feedback does not guide students to future learning. The analysis of the type of feedback provided to students' written work revealed that none of the levels echoed by Hattie and Timperley (2007) is catered for when teacher educators provide feedback in the written form.

Figure 2
Example of teacher educators' feedback type on students' assessment scripts (Source: Enu, 2021, p. 175)



With ticking and crossing, students were getting feedback about what they did wrong or right with no further information guiding them how to correct it and what they need to do to improve. As indicated in Hattie and Timperley's (2007) model, effective feedback should feed up, feedback and feed forward. The findings showed that the type of feedback provided to students' written work only tells them where they are. These feedback practices do not help students develop deep understanding, or to be able to self-regulate, or help them develop the skill to evaluate their learning process as purported by Hattie and Timperley's (2007) model and Shaughnessy et al. (2015).

As mooted by study Kastberg et al. (2020) that mathematics teacher educators' practices of feedback foreground attention to procedural knowledge. The same was evident with the present study, where the feedback given guides students to see which mathematical procedures they failed to apply correctly.

After synthesising the data, the findings showed discrepancy between MTEs' knowledge and practices. The findings showed that MTEs' knowledge of feedback encompass both the task level and process level, however, their practices showed that the most kind of feedback which MTEs adopt in their classroom and when marking students work is that of identifying students' weaknesses and providing corrective measures. According to Hattie and Timperley's (2007) model, this is considered to be the task level. For example, during class

observation with exception of Sekyi and Peprah, all the other MTE feedback practices were dominated by identifying students' knowledge gaps and providing corrective measures towards finding the expected answer with limited or no attention towards helping students construct meaning of the concept or monitoring their learning. Their ultimate aim was for students to see their weaknesses. While informing students about their weaknesses and revising instructional practices is important, effective feedback, as purported by many scholars (such as Chappuis, 2015, Oduro-Okyireh et al., 2015; Shaugnessy et al., 2015) should go beyond identifying students' weaknesses. Cassim (2010) noted that one's knowledge of assessment inform one's classroom practices. In this study, given that most MTEs considered feedback to be about corrective measures, the same practices were carried out in the classroom and when marking students' work. The unidirectional knowledge of feedback contradicts some of the feedback principles stipulated in the Ghanaian policy on assessment, which stipulated that feedback is a form of communication to students not about their weaknesses alone, but also about their progress. Again, it does not serve as communication to students only, it is also considered as a form of communication to teachers about their teaching (NaCCA, 2018).

Implications for teacher education

The findings of this study have implications for the current practices in teacher education institutions, especially in Ghana. First, the policy on assessment stipulates the guiding principles that should inform practices. However, the implementation has not yet occurred; therefore, interventions are needed to ensure that policy translates into practice. Overall, it may be argued that research findings need to enhance the current practices in Ghana and that mathematics teacher educators need to be developed towards translating policy to practice, and to understand what research argues for regarding providing effective feedback. The expectation of the assessment policy, which requires teacher educators to prepare pre-service teachers to become assessment literate so that they understand and apply the principles and procedures for sound classroom assessment, cannot not be materialised if teacher educators are unable to provide feedback that encompasses all the levels of effective feedback purported by Hattie and Timperley's (2007) model. For example, at the task level effective feedback should address knowledge gaps and provide corrective measures (which the participants of this study showed knowledge of, and executed, during classroom practices). However, the model also emphasises three other levels for effective feedback, namely, the process level that foregrounds giving feedback for the purpose of enhancing deep learning, self-regulation (which focuses on assisting students to regulate and monitor their learning), and self-feedback (which focuses on helping students evaluate their learning). Thus, professional development activities are needed to assist MTE improve their practices.

Conclusions and recommendations

The researchers concluded that the MTEs' knowledge of feedback was one-dimensional because it foregrounds improving learning. In addition, their knowledge was premised on providing corrective measures for helping students to identify what they had done wrong and

right only. Furthermore, they considered effective feedback as a means to inform students about their knowledge gaps, not as a reflective process for both students and teacher educators. Their practices were premised on guiding students towards the development of procedural knowledge, ignoring the aspects of process and self-regulatory learning as proposed by Hattie and Timperley (2007). Based on the findings, we concur with Oduro-Okyireh et al. (2015) that there is still a lack of alignment between policy and practice in the Ghanaian teacher education system and thus recommend that mathematics teacher educators engage more robustly with the research on the nature and purpose of formative assessment. The education system in Ghana teacher colleges is in the transitional period; thus, large-scale research is needed to understand the alignment between teacher educators' knowledge, practices, and policy.

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