

## **Exploring an alternative framework for measuring the assessment literacy of secondary school science teachers in England: the attitude-driven model**

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### **Abstract**

This paper sets out to identify and critique currently dominant standards-based models of assessment literacy, highlight their shortcomings and propose an alternative model for more effectively understanding and developing assessment literacy. An attitude-driven model to measure teachers' assessment literacy is proposed and applied in a pilot study to explore fifteen secondary school science teachers' attitudes towards assessment. This model considers teachers' assessment conceptions, assessment values, assessment behaviours and conceptions of teaching and learning. Their responses to semi-structured interview questions were analysed to test the components of the proposed model. The findings indicated that the framework for the model, centred on the relationship between attitude towards, belief in, and knowledge of assessment, was suitable for identifying the variation in teachers' assessment literacies and for determining the relationship between teachers' conceptions, values and practices. Finally, the benefits and limitations of the model were identified and discussed on the basis of its use in this pilot study and further research is recommended.

Keywords: Assessment literacy, Assessment attitude, Assessment conception, Teacher behaviour, Assessment model

### **Introduction**

Assessment literacy measurement frameworks are largely informed by the 1990 Standards for Teacher Competence in Educational Assessment of Students (DeLuca *et al.*, 2015). Whereas standards are regionalised and variation can occur within regions, the demand for sound teacher assessment literacy is universal. This is crucial, as there is a continuing need for the effective use of assessment as a tool for facilitating and promoting learning (Anisworth and Viegut, 2006; Popham 2011). To be assessment literate entails being knowledgeable of and competent in the use of assessment. It is also a reflection of the ability to make a distinction between 'sound and unsound assessment' (Stiggins, 1995, p.240).

Given the crucial role of assessment literacy as a tool for teachers (Earl, 2003 & Popham 2011), it is important that an effective framework for its exploration be identified.

Existing standard-driven assessment literacy like other forms is particularly focused on providing evidence in a particular form and for specific purposes (Webb, 2002). However, it is obvious that there is more than one goal of assessment and as such, assessment literacy must provide practitioners with the ability and skills to enable them to address all possible goals. In order to ensure that this goal is achieved, it is important that we have the appropriate instrument for evaluating the assessment litera-

cy of practitioners who are central to achieving these goals. Popham (2018) affirms that the essence of assessment literacy is the understanding of key concepts relating to assessment. This naturally requires an effective framework for exploring practitioners' understanding of these concepts (Popham, 2018). A natural question that emerges from this: to what extent are the existing models of assessment literacy able to provide us with an accurate evaluation of practitioners' assessment literacy? Although the literature is replete with positive features of the existing standard-driven framework, many have also highlighted the limitations to these frameworks including: not being subject specific (Brookhart, 2011), possibility of being deficient in one assessment theme (DeLuca et al, 2015), shortcoming of the tools of analysis associated with them, and the limited depth of the data they collect (Gotch and French, 2014). While these limitations have been highlighted, there is little offering of a replacement or alternative. In this paper, we respond to some of these limitations and suggest that existing models are not adequate and, therefore, propose an alternative. A comparative evaluation of the effectiveness of existing models and that of a proposed alternative model is a central concern of this paper. It sets out to explore the existing dominant standard-based models of assessment literacy, highlighting their shortcomings and, following this, proposes an alternative model for understanding and developing assessment literacy.

In doing this, the paper will answer two research questions: First, what are the limitations to the existing standard-driven model of assessment literacy? Second, how effective might an alternative model which is presented in this paper be in understanding the assessment literacy of science teachers?

### **Assessment literacy**

Many definitions of assessment literacy tend to focus on the development of assessment skills and knowledge. Assessment literacy has been described as one's ability to comprehend the different assessment concepts, processes and their purposes, and to use them in making informed educational decisions (Anisworth and Viegut, 2006; Popham 2011). It is 'the knowledge of means for assessing what students know and can do, how to interpret the results from these assessments, and how to apply these results to improve student learning and programme effectiveness' (Webb, 2002, p.1). The absence of such knowledge can be seen as a form of 'professional suicide' (Popham, 2011, p.269), as it is vital to the role of teachers. Assessment literacy has also been defined as assessment expertise which defines the relationship between assessment understanding and assessment facility (Lyon 2013, p.444). While teachers' assessment understanding includes belief in and knowledge of assessment, their assessment facility considers the application of these features (Lyon, 2013). Knowledge of assessment, therefore, is pivotal to the characterisation of assessment literacy.

The existing frameworks for assessment literacy emphasise the position of knowledge in the discourse. In a typical example, Abell and Siegel (2011) offer a science teachers' assessment literacy model which aims to outline the knowledge and skills required for the development of effective assessment-centred learning environments. At the core of this model is the teachers' view of learning, which supports their knowledge of assessment purposes, assessment strategies, what to assess and how to interpret and act on assessment information (Abell and Siegel 2011). In another example, Xu and Brown (2016) developed a conceptual framework of teacher assessment literacy in practice. This framework highlighted the role of knowledge as an essential tool in conceptualising teacher assessment literacy in practice. What is apparent is the fact that there are many components to assessment literacy and, therefore, any effective framework for its measurement must factor in these components. Based on this, we suggest that assessment literacy must, at the very least, involve teachers' compre-

hension of assessment, its place in teaching and learning and its application in a given context.

### **A review of standard-based assessment literacy models**

As a concept vital to effective teaching and learning, teachers' assessment literacies have been explored using different measurement tools. DeLuca *et al* (2015)'s review of teacher assessment literacy measures reveals the existence of different standards-based assessment literacy measures. Drawing on Deluca's framework, selected standards-based assessment literacy measures are analysed below based on source, process and product.

Standards-based assessment literacy measures are constructed to gauge teachers' conformity to assessment standards or their comprehension of them. For example, the Standards for Teacher Competence in Educational Assessment of Students (AFT *et al*, 1990), which originates from the US, has been used to generate at least six assessment literacy measures. Measures underpinned by these standards include the Classroom Assessment Literacy Inventory model (CALI) (Mertler 2003), utilised in several studies for the measurement of teachers' assessment literacy (Mertler 2003, Mertler and Campbell, 2005; Yamtim and Wongwanich, 2014) and the Assessment Practice Inventory (Zhang and Burry-stock 1994) which, in addition to these standards, is underpinned by classroom assessment literature.

Assessment standards tend to be regionalised, and, as such, resultant assessment literacy measures tend to be similarly regionalised. Dissecting standards-based assessment literacy measures uncovers the limited nature of the measuring tools. First, analysis of the existing measures revealed that standards can be deficient in one assessment theme (DeLuca *et al*, 2015). This suggests that no existing standard takes into account the entirety of the essential elements required for classroom assessment. For instance, the Standards for Teacher Competence in Educational Assessment of Students is deficient in the assessment for learning theme. This constitutes a limitation largely due to the standards' failure to consider the knowledge and skills required by teachers to work effectively in the current educational era (Brookhart, 2011). Furthermore, although the standards framework sets out to measure the core knowledge required for assessment in general, it fails to account for subject-specific content such as science education. In addition, it does not seem to have kept step with the revolution in educational practices caused by the crusade of evidence-based practices, which necessitates a revolution in its key integral elements such as assessment and curriculum. This ultimately results in the obsolescence of standards. The rate at which this can happen in some instances has a potentially huge impact on the consistency of teachers' developmental programmes.

The modality for implementing the standards can also be a limiting factor. The application of standards-based assessment literacy measures typically involves the use of multiple choice or Likert type questions underpinned by the standards. Although the use of standards-based questions gives users an insight into the concept of assessment literacy, this comes with a limited form of response which does not offer exhaustive answers. For instance, the Assessment Practices Inventory (API) (Zhang and Burry-stock 1994) considers teachers' responses on their competence in the use of the different assessment practices incorporated into the tool and the rate at which they use them. The tool considers teachers' self-efficacy and rate of use of the different assessment practices. However, self-efficacy is not based on one's skills but rather on one's perceived skills, and efficacy does not predict knowledge (Sharp *et al*, 2016). Similarly, a high rate of use is not synonymous with competence. As such, it is clear that the underpinning assumptions of this measure limit the extent to which one can map out the extent of assessment literacy. Limiting teachers' evidence of learning to their self-reported perceptions and usage actions alone generates only a partial repre-

sentation of these, on account of the fluidity, complexity and nuanced nature of teachers' thinking (Smith, 2017).

Finally, standards-based assessment literacy measures generate quantitative data which can be easily used for computation and comparison. This creates an opportunity for the incorporation of a benchmark; that presents a suitable tool for coordinating teacher development. While this is an important element of assessment literacy measurement, the data cannot be considered to be rich and robust, because of some of its inherent limitations, such as the use of Likert-type and multiple choice questions. Furthermore, there is weak psychometric evidence to support available assessment literacy measures (Gotch and French, 2014).

In view of the limitations to these models in generating a comprehensive description of teachers' assessment literacy, an alternative model which is devoid of standards, rubrics and ratings is proposed – an attitude-driven model of assessment literacy. This is clearly dissimilar to the qualitative use of the standard based models as it considers teachers' attitude as a tool for describing their assessment literacy. Its guiding principle is informed by the relationship between attitude, belief and knowledge.

To understand this rationale, let us consider teachers' assessment literacy as a reflection of their knowledge and skills, essential in the assessment of students' learning (Lian and Yew, 2016). Knowledge is 'the factual propositions and the understandings that inform skilful action' (Calderhead 1996, p. 715). Teachers' personal practical knowledge informs their practices by filtering their experiences and reconstructing them in order to respond to a particular teaching demand (Golombek 1998). Assessment knowledge, which reflects assessment literacy, therefore, informs assessment behaviour. However, much of teachers' professional knowledge can be more accurately considered to be their belief (Kagan, 1992). Teachers' classroom practices and their professional development are influenced by their educational beliefs (Zheng, 2009; Griffith *et al*, 2006). Drawing from these established facts, it is credible to infer that an understanding of teachers' belief about a concept can reveal their knowledge of the concept.

Despite the role of belief in reflecting knowledge, it has been argued that attitude has more impact on behaviour than general belief (Ashford and LeCroy, 2009). Attitude is characterised as a way of thinking, feeling or behaving based on one's belief, feeling, and summarily seen as 'the disposition to respond positively or negatively to people', objects, institutions and situations (Ricketts and Ricketts, 2010; Ajzen, 1998). It is considered to be the product of evaluation, positive or negative, of an object of thought (Bohner and Wänke, 2002; Oskamp and Schultz, 2005; Weiten, 2013). Therefore, the manifestation of one's attitude is a reflection of one's belief of what something is or should be, is used for or should be used for, how something works or should work and how favourable or unfavourable something is. Simply put, attitude guides the decisions and actions individuals that take in different situations that arise in their daily life (Fien, 2007).

If attitude is developed from beliefs that have been evaluated (Bohner and Wänke, 2002), then, a measure of attitude shows a reflection of the beliefs which present a reflection of the knowledge. An increased positive attitude towards classroom assessment correlates with higher educational assessment knowledge (Quilter and Gallini, 2000). It is, therefore, plausible to argue that the study of teachers' attitudes will enhance the understanding of teachers' knowledge. This, then, is a major rationale for the proposed attitude-driven model of measuring assessment literacy.

The underpinning argument for this proposed model can be summed up as follows. Attitude is essentially a form of knowledge structure stored in the memory and inferred from past experience, but can also be constructed on the spot (Fabrigar *et al*, 2005; Oskamp and Schultz, 2005). Because attitude depends on one's thoughts at any given time and is subject to change over time (Erber and Hodges, 1995; Eagly and

Chaiken, 1998), it is reasonable to assume that its understanding will give an insight into one's knowledge at any given time. This takes into account the view that the assessment knowledge required in order to become assessment literate is limited to the things relevant in making real-world differences in the daily decisions one takes in the education of a child (Popham, 2011). The review of one's attitude thus presents a more pragmatic reflection of their assessment literacy.

### The attitude-driven model of measuring assessment literacy

The proposed model has four components: teachers' assessment conception, assessment value, assessment behaviour, and teachers' conception of teaching and learning. These components represent the concepts that inform attitude towards assessment (Fig 1). In order to understand teachers' attitudes towards assessment, we argue, it is important that we become familiar with the characteristics of attitudes in general.

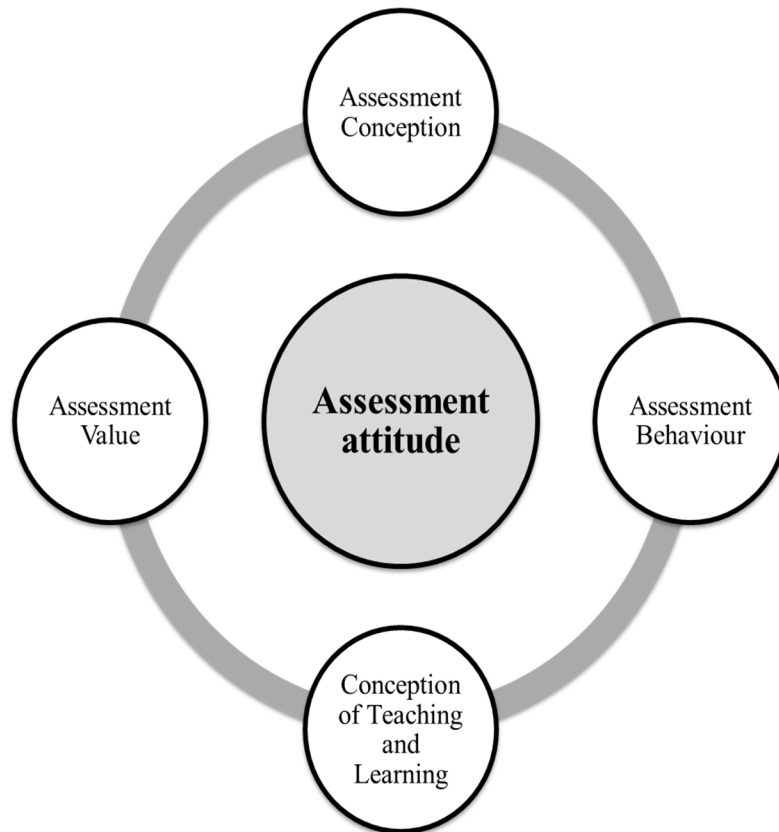


Fig 1: A model for teachers' assessment attitude  
Attitude

Attitude as a concept is made up of three components: the 'affective', which centres on one's feelings and emotions; the 'behavioural', which highlights one's actions towards attitude objects; and the 'cognitive', which reflects one's thoughts, beliefs and ideas (Johnson and Boynton, 2010; Olson and Maio, 2003; Bordens and Horowitz, 2002). Features from these components can come together to form one's attitude towards an attitude object (Eagly and Chaiken, 1998). Although these components are related, they are distinct (Olson and Maio, 2003; Hewstone 2011). In the

case of the proposed assessment attitude model, each of these components underpins one element of teachers' assessment attitude.

### **Assessment conception**

The cognitive element resonates with what is described in the literature as the knowledge of the attitudinal object (Reid, 2006). Assessment conception characterises the cognitive part of the assessment attitude model. Conception reflects how an individual understands the nature and purposes of an object, subject or phenomenon (Brown and Gao, 2015). Accordingly, the assessment conception element can aid in unravelling teachers' assessment beliefs through the exploration of their views on assessment and its purposes. The underpinning principle of this element is centred on the characterisation of belief as a constituent of one's conception of an idea (Thompson, 1992; Philipp, 2007), and, as such, conception as a reflection of one's belief. If knowledge is a 'justified true belief' (Nonaka and Takeuchi, 1995, p58), exploring belief will give an insight into one's knowledge. However, the study of belief as a sole means of understanding teachers' knowledge may be limited. Belief can be mere acceptance of a fact without real justification or understanding of the rationale. It is a construct that 'does not lend itself easily to empirical investigation' (Pajares 1992, p.307).

### **Assessment value**

Assessment value expresses the affective component of attitude. This component of the model has the role of harnessing teachers' feelings and their emotion-informed judgments about what constructive assessments should be. Underpinning the inclusion of this component is the recognition of the fact that attitude is the belief originating from the value placed on the object of thought and the expression of views of what should happen in different situations (Fien, 2007). Although the various components of attitude as proposed here might interact in different situations, each of them can become dominant at different times (Olson and Maio, 2003; Hassanein, 2015). Therefore, there is a need to recognise that each element might play different roles in the formation of ones' assessment attitude.

### **Assessment behaviour**

Assessment behaviour within this framework mainly focuses on teachers' assessment actions and hypothetically reflects the observable part of the model. Underpinning this element is the perception of knowledge 'as a capacity to act' (Sveiby 1997, p.37) and the idea that knowledge can be reflected in actions. It is also an acknowledgement of the fact that knowledge informs practice (Golombek 1998). Although there are strong links between knowledge and practice, the exploration of practice as a sole measure of one's knowledge provides a limited description. Other factors have been linked to practice. For instance, teachers' beliefs and values, in addition to external pressures, influence their assessment practices (McMillan, 2008).

### **Conception of teaching and learning**

The final component of the proposed assessment attitude model is the conception of teaching and learning. Informing the inclusion of this element are a number of arguments. First, assessment is considered as an integral part of teaching and learning (Bell and Cowie, 2001; Absolum, 2011). If we assume teaching and learning to be the superset, its exploration will involve an exploration of its subsets of which assessment is one. Second, teachers' beliefs about the key learning content and how learning occurs

influence what they assess; and, in effect, the knowledge of what and how to assess are key to teachers (Abell and Siegel, 2011). On that account, understanding teachers' conceptions of teaching and learning will give an insight into their assessment conceptions. Third, attitude formation is not limited to the link between the components of an attitude towards an object (intra-attitudinal), but can also be formed by creating linkages between the attitude object in question and other attitude objects (inter-attitudinal) (Eagly and Chaiken, 1998). As such, the exploration of assessment attitude should include the exploration of teaching and learning, both as the pedagogical concept embodying assessment, and as allied attitude object.

The proposed model addresses some of the limitations associated with the standard-driven model. First, because it focuses on attitude, it allows us to address the issue of the inability of the standard-driven framework to focus on subject specification (Brookhart, 2011). Secondly, because of the requirement to explore all the inherent components of attitude, the proposed framework provides the opportunity to generate a more robust compendium of teachers' assessment knowledge and practices thus address the shortcoming of limited depth of the data collected using the standard-driven framework (Gotch and French, 2014). Finally, because it is not standard driven unlike the sector driven focus of the standard-driven framework. It has the potential to be applied across sectors, regions and subject. In essence, it provides a framework that can be considered as having universal applicability. This means that amongst other manifestations of the universality of its application, it can be applied to different educational settings; primary, secondary, tertiary. Finally, we note that although the model still relies on individuals to make judgement on their competence in a particular area, it is their understanding of the different aspects of the model which is reflected in their answers that reflect their knowledge of assessment and its practices.

## **Application of the attitude model of assessment**

### **Methodology**

This model was applied in the exploration of a group of science teachers' attitudes towards assessment. A convenience sample of fifteen science teachers working in secondary schools in England participated in the study. The sample was selected from a group of teachers who often take part in an online science teachers' discussion forum. In the first place, the choice of participants was informed by convenience. Because of one of the researchers' awareness of the workings of the group, it was clear that it was composed of practitioners who are interested in assessment and who have some awareness of its metalanguage. In effect, the group was readily available and considered suitable because members were already involved in various discourses on educational issues including assessment, thus making them reflective practitioners. In addition, the group comprises science teachers from different parts of England, and is a convenient avenue to access science teachers with regional variations. Science teachers were considered for this research because science as a multifaceted discipline enables us to track the issue of subject specification which is considered relevant in the evaluation of existing standard-driven framework. The nature of the group is, therefore, a viable launching pad for one of the issues the study aims to investigate.

A random sample of fifteen science teachers stratified by their role, length of teaching experience and the type of school they work in were chosen. Stratified random sampling was employed to ensure a better representation of the group and reduce sampling error (Mulcahy and Gregory, 2009). Semi-structured interviews with open-ended questions served as the data collection tool. These were carried out virtually and by telephone and lasted for about 30 minutes.

We opted for the use of interview because of its ability to collect data on things that cannot be easily observed or incorporated into a questionnaire, and, as

such, have the potential to reveal one's attitude (Byrne, 2012). The issue being explored involves the insights of participants. This is difficult to elicit through methods such as surveys and questionnaires. In addition, the interview method used in this study was 'unobtrusive', thus discussions with participants were not likely to alter or influence their attitudes (Aiken, 2002 p.26). As a result, the data collected were more likely to reflect the authentic views of participants on assessment, and so present a more comprehensive account of their attitude. Furthermore, using interviews offered a pathway to understanding multiple realities in research. This is an assumption of this research, given the varied demographics of the participants in terms of experience and regional location. It was therefore expected that the interviews in this study would aid the discovery and presentation of multiple perspectives if they did emerge (Stake 1995). Interviewing the participants also allowed key identified questions to be asked without restricting the scope of the discussion between. The use of open-ended questions allowed better access to respondents' views (Byrne, 2012), which generated less restricted information. This is particularly important, as the questions did not impose restrictions on the type of assessment practices to discuss.

### *Issues of ethics*

The researchers recognised the ever-present potential for ethical issues to emerge in the process of conducting this research. At the heart of this are two issues. First is the recognition of our responsibility to the participants (BERA, 2018). Central to this in the context of this study is voluntary participation and informed consent and right to withdraw. Drawing on the injunctions of BERA (2018), we addressed the issue of voluntary participation and informed consent through the provision of detailed and transparent information to all potential participants prior to the commencement of the study and a request for a confirmation of willingness to participate. By the participants. Only those who confirmed their willingness were included in the study.

Another issue relates to the potential for harm to participants. Conscious of the fact that our potential participants were employed as teachers and could possibly be critical of practices in their places of employment, we assured them of anonymity in our reporting and publication and also offered them a chance to read the transcript to avoid misrepresentations. Taking the two steps above enabled us to address the two issues relating to our responsibilities to the participants.

We further recognise our responsibility to the research community in terms of the positionality of one of the researchers as a potential member of the group of participants. This raises the issue of reflexivity (Corlett & Mavin, 2019) and effective use of appropriate methodology (BERA, 2018). To address this, we ensured that the transcription and initial interpretation were carried out by the other researchers to see if there was any trace of bias in the contributions of the researcher who had the potential for being biased.

To explore science teachers' assessment attitudes, questions were developed around each component of the proposed attitude model, as shown in Table 1 (on the next page).



Element of the assessment attitude model	Indicative interview questions
Assessment conception	How would you define assessment? What are the main purposes of assessment?
Assessment value	Which assessment strategies do you consider valuable and why? Describe an assessment strategy you carried out and found to be useful. Describe an assessment strategy you carried out and found not to be useful. Which assessment strategies do you carry out often and why?
Assessment behaviour	
Conception of teaching and learning	How would you describe the term 'teaching and learning'? What does 'teaching and learning' mean to you in the classroom? What do you consider to be good teaching and learning strategies?

Table 1: Summary of the indicative questions

These questions formed the bedrock of the interview process as, in some instances, the responses received resulted in spin-off questions to elucidate participants' views. The data generated were analysed using content analysis techniques, with the components of the model serving as the initial codes. Interview recordings were transcribed and thoroughly read through. Codes were then identified from the text and grouped into themes. Further review of the transcripts led to the identification of relationships between themes which unravelled the relationship between the components of the model.

## Findings

### Alignment between Assessment conception and Assessment value

The first theme that we can construct from the findings is the relationship between participants' conceptions of assessment and their perception of valuable assessment practices. Assessment was predominately promoted by the participants as a tool or process aimed at eliciting students' understanding with the view to further enhance their learning. This signifies a formative purpose for assessment. Also, buried in their discourse was the summative use of assessment as exemplified in the extract below.

*'Assessment is a way of assessing prior knowledge and new knowledge. It used by teachers to inform planning and by students to check their level of proficiency/competency in skills being developed. The most valuable assessment practices are quick and easy formative assessment tasks to identify gaps in students' understanding'* (Participant A)

In the example, there was lack of clarity on the students' use of the assessment outcome, thereby making the categorisation of such assessment as formative or summative limited. Although participants agreed that assessment is for varied purposes,

their definitions of assessment reflect their understanding of the purposes of assessment. This was also found to be closely linked to their perception of valuable assessments. Illustrating this kind of relationship is an extract from participant B.

*'Assessment is a way of checking students' progress and measuring attainment. Its purpose is to check students' understanding, identify gaps in skills and knowledge and inform future planning.... I consider formative assessment as the most valuable assessment practice ...'.*

Here the participant described assessment as a process for checking students' understanding and using the outcome to inform future practices. Their view of valuable assessment practices echoes their belief of what assessment is and should be used for. This gives an indication of the views of the participants in relation to the conceptualisation of assessment and valuable assessment practices. Their beliefs about assessment influence their values in relation to it. The champions of formative assessment theory are promoters of formative assessment practices. This suggests that the framework has the potential of enabling participants to engage with their own understanding of the various roles of assessment. Clearly, this is a crucial element of assessment literacy. Their definitions of assessment and its purposes reflect their conception of assessment, and their perceptions of valuable assessment practices reflect their judgments about what constructive assessments should be. This finding draws a link between the assessment conception and assessment value which are both elements of the attitude driven model. The crucial point here is that the framework which we tested enabled this view to emerge. Participants were able to engage with their own position regarding the role of assessment from the onset.

### **Alignment between Assessment value and Assessment behaviour**

Another theme that emerged from our findings was the link between participants' perceived view of valuable assessments and their common assessment practices. Although there were variations in their common assessment practices, these practices mirror their belief of what a valuable assessment should be as exemplified in the extract below.

*'The most valuable assessment practices are quick and easy formative assessment tasks to identify gaps in students' understanding. In my teaching, I regularly use AfL practices for daily checks on learning' (Participant A)*

*'I consider formative assessment as the most valuable assessment practice. Often in my teaching, I carried out regular AfL in class and the use authentic assessment to assess both knowledge and skills.' (Participant B)*

This shows that participants understand the rationale for carrying out the different assessment practices they do and their importance. Promoters of the formative assessment practices are also regular users of such assessment practices. This finding shows that there is correlation between the participants' perceptions of the assessment process and its main purposes, which reflects their assessment conceptions, and their perceptions of valuable assessment practices which mirrors their regular assessment practices. Regular assessment practices were considered to be formative in nature, as activities to elicit students' knowledge and the utilisation of their findings were discussed. Critical review of the responses highlights some elements of summative assessment dispersed in the discussion of formative assessment; in so doing, this analysis exposes the discrepancies between the two forms of assessment. This demonstrates the ability of this framework to highlight conflicts in participants' comprehension of

assessment terms. Such attribute in tandem with the link between the different codes of analysis presents a more concise picture of the participants' assessment attitudes.

### **Alignment between Assessment conception and Conception of teaching and learning**

Also emerging from these findings is the relationship between participants' assessment conceptions and their conceptions of teaching and learning. Assessment was mostly described as the process of unveiling and ascertaining learners' learning, whilst teaching and learning was mostly described as a learner-based process of acquiring knowledge and skills facilitated and supported by the teacher. The participants' conception of teaching and learning were found to align with their conception of assessment. Illustrating this finding is the extract from the discussion with participant C

*Assessment involves checking what students have learnt and use the information to inform planning and to report to school and parents. ... I would describe teaching and learning as a process of providing information to students to enable them to understand it.*

It is logical for us to infer that the participants' description of assessment suggests its place in teaching and learning. It is the step of ascertaining and ensuring learning occurs. The link observed in our findings confirms the rationale for the inclusion of the conception of teaching and learning in the attitude-driven model. This further supports our argument for the suitability of this model in assessing teachers' assessment literacy.

### **Disparity between the components of the assessment attitude model**

Although there were clear correlations between the different components of the model used, a few instances were observed where explicit relationship between the different components of the proposed model were lacking. Demonstrating such instance is the extract from participant D

*Assessment is a way of ascertaining whether learning is taking place but not by grading. The main purpose of assessment is to assess students' progress in their scientific understanding in order to build on it. But for the school, it is a data-driven activity. ... I considered in-class AfL practices as the most valuable assessment practices. I regularly use AfL practices mostly for my KS3 classes, and for my KS4 classes the assessment practices are mostly test driven. ... Teaching and learning for me is a student-directed process.*

In this instance, the conception of assessment and the perception of valuable assessment practices varied with assessment practices in action. Where this was the case, the pressure of school accountability was cited. Such pressure is spurred up by the school management's obsession with meeting quantitative targets. This is a goal often instigated by external pressures such as Ofsted and the competitive UK school league table system; and could result in a curriculum tailored to teaching and assessment of students only to pass tests. Although these discrepancies abound, participants' understanding of assessment and its application in teaching and learning can be deciphered from their responses. This representation of their beliefs can elucidate their assessment knowledge and hence their assessment literacy. Once more, the crucial point here is that the framework which we tested enabled this view to emerge.

## Discussion

A comprehensive account of the science teachers' attitudes towards assessment was deduced. Assessment was described as an information finding tool with variations and ambiguity in answers occurring in relation to the use of the data collected. Exploration of science teachers' conceptions of assessment as part of the attitude-driven model offered a non-cued opportunity for their assessment beliefs to become more apparent. This is crucial as teachers' conceptions of assessment are ecological rationale and the application of rubrics linked to standards may limit the elucidation of their conceptions. The teachers gave responses that were not limited with pre-prepared statements and answer options, thereby exposing their thoughts. The individuality of responses extended to their description of valuable assessment practices. Findings reveal small distinctions between similar assessment practices, a characteristic that would be difficult to detect in the standard-based summative questions based models. These distinctions are important as they can aid in understanding ones' assessment knowledge, which allows appropriate developmental interventions to be offered. Moreover, the existence of varied assessment practices creates a challenge in the development of a compendium of assessment practices. The identification of the teachers' perceived valuable assessment practices and their regularly used practices exposed the link between their thought and actions. Variations existed between the two and, in some instances, correlation predominates. Clarifying the differences between the two promotes an accurate representation of ones' assessment knowledge.

The comprehension of assessment includes its role in teaching and learning. Exploring the science teachers' conceptions of teaching and learning exposed teachers' understanding of the link between the two and further helped to elucidate their assessment knowledge. Findings show that, in some instances, the science teachers' conceptions of teaching and learning reflect their conceptions of assessment and assessment practices, and in other instances, discrepancies exist. Arguably, any misconceptions on the place of assessment in teaching and learning is more pronounced in this model. The result of the data analysis supports the inclusion of teachers' conceptions of teaching and learning in the attitude-driven model. Essentially, this suggests the interlinked nature of both components of the model. The fundamental principle of assessment as an integral part of teaching and learning (Earl, 2013; Absolum, 2011) is thus upheld. Considering that assessment knowledge forms part of the pedagogical content knowledge (Magnusson *et al*, 1999) which is a component of great teaching (Cole *et al*, 2014), and teachers' pedagogical acts are all influenced by their conceptions of various educational '*artefacts*' (Brown, 2004), then the conception of teaching and learning should influence science teachers' attitudes towards assessment, as the study revealed.

The holistic nature of the model was highlighted by the existence of a link between the different components of science teachers' assessment attitudes. Hypothetically, this suggests the accuracy of the assessment attitude model. It can be inferred from the findings of this study that the science teachers' conceptions of assessment can be considered as a determinant in the formation of their attitudes towards assessment. Supporting this inference is the indication that teachers' conceptions of what assessment is, and is used for, form the bedrock of their actions (Brown, 2004; Opre, 2015). As explored earlier, belief is a constituent of one's conception of an idea (Thompson, 1992; Philipp, 2007). A positive correlation exists between teachers' assessment beliefs and their practices (Griffiths *et al*, 2006). In any instance where there are varied beliefs, as the findings show, understanding how they value different practices highlights their accepted beliefs. Value is an abstract concept of what is considered right, of importance or advantageous (Handoyo, 2015). Accordingly, value is conferred upon reflection. However, belief and values can sometimes be reliant on maintaining a pragmatic interface with authority and coping with pressure, as was

found in this study. Teachers' values can, as a result, sometimes be contravened by their assessment practices (James and Pedder, 2006). To this end, the exploration of the links between assessment conception, assessment value and assessment behaviour become significant. This not only unveils the correlation between the components but will expound the impact of different factors on teachers' assessment attitudes.

The study evidenced teachers' beliefs of what the concept of assessment is or should be. Although the effectiveness of the tool used in this study lies in its ability to comprehend teachers' attitude, the data collection technique of interviewing teachers in a semi-structured way and asking questions that explore their attitudes allowed for a more discursive account of teachers' views on assessment, unlike the standard based-summative models. Considering that both teachers' espoused and tacit beliefs can influence teachers' assessment practices (Dixon *et al*, 2011), the use of interview as a data collection process allowed for the exploration of both beliefs. The assessment attitude model, therefore, presents a more symbolically accurate representation of teachers' views on assessment.

This alternative open-ended symbolic model, which can be applied in an unlimited way to multiple local situations, also provided a more comprehensive account of teachers' assessment practices, unlike the standard-based summative models, which restricted the account only to the specific assessment practices presented in the model. The tool further enabled the comprehension of the rationale for the assessment practices discussed. In contrast to the standards-based summative model, the purpose and justification of each assessment practice were easier to infer from the finding. The variation between teachers' espoused theory of assessment and their theory-in-use was made more lucid. These inferences are of importance, as the restriction of the teachers' assessment practices discourse to regularly used assessment practices or solely standards-based assessment practices has flaws. Teachers do not operate in isolation; rather, their actions are influenced by local and national policies (Maughan *et al*, 2012). Although teachers' assessment practices in schools can be informed by external pressures (McMillan, 2008), their assessment practices are often influenced by their conceptions of assessment (Samuelowicz and Bain, 2002; Postareff *et al*, 2012), which is a reflection of their beliefs. If knowledge is a 'dynamic human process of justifying a person's belief towards the truth' (Nonaka and Takeuchi, 1995 p.58), then understanding teachers' perceptions of what constitutes valuable assessment gives a better understanding of their beliefs, which mirrors their knowledge.

The use of open-ended questions linked to a flexible model removes the lid that curbs the exploration of teachers' assessment views and practices. In so doing, this research process allowed the exploration of both current and previously used practices and held views, thereby throwing more light on the evolution of science teachers' assessment attitudes. In this instance, we can argue that the model unravelled the tacit knowledge which is knowledge 'deeply rooted in an individual's action and experience, as well as in the ideals, values or emotions he or she embraces' (Nonaka and Takeuchi, 1995 p.8). In line with this description, if cognitive and technical abilities are reflected in the concept of knowledge (Nonaka and Takeuchi, 1995), then an assessment literacy model which explores the cognitive, affective and behavioural components of attitude offers a more comprehensive representation of it.

## Conclusion

It has been shown that in practical terms the dominant models of assessment literacy are limited by the nature of standards which are often regionalised, and the process which usually involves multiple choice or Likert type questions that limits one's attitude to predetermined descriptors. Findings reveal that the attitude-driven model characterised by open-ended questions can present an account of science teachers' assess-

ment conceptions, assessment values, assessment behaviours, conceptions of teaching and learning, and the relationships and variations among them.

Based on these findings, we can argue that if understanding how teachers' assessment behaviours relate to their assessment beliefs and values brings to light their assessment knowledge, then exploring them using a self-reflection proforma which generates richer data will give a more accurate symbolic account of their assessment knowledge. In this regard, the proposed attitude-driven model can be effective in a practical context. Furthermore, if the quality of assessment literacy is reflected in teachers' selection of assessment activities with rational justification for choice (Engelsen and Smith, 2014), then a review of their assessment attitudes which centres on their conceptions, values and behaviours will give an insight into their assessment literacy.

Conversely, it was found during the process of using this model that the multiplicities of science teachers' conceptions of assessment lead to conflicts, which may possibly affect their assessment attitudes at any given time. Such a finding suggests the dynamic nature of their attitudes. This raises the issue of the difficulty in ascertaining teachers' assessment literacy using this model, thus the limitation of its use in practical context. Moreover, the varied and overlapping conceptions of assessment exhibited by the participants are in line with research on teachers' conception of assessment which has shown to be multiple and conflicting, on the grounds that belief systems are ecologically rational (Brown 2011). This can be further supported by Thompson's (1992:149) assertion that 'belief systems are dynamic, permeable mental structures, susceptible to change in light of experience'. Therefore, the conception of assessment may possibly evolve with changes in experience. On the grounds of an evolving attitude, ascertaining teachers' assessment literacy using this model could be limited. Further research is recommended to explore this area. The effect of teachers' conception of teaching and learning, and teachers' pedagogy on their assessment conceptions could be carried out to ascertain how these impact on their assessment attitudes. This may throw more light on the dynamic nature of assessment literacy in practical context.

Although this study focuses on teachers who are essentially based in the school sector, a crucial question emerges from the findings in terms of its implication for the Higher Education (HE) sector. This is crucial because the researchers work in an HE context. We suggest that there are two ways in which the study becomes relevant for the HE sector. First, although, the findings emerged from the views of science teachers, a key feature of the proposed framework is that it has universal applicability. In addition, it is also very capable of being applied across subject specific areas. Drawing from these features, it is evident that the same principles can be applied in an HE setting. Assessment is a crucial part of teaching and learning in HE. Therefore, although the study focused on science teachers in secondary schools, the concepts and their implications are not exclusive to school science teaching and assessment alone.

The second point in relation to the relevance of this study for HE is the role that HE plays in teacher education. Teacher education across all sectors is currently substantially located in HE with trainee teachers studying on the PGCE programme. Given that the development of teachers' skills in various areas of their practice including assessment is initiated during their training, this study and the proposed framework becomes important both in the context of developing trainee teachers' knowledge and in informing the curriculum content of teacher training programmes delivered in the HE sector.

### **Limitations to the study**

We recognise the possibility of the limited source of participants being a limitation to the study. Without a doubt, this limits the extent to which the findings can be general-

ised. While acknowledging this potential limitation, we note that the study still achieves the goal of focusing attention on this issue. In addition, we argue that previous awareness which is a distinctive feature of the participant group is not necessarily significant for establishing attitude which is central to this study.

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