Characterising formative assessment practices in the mathematics classes

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Abstract. This study investigated how formative assessment is conducted in one of the secondary schools Brunei Darussalam. A framework that consisted of the five key strategies was utilised to observe two mathematics teachers teaching at the Year 7 and Year 10 levels. The qualitative approach was used in analysing the data in which two classroom observations and interviews with the teachers and randomly selected students were conducted. From the lesson observational findings, only a few of the characteristics from the modified key strategies were observed. The interview findings revealed contrasting findings with one teacher being aware of using formative assessment in her lesson and using activities to access her students’ understandings of the lesson. However, the other teacher was not aware of using formative assessment in her lesson and prefers her students to think independently. In order to improve the teachers’ performance to teach formatively, more time should be given for the teachers to plan, reflect and design formative assessment activities.

1. Introduction

The use of formative assessment practices is sometimes overlooked in the classrooms, as teachers typically tend to measure students’ performance through summative assessments [1, 2]. However, formative assessment could also improve students’ achievements [3, 4]. Formative assessment in Mathematics is an important tool to improve the level of learning in the Mathematics classroom. It is a deliberate instructional process utilised by teachers and students to provide specific, actionable and immediate feedback to students through daily, ongoing instructional strategies that are more focused towards student-and-classroom-centered [5]. Accordingly, Black et al. [6] suggested a few criteria for teachers in order for formative assessment to be practiced and implemented in the classrooms, such as teachers need to discuss and share the learning objectives with their students, teachers are encouraged to ask higher order thinking questions that encourage students to explore and make connections from their previous lesson, and to give constructive feedback to students by letting them know how they progress during the lesson [7-9], for example, what they have done well and how to improve their learning.

This study investigated how formative assessment is carried out in a secondary school in Brunei Darussalam. A framework from Wiliam and Thompson [10] that consisted of the five key strategies was utilised to observe two teachers teaching Year 7 and Year 10 respectively. Table 1 displays how...
each of the key strategies are related to define the features of formative assessment. Several characteristics of formative assessment were observed with reference to this framework and a checklist was used to identify if the two teachers had achieved the stated criteria. The chosen framework was used because Anderson and Palm [3] discovered the effectiveness of the key strategies based on the professional development given to the teachers in implementing the formative assessment activities in their lessons. From their findings, it was reported that the students’ academic performance had improved when compared to the control group. In addition, the framework encompassed the approaches on the use of students’ learning as evidences that adjusted the mode of instructions in order to suit the students’ learning ability.

| Table 1. The framework comprised of the five key strategies (taken from [10, p 107]). |
|-----------------------------------------------|
| **Key Strategies and Characteristics**        |
| KS1 – Clarifying, sharing and understanding learning intentions and the criteria for success |
| KS2 – Engineering effective classroom discussions, questions and tasks that elicit evidence of learning |
| KS3 – Providing feedback that moves learners forward |
| KS4 – Activating students as instructional resources for one another |
| KS5 – Activating students as the owners of their own learning |

Ruiz-Primo [11] suggested another form of informal formative assessment where teachers used instructional dialogues such as assessment conversation that are dialogic and interactive in nature. The main role of the teachers is to encourage students to ask and then answer the questions, subsequently, the students learn how to participate in reasoned argumentation with the requirement to be investigative, be independent by thinking critically and learn how to solve problems with their peers [12]. However, regardless of the teachers’ teaching experiences, not all the teachers practiced and implemented the skills that were shared during the professional development [13]. The teachers preferred the direct instructional method.

Only recently, the Mathematics teachers from Brunei government schools were given professional development in dialogic teaching so that the students will be asked higher order thinking skills questions to assess their level understanding during the lessons. Therefore, this study aims to compare the classroom practices of two mathematics teachers. Teacher A who was the Program for International Student Assessment (PISA) learning partner, trained by the PISA International Coach to implement formative assessment strategies in her lessons, whereas Teacher B is an experienced teacher who had been teaching for more than 20 years who mainly prefers the direct method of instruction. The investigations centred to whether both teachers had shown the stated key strategies that were derived from the framework by Wiliam and Thompson [10], and to compare, if any, differences with the mathematics performance of their students in the respective classrooms.

2. Method

The two participating Mathematics teachers in the study were conveniently selected. Teacher A is in her late twenties, possessed a Master qualification with two years of teaching experience. Teacher A taught the Year 7 Mathematics topic on ‘Congruency and Similarity’. Meanwhile, Teacher B is in her late fifties, with a Certificate qualification but had more than 25 years of teaching experience, and she taught the Year 7 Mathematics topic on ‘Directed Numbers’. Each of their Year 7 mathematics lessons were observed and the teachers were subsequently interviewed. In total, six students (three from each of the teachers’ classes) were also interviewed to seek their views on formative assessments that were used in their respective lessons. These students were randomly selected from both classes. Due to ethical considerations, the identity of these students will not be revealed.

This study used the qualitative approach in which two classroom observations and interviews were conducted. The two lessons were video recorded in order to analyse the respective teachers’
assessment strategies. Semi-structured interview questions were used and the interviews lasted approximately 10 minutes. The conversations with each teacher from the interview recordings were then analysed for themes that focused on the teachers’ views on the use of feedbacks and their opinions on formative assessment activities. A checklist, modified from Andersson and Palm [3, p 113] that consisted of the five key strategies with detailed formative assessment description activity used in the classrooms. The checklist was also used to report on the lesson observational findings that focused on the strengths and weaknesses for both teachers.

3. Results and discussions

3.1. Lesson observational findings

Few of the characteristics mentioned from the key strategies [10] were observed during the lesson observations. The formative assessment activity for each teacher are reported in Table 2, which gives the overall report based on the five key strategies adapted from the framework [3, p 113].

| Table 2. Details of the overall report for the two observed teachers. |
|---------------------------------------------------------------|
| Formative Assessment Activity                              | TA | TB |
| (AN1) Clarifies learning goals by specifying sub-goals or success criteria | ✓  | ✓  |
| (AN2) Clarifies relevant mathematical procedures as learning goals by specifying sub-goals or success criteria | ✓  | ✕  |
| (AN3) In oral and written communications, the teacher emphasises learning as a goal in contrast to completing a task | ✓  | ✕  |
| (AN4) Clarifies relevant mathematical communications as learning goals by specifying sub-goals or success criteria, in most cases using rubrics | ✕  | ✕  |
| (AN5) Teacher uses mini-whiteboards to produce evidence of students learning | ✓  | ✕  |
| (AN6) Teacher uses exit passes to produce evidence of students learning | ✕  | ✕  |
| (AN7) Teacher uses tests to produce evidence of students learning | ✓  | ✓  |
| (AN8) Encourage students to ask questions and allow students to inform their misconceptions | ✓  | ✕  |
| (AN9) Teacher uses feedback | ✓  | ✓  |
| (AN10) Provides more thoughtful feedback | ✕  | ✕  |
| (AN11) Gives students comments instead of grades | ✓  | ✕  |
| (AN12) Encourages students to help each other | ✓  | ✕  |
| (AN13) Provides students with the descriptions of how to act as a resource for one another | ✕  | ✕  |
| (AN14) Provides students with the descriptions of how to regulate their learning | ✕  | ✕  |
| (AN15) Provides students with descriptions of how to handle situations when they do not know to solve tasks | ✕  | ✕  |
| (AN16) Organises activities for students to monitor and evaluate their use of time. | ✕  | ✕  |

Note 1: KS1 = AN1; AN2; AN3 & AN4; KS2 = AN5, AN6, AN7 & AN8; KS3 = AN9, AN10 & AN11; KS4 = AN12 & AN13; KS5 = AN14, AN15 & AN16. Note 2: KS denotes Key Strategy; AN denotes Activity Number; TA denotes Teacher A and TB denotes Teacher B.

From the Table 2, Teacher A was observed to implement 11 of the 16 formative assessment activities in her classroom, whereas Teacher B only managed three of the stated activities. It seems that Teacher B did not strengthen the first dimension of conducting formative assessment, such as clarifying mathematical procedures as the learning goals and the oral and written communication. Teacher A was observed to strengthen the learning goals clearly by communicating with her students at the beginning of the lesson and what to achieve at the end of the lesson. However, she did not use rubrics as a tool to interpret and grade the students’ work against criteria and standards for the
particular tasks. For the individual work, she also assigned two tasks targeting the particular learning goals, allowed student discussions so that answers were shared, and mistakes and questions accepted.

To produce evidence of students’ learning (KS2), Teacher A had used mini-whiteboards to access individual students’ understanding of the given task, such as in identifying the differences and similarities of the two given shapes. The students wrote their answers on the mini-whiteboards and held them up for the teacher’s view. Teacher B, on the other hand did not strengthen this key strategies (KS2) but she tend to give a lot of direct questions as a review from the previous topic. The students were given a time limit of 15 minutes to answer the questions on the whiteboard and then exchanged their books to mark their peer’s work. Answers were discussed directly with the students but they were not given any opportunity to talk and to discuss the corrections among themselves. However, both teachers did not use exit passes to provide evidence of students’ understanding of the lessons. For the KS3 dimensions of learning, Teacher A was observed to give oral feedback to individual students as she monitors the students’ work during the individual tasks. She replaced scores with comments. Meanwhile, Teacher B did not give any comments for her students to improve their understanding of directed numbers. However, she did ask the students verbally if they need more questions as a review for the current topic. Additionally, the female students were seen to respond more compared to the male students who were silent throughout the lesson.

For the second dimension involving all agents in the classroom, Teacher A encouraged her students to assist one another (KS4), however she did not provide any descriptions, or develop the application techniques of formative assessment to the students in supporting one another. Teacher B was not observed to carry any of these (KS4) strategies. In KS5, Teacher A organised an activity through peer assessment where students discussed and corrected their peers’ work within the given time limit. She monitored the time limit for each activity, however the students were not allowed to monitor and reflect their time usage for the activity. Although Teacher A discussed the answers with her students at the end of the lesson, no encouragements were given for the students to do self-assessment of their learning with respect to the given goals. For the KS5, Teacher B was not seen instructing her students to regulate their own learning. The students were drilled to answer all the 17 questions from the whiteboard and they were not given any opportunities to reflect and self-assess their own learning as they were not informed of the goals needed to be achieved at the end of the lesson.

3.2. Interview findings

From the interview sessions, the teachers were asked on their views on formative assessment. Teacher A was aware of it but not for Teacher B. Due to her education background, Teacher A had no difficulties in describing the purpose of using formative assessment during her lesson, but not for Teacher B. Teacher A’s opinion on formative assessment is an on-going assessment and it can also be used after a summative assessment, such as giving feedbacks to the students. She personally thought that formative assessment is more important after the summative assessment where it reflects the performance of the students. Teacher A expressed her opinions on the sharing of objectives of the lesson, in which she stated that it depending on the flow of the lesson. She sometimes shared it at the beginning of the lesson and if the students had achieved the goal of the lesson, she will let the students know at the end of the lesson. Teacher B was not aware of sharing the objectives of the lesson with the students and she disregarded it. She explained that she would only know how much her students understood after answering her questions through classwork. Nonetheless if many of her students made mistakes, then she would use mental arithmetic to tackle her students’ mathematical skills. She also asked her students if they needed more questions from the previous topics and she would drill them with more questions before beginning a new topic. Teacher B preferred to assess her students through summative assessment.

Teacher A explained that using the mini-whiteboard is an efficient way to access her students’ understanding of the lesson where it could help her to correct the students’ mistakes immediately. She would correct the students’ misconceptions immediately before giving the classwork or else it would be too late to give the students’ feedback after marking the classwork. She would also use pre-
designed activities that targeted the student’s misconceptions and sometimes she gave a short test from the past year examination questions for 10 minutes, which she immediately discussed the answers with them. Teacher B did not believe in giving group work or activities to access her students formatively. She preferred her students to sit down, solve the problem and to think individually. Nonetheless, she allowed her students to ask her questions if they did not understand. When asked on giving feedbacks, she told the students to see her during her free time and she retaught the whole lesson once again. She would instruct the students to do the corrections immediately and if the students did not attempt the corrections, the students would face punishment. From the interview findings, it seems that Teacher A was aware of using formative assessment in her lesson and used activities to access her students’ understandings of the lesson. However, Teacher B was not aware of using formative assessment in her lesson and prefers her students to think independently. She also did not want to practice any activities that is used to access students formatively. She preferred to access her students by giving more extra questions and instructs students to do the corrections in order to avoid repeating the same mistakes.

The six students were interviewed on their views of being formatively assessed by their teachers in class and the use of peer feedbacks. The familiar themes that emerged were: All preferred to discuss their answers with their peers; Through the activities done by Teacher A and the use of mini-whiteboards, the students were aware of being assessed formatively and it helped them to understand better; Teacher B’s students were not aware of being assessed formatively mainly because the teacher instructed and discussed the answers with them and; They are used to being assessed through tests and preferred to be given numerical grades in order to see if they had done well in the examinations.

3.3. Discussions

The Wiliam and Thompson [10] framework is well structured, as it comprised of the three dimensions of learning within the five key strategies. The first dimension consisted of the three processes in teaching, learning and formative assessment and it establishes where the learners are at a specific stage in their learning, where the learner is currently and what required to be done in order to get there [10]. The first dimension clearly states what the teacher needs to be aware of in her teaching, which focuses more on where and how to move the learners from one stage to another. As observed from the framework, Teacher A had covered the first and second dimensions of the framework where she gets her students going by clarifying her learning objectives and the goals of her lesson. This framework is structured to acknowledge the importance of teachers and students to reach a common understanding of the specific goals, the processes focused on eliciting, interpreting and to use the information to make decisions on what needs to be done in the next steps in teaching. The second dimension of the framework involves the three agents in the classroom, which is the teacher, peer and the learner who participated in the formative assessment processes. This framework touches on the importance of students that need to act as both learners and peers, thus indicating where students need to help each other as well as themselves. Teacher A had involved her students to work cooperatively and collaboratively [14-17], her students were actively engaged during the discussions, and she also motivates her students to keep trying the questions.

The third dimension of this framework is used to differentiate the different ways of managing formative assessment, which is the time frame of the adjustment cycle. The framework is virtuous as it includes the length of the adjustment cycle where the teacher will adjust her teaching strategies according to the students’ feedback and students will adjust their learning behaviour after receiving the feedback from the teacher. During instruction time, teachers should be aware of the students’ feedback while assessing them formatively and at certain time, teachers need to make changes in planning their lesson, such as differentiating different tasks for different students’ abilities. Perhaps, to review the topic before moving to the next lesson if the objectives of the lesson were not achieved. The three dimensions of the formative assessment from this framework are useful in order to structure a checklist for analysis of any teachers’ formative assessment classroom practice.
4. Conclusions

According to the study conducted by Andersson and Palm [3] who had reviewed Wiliam and Thompson [10] framework, students’ achievements improved when teachers changed their method of instruction through the professional development that consisted of the five key strategies. So far, professional development that was conducted by the PISA International Coaches did not contain certain elements of these key strategies. In order to improve the teachers’ performance to teach formatively, more time should be given for the teacher to plan, reflect and design formative assessment activities in order to make it work.

It is recommended that teachers should be given time to focus more on their professional development. In addition, the teachers should be monitored frequently and given guidance to improve their instructional strategies. As observed from this study, Teacher A, who is the PISA learning partner had implemented most of the key strategies from the framework. However, she did not use the rubrics, which is a comprehensible set of criteria for students’ work that included descriptions of levels of performance quality on the criteria [18, 19]. She should also allocate more time for the students to do peer assessment like checking their peers’ work, encourage students to make decisions, to converse more and ask questions in class. In contrast, Teacher B who is an experienced teacher did not want to apply the knowledge from the professional development. Through the use of summative assessment, Teacher B viewed that it is the best method for students to improve their academic performance, thereby overlooking the formative assessment strategies. She should put in more effort in making use of the formative assessment activities so as to assist her students to better learn the skills rather than studying through rote learning without understanding what to achieve at the end of the lesson. However, Teacher B did not want to change her method of instructions because she believed that she had produced a number of students who had excelled in their examinations.

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