| | |
|---|---|
| Title | Assessing students' learning of primary science in the multicultural context of Singapore: Considerations influencing task selection for formative assessment |
| Author(s) | Poh Hiang Tan and Aik Ling Tan |
| Source | *37th Annual Conference of the International Association of Educational Assessment (IAEA) on "Assessment and the Challenge of Globalization", Manila, Philippines, 23 – 28 November 2011* |

IAEA Annual Conference 2011

**Assessing students' learning of primary science in the multicultural context of Singapore: Considerations influencing task selection for formative assessment**

Poh Hiang TAN and Aik Ling TAN
*National Institute of Education/Nanyang Technological University, Singapore*
*pohhiang.tan@nie.edu.sg; aikling.tan@nie.edu.sg*

**Abstract**
This research reports the considerations influencing task selection for formative assessment among 30 primary school science teachers. Education and assessment are high stake enterprises in this multicultural city-state of Singapore. The 39 participants were chosen through random sampling from six primary schools located at different parts of Singapore. The participants responded to an instrument comprising of activities on the concepts of electrical circuits and conductors. The activities, set in different contexts but based on the same learning outcomes, were presented to the participants as possible tasks to assess students' learning. The participants' responses to the questions were analysed. The findings revealed that the teachers prioritised students' abilities and their learning over and above other factors. The writers argued that the teachers' focus on students' abilities may work against the current initiative of inquiry approach towards teaching and learning. While studies on teachers' conceptions on assessment have been undertaken, the contribution of this paper lies in illuminating influences on the implementation of formative assessment in Singapore primary science classrooms.

***Key words: formative assessment, task selection, primary school science***

**Introduction**
Education and assessment practices are strongly coupled and in education systems around the world, these two aspects are taken into consideration in the formulation of educational and assessment policies and reforms. An ideal education and assessment system is one that caters to the needs of diverse groups of learners from different cultural and social background. This perfect education and assessment system will require in-depth understanding of cultural influence of teachers, students and society, and is difficult to actualise. Teachers' actions, ideas and decision making on all aspects of education and assessment has profound impact on students' learning proficiencies and their experiences of school and success (Bernstein, 1990). As such, it is important to develop an accurate and realistic knowledge of the considerations that teachers take into account when they make decisions about assessment in a multicultural social context in Singapore. The main objective of this study is to understand how teachers view formative assessment in the primary science classroom and what they value as suitable tasks for formative assessment. As argued by McRobbie and Tobin (1995), teacher's beliefs and their goals have a strong impact on their behavior within the context of action which in this case is the primary science classroom. Besides, to enhance learning, formative assessment should be instructionally linked or embedded in classroom activities (Popham, 2008; Shepard, 2000). Particularly, in science classroom, there could be a range of activities within a specific topic available to teachers for selection.The research question that guides this research is "What factors do teachers take into consideration when they choose tasks for formative assessment in science?"

Education and assessment are high stakes in the multicultural city-state of Singapore where there are three major ethnic groups, namely Chinese (74.1%), Malay (13.4%) and Indian (9.2%). Promoting racial harmony and social cohesion is one of the most important

considerations in government policies. In education, the national schools provide opportunities and environment for different races to interact. In fact, one of the major steps taken to ensure social cohesion is to provide a common education to all children through the implementation of the Compulsory Education Act which ensures that a child must attend a national primary school regularly except for the rare exceptions who opted for home-schooling.

In the primary schools, the core subjects taken by the children are English Language, Mathematics, Science and Mother Tongue and English is the medium of instruction for all the subjects except Mother Tongue. At the end of the primary school education, it is mandatory that all children sit for the Primary School Leaving Examination (PSLE) which is an emplacement examination for further education in the next level. As Singapore has a tracking system, this first national examination that twelve year-olds sit for is perceived by parents, students and teachers as a major and important examination.

**Theoretical Considerations**

The negative impact of high stakes assessment on classroom practices was reported in many studies. In the once-off high stake assessment, it is only possible that a fraction of the content and skills delineated in the curriculum could be assessed. This could result in the narrowing of curriculum in which both teachers and students focussed their attention on the domain that would be assessed and classroom assessment tends to emulate the high stake assessment (Shepard, 2008; Harlen, 2005; Popham, 2001; Black, 2000; Black and Wiliam, 1998; Gipps, 1994) and often there were concerns about the impact of such testing on students' learning (Popham, 2001; Shepard, 2008) whereby incessant teaching to the test concentrates classroom efforts towards certain contents and skills that will be assessed and ignored others. While this practice may drive up students' performance in the assessment, Harlen (2005) also warned that it may also have negative impact on students' motivation in which students show a strong orientation towards extrinsic rewards like grades instead of showing an interest towards learning.

Similarly, Shepard (2008) concurred that extrinsically motivated students would work towards performance goals like obtaining good grades or appearing to be competent. Such students tend to select easy tasks and would not risk failure. She drew upon research on self-efficacy and how children view their own abilities in learning. According to her, when praises focuses on students being 'smart', it may unintentionally lead students to believe that ability is fixed and thus avoid challenges. On the other hand, students who were taught that ability could be increased by effort are more likely to take up challenges and less inclined to avoid difficult problems. According to Black and Wiliam (1998), feedback that focussed on students' effort is one of the strategies for formative assessment which will help students improved their learning.

Formative assessment has its research based on motivation and cognition studies, both of which have strong links to socio-cultural theory. Drawing upon the theory, students' learning could be viewed as not only an individual effort but also a social interaction within the classroom where support from the knowledgeable one like teacher or peers allows the student to take part in activities (Shepard, 2008; Gipps, 1999). To understand the implications of socio-cultural theory from learning to formative assessment, it is important thus to clarify what constitute formative assessment.

Shepard (2000) viewed assessment as part of the learning process where both teachers and students see assessment as providing information which serve to improve classroom teaching and learning. In doing this, assessment would be closely tied to instructions or what Popham (2008) called it "instructionally oriented classroom assessment". He sees an advantage in using a learning progression to help map students' learning towards an ultimate

goal. A learning progression consists of a set of sub-skills and enabling knowledge students required in order to reach a certain curriculum goal. Knowing the enabling knowledge and sub-skills required would help both students and teachers to understand the type of information or evidence to be collected that would inform them on students' learning.

On the other hand, Pellingrino, Chudowsky, and Glaser (2001), conceptualize assessment as a process that is based on triad relations of cognition, observation and inferences. In this triad relation, assessment is based on good understanding of what accounts for learning (or the knowledge and skills) for the area of study. In classroom context, teachers could then design appropriate situation or task so that students have the opportunity to display what they have learnt and the evidence of which can be appropriately interpreted and used. While the three elements are important in formative assessment, the development or selection of task will impact students' performance directly and also how information about students' learning could be elicited.

In Singapore, science education embraces the inquiry approach in teaching and learning. The National Science Education Standards or NSES identified the five essential features of inquiry approach in teaching and learning. They are:

1. Learners are engaged by scientifically oriented questions.
2. Learners give priority to evidence, which allows them to develop and evaluate explanations that address scientifically oriented questions.
3. Learners formulate explanations from evidence to address scientifically oriented questions.
4. Learners evaluate their explanations in light of alternative explanations, particularly those reflecting scientific understanding.
5. Learners communicate and justify their proposed explanations.

(Olson and Loucks-Horsley, 2000, p25)

The Biological Sciences Curriculum Study (BSCS) has designed an inquiry approach which includes 5 stages in the teaching and learning process, namely, engage, explore, explain, elaborate and evaluate. This model of inquiry is widely used in many primary schools and has been introduced in many in-service workshops aimed at developing teachers' competency in teaching science. Resources for specific topics are also made available for teachers to help them carry out science lessons, many of which include student-centred activities.

At the same time, in the review of primary education (PERI, 2009) undertaken by the Ministry, it was highlighted that school assessment should shift the focus towards more formative assessment or assessment *for* learning. Currently, many schools have embarked on the journey to implement formative assessment either within the school or in collaboration with Ministry of Education. This paper will highlight some of the issues which arise as a result of teachers trying to make sense of the two initiatives.

**Research Methodology**

This is a qualitative exploratory study motivated by a study carried out by Tomanek, Talanquer and Novodvorsky (2008). In their study, written probes were used to identify factors that influenced potential and experienced secondary science teachers' reasoning when they select or evaluate tasks for formative assessment purposes.

In this study, the data were obtained from 39 primary science teachers from six schools located in different parts of Singapore. Over the year, Singapore students' performance in international comparative studies like TIMSS, and more recently in PISA, has captured the attention of the rest of world. From cultural and social perspectives, as a country that value meritocracy, Singaporean looked upon education as a key to success and thus

national examinations are viewed as important and hence high stakes. As such, there is a strong emphasis on summative assessments in schools and the results of such assessment are used to emplace students into different ability groups and for policy and curriculum planning.

*Research participants and Data collection*

In this study, the 39 participants were randomly selected and their experiences range from beginning teachers of 1 year to experienced teacher of 40 years. They are currently teaching in six different primary schools and their educational backgrounds are also varied (from A-levels to Masters degree). The only condition for selection of the teachers is that they must have all taught elementary science and the topic of electricity. This is necessary as the probe used was based on electricity and knowledge of the learning outcomes related to the topic is necessary in order that the teachers could make an informed choice based on their experience in teaching electricity. The probe used in this study is in the form of a questionnaire with three activities based on topic of electricity. The participants were asked to select one activity which they feel would also allow them to assess their students' learning and also to give their reasons for their choice as well as reasons for not selecting the other two activities.

*The probe*

There is a common science curriculum used in all the national primary schools and the topic on electricity is usually taught to Year 5 students. The probe consists of three activities, labeled T1, T2 and T3 on electricity that would at least assess the following three learning outcomes found in the primary science syllabus:

1. Recognise that an electric circuit consisting of an energy source (battery) and other circuit components (wire, bulb, and switch) forms an electrical system.
2. Show an understanding that a current can only flow through a closed circuit.
3. Identify electrical conductors and insulators.

Task T1 was intentionally designed to emulate the PSLE Science examination format and is a pen and paper task that requires students to work individually. This task was included in the probe to better understand whether the participants' view on formative assessment could be linked in some way to how they perceived students would be assessed in the national examination.

Task T2 was designed to be similar to the activities found in science resource books requiring the students to work in pairs. Such activities are normally conducted in the science laboratory and required the students to work in pairs. It follows the Predict-Observe-Explain (POE) sequence commonly used in science teaching in Singapore classrooms. The apparatus required in this activity are readily available in the science lab. The rationale of designing this task is to understand whether teachers see possibility of formative assessment in the usual teaching procedures in classroom.

Task T3 was a novel activity that required each group of four to five students to create a puzzle for another group of students to solve. At the end of the activity, the students were required to share with the owner of the puzzle how they arrive at the answers. The set-up for activity, though not complicated, would require teachers to source for shoebox and to mount a switch, two light bulbs and a set of batteries on the box cover. The task is designed as a puzzle to include some fun element but at the same time allows group discussion and collaboration to create a puzzle as well as to solve another puzzle. The rationale of this task is to understand whether teachers view possibilities of formative assessment in student-led group discussion.

*Data Analysis*

The responses from the teachers form the data corpus for this research. We adopted a modified process of coding (open coding, axial coding, and selected coding) as suggested by Glaser and Strauss (as cited in Flick, 2006). In the first instance, we carried out open coding whereby the two investigators examined all the responses independently to search for frequent ideas expressed by teachers. The factors were coded using phrases or words that were frequently used by the participants. For instance, many of the participants took into consideration whether their student "have or do not have the ability" to do the task. Another factor frequently considered was whether the task would allow students to show their "understanding of concepts of (closed) electrical circuit". In the primary science syllabus, there is strong emphasis on science process skills like analyzing, evaluating etc. Hence, another commonly stated factor related to whether students have opportunities "to predict/analyse". Coding was carried out by two researchers using NVivo 9 and inter-rater agreement was set at kappa value of at least 0.5, indicative of fair to good agreement among the two coders.

Subsequently, we carried out axial coding or what Tomanek, et al (2008) referred to as interpretive coding process where we looked into the relationships among the frequent ideas expressed by the teachers and developed four themes (implementability; learning outcomes; nature of task; and students) based on the responses of the teachers.

Finally, for selective coding, we examine the details and context of the responses to finalize the integrated themes among the responses so that we could understand the factors guiding the teachers' decision making for selecting tasks for formative assessment.

## Findings

The factors that affect teachers' decision making in task selection for formative assessment are (1) nature of task; (2) students; (3) learning outcomes; and (4) implementability of task. As can be seen from table 1, the nature of the task is most important when teachers select tasks for formative assessment. Teachers also relate the nature of the tasks to students' ability when they are selecting the task as can be seen by the similar percentage coverage of the codes.

The data also showed that teachers pay a lot of attention to students' abilities when they are considering tasks for formative assessment (10.2% coverage). In their responses, the teachers mention alignment of level of difficulty of tasks to students of different ability levels. Responses such as:

"*Weaker pupils will be able to handle it well.*" (Tr7)

"*Task 2 may be given to middle and low ability groups.*" (Tr9)

"*The middle ability should be able to tackle this.*" (Tr15)

Teachers' perception of students' abilities are related to the students' performances in their examinations. "Weaker students", "middle ability groups", "low ability groups" and "high ability groups" are common language used by teachers to describe the abilities of their students. The common issue among "weaker and low ability groups" is one of language. Students belonging to this category generally come from non-English speaking homes and as such generally do not perform well in all subjects in school, including science. The teachers' expressed that the students' low ability in the English language hindered their comprehension of the subject matter and their ability to express themselves in oral and written communication. These are essential skills that are required by students to practice good science in school. Similar to a vicious cycle, the motivation of students are also affected when the activities that they are exposed to are less varied. The teachers in this study indicated that while activities such as T3 may be interesting and motivate students, they are hesitant to expose "weaker" students to these activities, opting instead for more routine and direct tasks. An important observation is that there is a comparatively lower emphasis on the role of teachers in

helping students through the tasks (2.5%). Since the focus of this study is not on classroom teaching, this should not be taken as an indication of how teachers view their roles in classroom activities. However, it may have some bearings on the influence of external assessment in which teachers view themselves as judging the students' ability to carry out the activity. This is not conclusive from the study but could be an area for further study.

Table 1: Factors affecting teachers' decision making for formative assessment task selection

| **Categories** | **Sub-category** | **Percentage Coverage (%)** |
|---|---|---|
| Nature of task (18.9%) | - Task is good for enrichment or to prepare PSLE or for tuning in or as an extension | 5.6 |
| | - It is challenging | 4.8 |
| | - It is simple enough | 3.6 |
| | - To assess students' understanding or for summative assessment | 3.4 |
| | - To identify misconceptions or students' understanding of conductor and non-conductors | 1.5 |
| Students (18.2%) | - Have or do not have the ability to do the task or for high (er) ability or for average ability or for low (er) ability | 10.2 |
| | - Students will like or enjoy or find interesting | 5.3 |
| | - Collaboration or group work or work as a team | 2.8 |
| Learning outcomes (14.7%) | - Understand concept of electrical circuit / electricity / conductors / electrical components | 8.9 |
| | - hands-on / process skills / predict / analyse | 5.8 |
| Implementability (12.7%) | - Will be able to handle or manageable or too complex to carry out | 4.4 |
| | - investment of time | 3.8 |
| | - Teachers' guidance or help / needs to monitor or *scaffolding* | 2.5 |
| | - Easy to get materials or time consuming or apparatus is available | 2.1 |

At the same time, similar to the findings of Tomanek et al (2008), the interpretation of the cognitive demand of the task across teachers differs. For instance, while most teachers viewed Task 3 as challenging, there seems a difference in interpretation of the cognitive demands of Task 2, an activity similar to those available in teachers' resources:

> "*Task 2 is a combination of asking pupils to make predictions based on their prior knowledge and then actually carrying out the experiment to confirm their predictions. By carrying out the experiment, it is more hands-on and will help pupils better remember materials which are conductors and non-conductors of electricity*." (Tr10)
> "*A straightforward task that basically confirm pupils' understanding that metals - conductors non-metals - non-conductors. Circuit is easy to set up as well.simple and*

*straightforward, allows independent work from students given illusions that they are investigating.*" (Tr 28)
*"T2 - for high ability class*
*(carries out) when the time permits as the task is rather open." (Tr38)*

The teachers in this study also privileged the science content (8.9% coverage) that the students' will learn when they select tasks for formative assessment. They are concerned about the alignment of the tasks to the intended learning outcomes as spelt out in the national curriculum documents. While this is expected of teaching and learning in the reality of classroom life, it suggests a dilemma that teachers face in selecting and deciding what could be implemented in classroom to support instructions and assessment. For instance, the responses from some participants suggest that task selected should focused strictly on whether it could meet learning outcomes as seen in the response below:

"*The learning outcomes 'Recognise …, Show… and Identify…' do not require any higher order thinking skills. Hence, to achieve the learning outcomes, Task 1 will be the most appropriate. For Task 2 and Task 3, they require more thinking as the pupils need to 'Design a circuit'*." (Tr15)

At the same time, there are teachers who seem willing to venture beyond the requirements of the stated learning outcomes:

"*It appears challenging and yet fun for the pupils. The hands-on task will engage the pupils. This task would expect them to apply what they have learnt when designing a possible circuit. Working in groups allow pupils to discuss the set up in the shoe box, and is less threatening to pupils in the low and even middle ability groups.*
*Various circuits would be created, allowing pupils to explore further and solve the puzzle. Drawing out the possible connections also assesses pupils' visual ability in presenting from concrete to abstract presentation."* (Tr 8)

It is apparent the selection of task requires teachers to strike a balance among a number of factors like the contents stipulated in the curriculum, the issues of engaging students in the activities as well as other considerations like students' ability and time factor. Responses pertaining to these factors are as follows:

*"… pupils need good knowledge of electricity before being able to carry out this task"* (Tr 6)
*"…Much time is also needed in doing task 3. Monitoring by the teacher is also essential in ensuring the success of task 3. In the curriculum task 3 is an ideal task but a luxury to have…" (Tr2)*
*"… For the average class pupils, I think they will be able to handle the task, especially when working in groups. More learning will also take place because more possibilities will be generated.*
*The task is also not so difficult that it will frustrate the pupils to the extent that they give up." (Tr9)*
*"T3 is for higher ability pupils"* (Tr 2)

Task T3 was an unfamiliar task that required the teachers to create the shoebox set-up. A number of the participants did focus on its novelty and made similar observations like and *"It is too time-consuming to be done in class"* (Tr 26). However, contrary to our initial

hypothesis that teachers will focus on the implementability of the task in their decision-making, we found that while this is a concern, it is not a major issue with most teachers (12.7%).

Within the probe, there were two tasks that required student collaboration. In the findings, we were surprised at the relatively little attention given to the effects of group activities which have increasingly become a common feature in the primary science classroom (2.8%). This could be an indication of teachers prioritizing the different criteria of selection of tasks or it could be a case of teachers seeing group activities as part and parcel of science classroom.

The teachers in the study appear to dichotomize the ideas of summative-formative assessments and assessment-classroom activity. As one participant pointed out, "*But if it is for summative assessment purposes solely then T1 is more suitable. T2 and T3 provide more for formative assessments - to inform teacher and pupil about child's progress and readiness*" (Tr 1). While Task T1 was intentionally set in the same style as PSLE science question, the explanation given by students in the question could still reveal students' learning of electricity. As Bennett (2010) pointed out, there tends to be an oversimplification of summative assessment for the purpose of assessment *of* learning and formative assessment for assessment *for* learning. While the primary purpose of summative assessment could be for documentation purpose, it could still fulfill a secondary purpose of assessing students' learning. The same argument would go for a formative assessment. When used appropriately, it could provide documentation of students' learning journey. As suggested by Black, Harrison, Lee, Marshall, and Wiliam (2003), the assessment is considered formative if the task could provide information on the students' learning for teacher to make an informed decision on the next course of action.

Another significant finding from this study is that a number of teachers tend to draw a distinction between assessment and the classroom activity per se (5.6%) with a number of participants seeing the task as an "*enrichment activity*" (Tr 3, Tr 18, Tr 38) or "*extension activity"* (Tr 19, Tr 36, Tr 37). As a teacher (Tr 16) pointed out, "*The other 2 tasks are more direct and can be used immediately after the basic lessons are taught. I think they are not very suitable for formative assessments"*. This finding reflect what Kind (2009) expressed in her review of nine models on pedagogical content knowledge (PCK) arising from different studies. Kind found that only two models by Magnusson, Krajcik, and Borko (1999) and Veal and MaKinster (1999) considered assessment as part of PCK that teachers need to be equipped with (as cited in Kind, 2009). In this study, the participants seem to view formative assessment as separate from classroom instruction instead of one that is embedded in classroom teaching and learning activities as proposed by Popham (2008) and Shepard (2000).

Our findings show that while many teachers see tasks with a distinct summative or formative purpose and separate from teaching and learning, there are also teachers who perceived that formative assessment are often associated to hands-on activities. In our interaction with many teachers, there seems a perception among teachers that all forms of assessments carried out in class are formative in nature with less attention paid to the interpretation of the elicited evidences.

**Implications and conclusion**

This paper considers the factors that teachers take into account when they make decisions pertaining to task selection for formative assessment. Our results showed that teachers privilege (1) the nature of task; (2) students' ability; (3) learning outcomes to be fulfilled; and (4) implementability of task in the classroom constraints.

While formative assessment has been widely accepted as a way forward to improve classroom teaching and learning, evidence from this study shows that the participant teachers' belief about their students' abilities may impose restrictions on the form of activities carried out in class. Generally, the participants in the study seem to place a strong emphasis on matching task to abilities, that is, there is general preference for activity that their students could tackle competently rather than one that challenges them. The immense attention paid to students' abilities during selection of tasks may restrict the type of activities and opportunities given to students during classroom teaching. Particularly, when students were perceived as "average" or "lower" ability, there tends to be a preference for more routine and familiar tasks. This interplay between teachers' perception of students' abilities and type of task selected may work against the direction of our primary science classroom teaching through inquiry as envisaged by the Ministry. As for the few participants who expressed their willingness to expose their students to challenging activities, an in-depth study will be conducted to better understand how the teachers enact formative assessment during such activities.

The findings also show teachers privileging students' learning during activities but their interpretation of the level of cognitive demands for the activities differ. This is true for teachers within the same school as well as teachers across different years of experience. How this difference arise - whether it is due to exposure of teachers, educational background of teachers- the results of this study did not allow us to make any valid conclusion. However, it does indicate that there is a need for teachers to have opportunities for professional exchanges of ideas in classroom teaching.

While Popham (2008) and Shepard (2000) espoused the need for formative assessment to be embedded in classroom instruction, the findings from this study show that there are teachers who view assessment as separate from classroom instructions, with seeing the activities as instances for specific teaching purposes like enrichment, reinforcement and less as opportunities for finding out about what students know or can do. This has strong implications on science teaching as classroom activities are not fully optimised to provide information on teaching and learning.

**Contribution to the teaching and learning of science**

The significance of this paper lies in understanding teachers' ideas about assessment and their classroom practices. Our results show that teachers take students' abilities into consideration in selecting classroom tasks. Further, our results also show that some participant teachers risk making disparate distinction between assessment and classroom instruction. These analyses of the results have the potential to inform teacher professional development and reform curriculum and assessment changes.

## References


Bennett, R. E. (2011). Formative assessment: A critical review. *Assessment in Education: Principles, Policy & Practice*, 18(1), 5-25.

Bernstein, B. (1990). Social class and pedagogic practice. *The structuring of pedagogic discourse, IV*: Class, Codes and Control, pp 63-93, London: Routledge.

Black, P. (2000). Policy, practice and research: The case of testing and assessment. In Millar, R., Leach, J & Osborne, J. (Eds), *.Improving science education: The contribution of research* (pp327-346). Milton Keynes: Open University Press.

Black, P., Harrison, C., Lee C., Marshall, B., & Wiliam, D. (2003). *Assessment for learning: Putting it into practice.* Maidenhead: Open Press University.

Black, P., & Wiliam, D. (1998). Assessment and classroom learning. *Assessment in Education: Principles, Policy & Practice*, 5(1), 7-71.

Flick, U. (2006). *An introduction to qualitative research*. London, Thousand Oaks, CA: Sage.

Gipps, C. (1994). *Beyond Testing: Towards a theory of educational assessment*. Great Britain: The Falmer Press.

Gipps, C. (1999). Socio-cultural aspects of assessment. *Review of Research in Education*, 24, 355-392.

Kind, V. (2009). Pedagogical content knowledge in science education: Potential and perspectives for progress. *Studies in Science Education,* 45(2), 169-204.

McRobbie, C., & Tobin, K. (1995). Restraints to reform: The congruence of teacher and student actions in a chemistry classroom. *Journal of Research in Science Teaching,* 32(4), 373 - 385.

Ministry of Education, Singapore. (2009). *Report of the primary education review and implementation committee.* Retrieved from http://www.moe.gov.sg/media/press/files/2009/04/peri-report.pdf

Olson, S., & Loucks-Horsley, S. (Eds.). (2000). *Inquiry and the national science standards: A guide for teaching and learning.* Washington, D.C.: National Research Council.

Pelligrino, J. W., Chudowsky, N., & Glaser, R., (Eds). (2001). *Knowing what students know: The science and design of educational assessment*. Washington, D.C.: National Academy Press.

Popham, W. J., (2001). *The truth about testing: An educator's call to action*. Alexandria, VA: Association for Supervision and Curriculum Development.

Popham, W. J., (2008). *Transformative assessment*. Alexandria, VA: Association for Supervision and Curriculum Development.

Shepard, L. A.(Ed.) (2008). Formative assessment: Caveat Emptor. In Dwyer, C.A. (Ed), *The future of assessment; Shaping teaching and learning* (pp.279-303). New York: Lawrence Erlbaum Associates.

Shepard, L. A., (2000). The role of assessment in a learning culture. *Educational Researcher, 29*(7), 4-14.

Tomanek, D., Talanquer, V., Novodvorsky, I. (2008). What do Science Teachers consider when selecting formative assessment tasks? *Journal of Research in Science Teaching.* 45(10), 1113-1130.