Analyzing preservice teachers' rubrics for assessing students' learning in primary science education

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Analysing preservice teachers’ rubrics for assessing students’
learning in primary science education

Dr Peter Hudson
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Abstract
Assessment needs to be linked to syllabus outcomes in order for teaching and learning to be purposeful and systematic. Second-year preservice teachers (n=255) were involved in a primary science education program with a focus on devising a science unit of work with assessment tasks and associated rubrics. These assessment rubrics considered scales for differentiating student achievement of outcomes but also focused on scientific concepts and social interaction appropriate to the grade level. Although perceptions of adequate assessment techniques varied, most constructed rubrics with links to syllabus outcomes. This paper aims to discuss issues behind designing assessment rubrics.

When we try to pick out anything by itself, we find it
is tied to everything else in the universe. John Muir
(1838-1914, US naturalist, explorer).

Reform in science education is becoming more globalised by promoting standards in science education (National Science Teachers’ Association, 1996) with a focus on an outcomes-based system (e.g., Queensland School Curriculum Council, 1999). Outcomes-based education implies that planning for learning experiences in science education has standards with desirable outcomes. In addition, assessment becomes an integral part of educational reform (Bond, 1995). Assessment needs to be linked to syllabus learning
outcomes in order for teaching and learning to be purposeful and systematic but is also used to measure the success of students’ achievement of such outcomes.

In keeping with outcome-based reform measures, assessment may be viewed as the process of collecting, analysing, and recording information about a student’s progress that indicates the level of achieving specific syllabus outcomes. There are key issues surrounding assessment. For example, more than likely, teachers are involved in an education system whether public or private, and as such these education systems have policies, principles and procedures that aim toward addressing quality assurance and gaining public confidence. So, contexts and principles for assessment need to be analysed before discussing the assessment forms and strategies for collecting, analysing and recording assessment.

Assessment: contexts
The contexts for assessment involve consideration of key stakeholders, economic conditions, equity and social issues, and the call for accountability (Brady & Kennedy, 2001). The key stakeholders include students, teachers, parents, principals, the education system, affiliated interest groups, and the government. Students are a focal point as outcome-based assessments need to include student performance, and as such, students need to have input into assessments on as many levels as possible. Teachers have a vested interest in assessment as data gained from assessment may determine the effectiveness of teaching strategies and programs. These data may also be used to enhance teaching programs for future teaching and learning (Woolfolk, 2004). Most parents are interested in their child’s achievement in particular subject areas. Assessment results are reported to parents to provide information about their child’s performance. This may also provide information for parents to make judgments about the quality of teaching and learning occurring within a particular school setting. Principals use assessment data to enhance teaching programs and report to their education system who in turn report to the government of the day. There are affiliated interest groups also interested in student outcomes, for example, universities are interested in potential students who may enrol in science or science education degrees, and the science
community (including scientists in the field) is interested in prospective scientists to carry on their work and research activities. Indeed, Year 12 assessment results can impinge upon the future of such organisations.

Economies develop because of their knowledge base, so assessments of learning outcomes may provide information on forthcoming economic advancements. Hence, each and every person needs to be valued for their potential contribution to the economy. Schools are fundamental to this process and, as such, need to facilitate socially just and equitable education, which is non-discriminatory and seeks improvement of outcomes for disadvantaged groups, including the Indigenous, cultural and linguistic sectors (Brady & Kennedy, 2001). Government money (through public taxes) supports and subsidises education at various levels. Australian governments spent $21.3 billion on primary and secondary education operating expenses in 2001-2002 (Australian Bureau of Statistics, 2003); hence there is accountability for spending public money on education. Assessment may be viewed as a measure of worth and educational well-being, as noted by rank-ordering higher school certificate results (e.g., US, UK, and Australia). Accountability appears to be provided through results gained from basic skills tests at various intervals throughout a child’s education (e.g., NSW Department of Education and Training [DET], and Education Queensland). The results from outcomes-based assessments can provide a measure of accountability for public spending on education (Woolfolk, 2004); however such assessment needs to be valid and reliable.

Assessment: principles
Outcomes-based assessment needs to be linked to learning experiences, explicit criteria, identifying achievements, and using indicators as evidence (Harlen, 2004). Outcomes-based education involves the elimination of failure by declaring every student can succeed (McGhan 1994). Students’ achievement of an outcome may be linked to a number of indicators as checkpoints on students’ ability to succeed. Assessable indicators need to be related to explicit criteria and the students’ learning experiences, as students generally focus their learning on how they will be assessed and explicit criteria can drive students to learn content, skills and processes (Albon, 2003). In this way,
achievements can be identified to indicate students’ level of readiness for advancement to the next educational stage. Both educators and students need to be aware of the indicators for assessment (Winking, 1997). It is also important that more than one indicator (or piece of evidence) be gathered in different contexts as this allows for a more comprehensive assessment of the student’s abilities. For example, indicators may involve individual, group, and class work associated with a learning outcome, and on a variety of tasks.

Students need to be included in the assessment process, as self-assessment can provide another perspective on assessing students’ learning (Black & William 1998; Hart, 1999). It can present an avenue for engaging students in intellectual evaluation of their learning, and an opportunity to critically assess their progress (Woodward & Munns, 2003). Assessment needs to incorporate open-ended tasks that are closely linked to learning criteria, as such tasks can cater for the range of student abilities in a class. These tasks must be sensitive to learning situations and inclusive of all learners (Brady & Kennedy, 2001). Hence, “teachers should not judge the accuracy of their assessments by how far they correspond with test results but by how far they reflect the learning goals” (Harlen, 2004, p. 96). In addition, the more thoroughly teachers understand assessment criteria (e.g., teacher-devised assessment rubrics) the more consistently they apply them (Hargreaves, Galton, & Robinson, 1996).

**Assessment: forms and parameters**

There are various forms of assessment, including formative and summative assessments. Formative assessment can include any activity that provides information on students’ learning for diagnostic analysis to improve teaching and learning (Athanasou & Lamprianou, 2002; Black & Wiliam 1998). Formative assessment also aims to gather a cumulative profile of each student’s learning for providing feedback to particular key stakeholders (e.g., teachers, principals, parents). Feedback from formative assessment can assist the learner to become more aware of gaps between desired goals and current knowledge (Boston, 2002; Sadler, 1989). Summative assessment aims at collecting data for making judgments about teaching and learning at the end of a unit of work or school...
term (Lovat & Smith, 1995) and aims to establish whether the intended curriculum transpired (Print, 1993). Choi (1999) noted that assessment was likely to be a problem in systems where the summative assessment has “high stakes” for the students. Hence, there was a shift from one-off summative assessments for Higher School Certificate examinations to a combination of formative assessments and summative assessments (e.g., NSW DET).

The broad parameters for assessment are formed around students’ knowledge and understanding, demonstration of skills, and values and attitudes (Brady & Kennedy, 2001). There is also the issue of grading such assessments. For example, there is a shift from norm referencing (e.g., using the bell curve) to criterion-based referencing (e.g., Basic Skills Tests; University of New South Wales competitions; see also Athanasou & Lamprianou, 2002), as criterion-based referencing aims to provide more information on a student’s achievement according to desirable outcomes.

**Assessment: strategies**

Apart from systematic observation as a common technique for obtaining authentic assessment, a variety of strategies need to be employed for assessing students’ work including tests and tasks (Benbow & Malby, 2002). Tests may take the form of multiple choice questions, true/false questions, short responses to questions or statements, matching statements, cloze activities, and essays (Athanasou & Lamprianou, 2002). However, many tests, like multiple choice and true/false questions, do not provide students with opportunities to apply their knowledge (Bond, 1995). For more than a decade, standardised tests have been criticised as superficially matching syllabus content, and this type of assessment may emphasise teaching only basic knowledge and skills (Bond, 1995). Yet, a test can include more diverse ways of gathering student information such as students’ construction of a concept map, annotated diagrams, or a teacher-student interview with questions constructed purposefully.

Although all forms of assessment have advantages and disadvantages (see Athanasou & Lamprianou, 2002), authentic tasks can provide greater scope for assessing students at
various levels of competencies (Bond, 1995; Brady & Kennedy, 2001; Harlen, 2004). These tasks can include written tasks such as descriptions, information reports, analytical expositions, explanations, reviews, scientific reports, and student journals but may also involve oral tasks such as group discussions, presentations, debates, role-plays, and interviews. Indeed, there can be a wide variety of tasks associated with any particular criteria, especially if students can negotiate their demonstration of a criterion by providing physical evidence such as constructing models, posters, audio/videotapes, photographs, or presenting a project, exhibition, or portfolio. For example, Williams, Davis, Metcalf, and Covington (2003) argue that the presentation of a portfolio as an assessment item allows students greater opportunities and flexibility for demonstrating their achievement of the proposed outcomes.

Selecting assessment strategies is generally a teacher’s professional decision. However, authentic assessment is linked to criteria that aim to gather information from a variety of sources, which may increase the validity and reliability of results (Athanasou & Lamprianou, 2002; Puckett & Black, 2000). Reliability of assessment is low when the criteria are more general and not matched to particular pieces of work (Shapley & Bush, 1999). Conversely, reliability is increased when tasks are closely related to specific criteria. Importantly, teachers need to be aware of bias in their assessments with “school assessment procedures including steps to guard against unfairness” (Harlen, 2004, p. 96). This paper investigates preservice teachers’ development of outcomes-based assessment for science education. The aim of this paper is to present and analyse preservice teacher examples of assessment rubrics that aim to link indicators and outcomes.

Data collection methods and analysis
Preservice teachers were involved in a primary science pedagogical development course of one semester duration at one university. These preservice teachers (n=255) represented two separate cohorts within their middle years of tertiary education. The course focused on developing their understanding of theoretical underpinnings used for: developing a science curriculum; understanding the development of children’s concepts, abilities, skills, and attitudes; understanding effective planning for science teaching and
learning; and implementing effective science teaching practices. Included in the course content was the development of a primary science unit of work that required these preservice teachers to link outcomes and assessment for recording students’ learning and involvement in science activities.

Pairs of preservice teachers constructed units of work (i.e., a program) based on science topics (e.g., weather, electricity, pond studies, processed materials). The unit of work was an assessable item requiring them to follow explicit criteria, viz:

- Provide a well-referenced rationale articulating clear reasons for teaching this unit of work, including potential school/class scenario, content significance, key concepts, theoretical design, teaching strategies, links to the syllabus, sustainable living, inclusivity, and methods of assessing and evaluating the unit.
- Develop a well-structured overview of a science unit of work.
- Provide specific unit outcomes linked to key concepts and science syllabus outcomes.
- Develop a well-structured integrated overview with activities linked to syllabus outcomes.
- Present a detailed lesson description for achieving your outcome(s) and key concept(s) on sustainable living, and providing hands-on experiences for students (including indicators for assessment and a comprehensive list of resources).
- Present a detailed lesson description for achieving your outcome(s) and key concept(s) with links to integrating another key learning area, and providing hands-on experiences for students (including indicators for assessment and a comprehensive list of resources).
- Highlight the teaching and classroom management strategies that provide inclusive learning for all students.
- Present quality assessment and evaluation proposals, including assessment rubrics based on the desired learning outcomes.
• Provide quality evidence of links to contemporary science education issues arising from readings, lectures, tutorials, workshops, and other B Ed units.

Lectures, workshops and tutorials scaffolded the preservice teachers’ pedagogical development for meeting the above criteria. The link between outcomes and assessment was also emphasised with examples from educational texts (e.g., Athanasou & Lamprianou, 2002) and previous preservice teachers’ examples of assessment rubrics. These preservice teachers’ \((n=255)\) units of work were examined for understandings of such links. This included justifying assessment procedures in the unit rationale, linking assessment and outcomes in the science unit overview and detailed lesson plans, and providing examples of assessment rubrics to demonstrate potential assessment forms.

This paper analyses various assessment rubric examples. In particular, this paper focuses on preservice teachers’ understandings of designing assessment rubrics.

**Results and discussion**

As expected, these preservice teachers’ assessments in their unit of work varied considerably. Some focused on broad outcomes while others provided specific indicators linking to an outcome. Assessment rubrics devised around broad outcomes in science education include, for example, Table 1 checklists on a student being able to: identify effects and characteristics of different forms of energy; predict the impact of science on community and environments; or display knowledge of different types of lifecycles. These broad outcomes may lack depth in the assessment process if they are not associated with particular indicators. To illustrate, the Core Learning Outcome (CLO) EB3.1 (QSCC, 1999) “Identifies interactions between systems on earth and beyond” has diverse applications. How and at what level does a student identify interactions between systems? What are these systems? Is this also implying that the student needs to identify interactions between systems on earth and the solar system? Teachers’ expectations vary as a result the interpretation of such an outcome, which may lead to invalid and unreliable assessments.
Table 1:
Checklist of Science Education Outcomes

<table>
<thead>
<tr>
<th>OUTCOME</th>
<th>EC3.2</th>
<th>SS3.3</th>
<th>LL3.1</th>
<th>LL3.2</th>
<th>EB3.1</th>
</tr>
</thead>
<tbody>
<tr>
<td>STUDENT</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Can identify effects and characteristics of different forms of energy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Predicts the impact of science on communities and environments</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Demonstrates knowledge of living things and the environments in which they live</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Displays knowledge of different types of lifecycles</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Identifies interactions between systems on earth and beyond</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

This assessment rubric (Table 1) was linked to particular science activities. One activity had three outcomes assigned. This assessment implies 3 outcomes x 30 students = 120 assessable outcomes. Would 120 outcomes be possible to assess in a 30 minute lesson? The number of outcomes per lesson does not appear to be clear in syllabus documents, nor does the balance between the time required for teaching and the time required for assessment.

Assessment criteria need to be based around more specific indicators associated with an outcome. These indicators need to be tangible and assessable. However, teachers also rely heavily upon observation for many assessments, particularly when students are involved in the physical demonstration of an assessable item (e.g., group work, project presentation). Once again, the teacher makes a professional judgment as to the indicator that may determine if a student is achieving a particular outcome. The degree to which a student has achieved an indicator also relies on teachers’ professional judgments. For example, one preservice teacher decided that students can be assessed on their understanding of Life and Living outcome 3.3 (QSCC, 1999) by observing students describing or observing particular changes or interactions (Table 2).
Table 2:

*Indicators for Core Learning Outcome – Life and Living 3.3*

The student can:

1. Describe an observable relationship between living things (e.g., living together or a feeding relationship).
2. Observe interactions between living things and non-living parts of the environment.
3. Describe an interaction between living things and non-living parts of the environment on the beach.
4. Observe and record natural changes in the environment.
5. Describe natural changes in the environment in regards to weathering, erosion and changes in temperature.

<table>
<thead>
<tr>
<th>Student Name</th>
<th>Observed criteria</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1  2  3  4  5</td>
<td></td>
</tr>
</tbody>
</table>

How can teachers observe a student observe an interaction and make an assessment of the student’s learning? A student description of an interaction may provide evidence of the articulation of cognitive processes; however this will also be subjective and can rely up a teacher’s preconceived ideas about the content of such descriptions and the manner to which these descriptions are articulated. This preservice teacher stated in the unit of work rationale, “Indicators of student learning have been developed to assist with an equitable assessment process and identification of student performance.” Undoubtedly, teachers need to be explicit about assessment criteria so students know what to expect and are given opportunities to shape their articulation of the assessment accordingly. There are also concerns when assessment is based solely on teacher observation (Harlen, 2004); hence teachers need to use a variety of assessment methods.

Some assessment criteria focused on social development rather than achievement of outcomes. Many preservice teachers incorporated social engagement as indicators on their assessment rubrics (e.g., Table 3). Indeed, there is a need to understand how
students work together in science education. Working scientifically is presented by science syllabi as an essential component for learning about science, and constructivism is promoted as socially constructed knowledge (Vygotsky, 1978). However, outcomes in the Queensland science syllabus are primarily focused on content knowledge and there are no explicit outcomes in the syllabus that allows teachers to provide feedback on social development. Parents are very interested in their child’s behaviour and participation at school, particularly in academic subject areas. Recording teacher observations about a student’s social development may assist in reporting to parents, and may also provide an indication to the balance between the student’s efforts and achievements. Stronger syllabus directions on student social participation will provide teachers with more directions on the types of social interactions that need to be observed.

Table 3:

Assessment Observation Sheet on Group Work Participation

<table>
<thead>
<tr>
<th></th>
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<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Student</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

Various preservice teachers provided assessment criteria that linked to a particular task or project in order to gain a more detailed understanding of the students’ achievements. Table 4, for example, provided criteria to assess students’ designs for an energy-efficient house. Teaching practices and scaffolding for learning need to be embedded in such assessment criteria. That is, the teacher would need to teach about elements of design
(e.g., insulation or roof colouring) for proposing an energy-efficient house, otherwise, the criteria on this particular assessment rubric may not be valid.

At this stage, it is interesting to note the different scales, measures or keys for determining the level of achievement. Table 1 provided no scale or measure, whereas tables 2 and 3 used checks (ticks) or parts of checks to indicate a level of achievement. Table 4 provided faces (i.e., happy, no emotion, unhappy), which infers the teacher will check in the column linked to the relevant indicator. Each of these scales indicated varying degrees of achievement. Indeed, the design of the scale may lead to providing more accurate recording of the assessed item.

<table>
<thead>
<tr>
<th>Table 4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Assessment Criteria for Designing an Energy-Efficient House</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Necessary Elements Of Design</th>
<th>☺</th>
<th>☺</th>
<th>☺</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insulation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Curtains/Blinds</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exterior materials</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flooring</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shade</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>House orientation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Placement and size of windows</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ventilation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Roof colouring</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Landscaping</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Lighting</td>
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</tbody>
</table>

As the science syllabus bases outcomes around content knowledge, assessment criteria rubrics will need to reflect such outcomes. Table 5 shows an assessment rubric based on students’ written information about biomass energy. The core learning outcome (4.3; QSCC, 1999) allows for “Students present alternative ways of obtaining and using energy (including energy from the sun and from fossil fuels) for particular purposes” (p. 22). The criteria key (or scale) allowed for assessment at three levels (i.e., beginning, developed, and proficient). In this case, the teacher may be able to identify specifics such as three or more advantages of chosen biomass energy.
Table 5: 
Assessment Criteria for Biomass Fact Sheet

Student’s name: __________________________

CLO: 4.3 Students present alternative ways of obtaining and using energy (including energy from the sun and fossil fuels) for particular purposes.

Key:  (B) Beginning  (D) Developed  (P) Proficient

<table>
<thead>
<tr>
<th>Student’s written report addresses the following criteria:</th>
<th>B</th>
<th>D</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fact sheet has a title</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Displays three or more advantages of chosen biomass energy</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Displays three or more disadvantages of biomass energy</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Provides links and explanation of biomass experiment within text</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Provides images that support the text</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Have shown evidence of copyright when using internet sources</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Information is clearly presented with correct grammar and punctuation</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 6 provided a numerical scale for assessing particular indicators. The criteria key (e.g., EA=extensive achievement=9+) also allowed for efficient checking of each indicator. Teachers need to consider the scope of any one criterion. For example, the first criterion in Table 6, “Brochure is informative and contains relevant information,” is very broad, which may be left open to subjective interpretation. Further details may be outlined to indicate what made the brochure informative, and what was considered relevant and irrelevant information. This type of clarity needs to be included in teaching and learning activities. There is also a need to separate science outcomes and outcomes from other syllabi for evaluation and reporting purposes. For example, the indicator “Brochure includes correct layout, structure, grammar and spelling” predominantly resides in the English syllabus, as there are no core-learning outcomes across the five strands of the Queensland science syllabus stating students need to have correct grammar and spelling.
### Table 6

*Criteria for Constructing a Brochure on Biomass*

Student’s Name:______________________________

<table>
<thead>
<tr>
<th>Criteria</th>
<th>EA = 9+</th>
<th>CA = 7-8</th>
<th>MA = 4-6</th>
<th>LA = 0-3</th>
<th>Out of</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brochure is informative and contains relevant information.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>/10</td>
</tr>
<tr>
<td>Brochure identifies and describes the problem and its causes and effects.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>/10</td>
</tr>
<tr>
<td>Brochure incorporates an appropriate action plan to reduce pollution.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>/10</td>
</tr>
<tr>
<td>Brochure includes correct layout, structure, grammar and spelling.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>/10</td>
</tr>
<tr>
<td>Brochure is creative and visually appealing.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>/10</td>
</tr>
</tbody>
</table>

**Key:**
- EA = Extensive Achievement
- CA = Considerable Achievement
- MA = Moderate Achievement
- LA = Limited Achievement

**Total Score** 50

Generally, students need more than one opportunity for a teacher to determine the successful achievement of any particular outcome (Athanasou & Lamprianou, 2002; Harlen, 2004). The following example in Table 7 demonstrated specific criteria associated with an outcome in the science strand Natural and Processed Materials (NPM). This preservice teacher emphasised in the rationale for the unit of work that assessment needs to be ongoing with multiple opportunities for students in a variety of contexts. The criteria, “Students can explain the purpose of insulation” allowed for a variety of explanations and focused on students’ communication skills. However, the form of the students’ explanations will need to be a stronger consideration (e.g., oral, written, diagram, presentation). Also, how many opportunities are students provided before the teacher is compelled to move to the next teaching phase? This preservice teacher suggested three opportunities for students to demonstrate their ability to achieve an outcome. Yet, unlike the attempts of an Olympic high jump feat, a student unable to achieve an outcome should not be “counted out”, which is a much wider issue not fully
addressed in education to date. Undeniably, not being counted out is fundamental to the outcomes-based approach (McGhan 1994). Nevertheless, more direction and guidance is required on managing the education of students within the same classroom who are on different levels of academic and social achievement.

Table 7

Criteria for Assessing CLO NPM 4.3

NPM 4.3 - Students examine and assess ways that materials can be changed to make them more useful.

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Date</th>
<th>Date</th>
<th>Date</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students can explain the purpose of insulation.</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Students are able to show an understanding by suggesting why certain materials are more effective than others for insulation.</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Students effectively communicate their results from the experiment to their peers.</td>
<td></td>
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</tbody>
</table>

Conclusion

It is important that teachers design assessment around current syllabus outcomes that are linked to specific assessable tasks (Brady & Kennedy, 2001; Harlen, 2004). As indicated in this paper, assessable tasks focus on students’ social interaction and content knowledge within criterion-based assessments. Indeed, social interaction for science education (and for many other, if not all, subject areas) is considered an essential element for developing knowledge (see also Vygotsky’s constructivism, 1978). However, content knowledge is emphasised in state and national examinations, and in outcomes presented in science syllabi, even though the world’s knowledge base on any subject or topic is unknowable by any single person. Yet teachers are expected to devise criterion-based assessments that link to curriculum documents without adequate modelling or guidance. At the same stage, educators and education departments grapple with implementing new concepts about educational practices, including outcomes-based education and associated assessments. Syllabus documents provide the key ingredients for teachers to consider in their assessment practices. To illustrate: “Multiple opportunities for the demonstration of learning outcomes should be planned. A range of activities incorporating contents and
contexts should be utilised to provide these opportunities” (Queensland School Curriculum Council, 1999, p. 32).

The science syllabuses for New South Wales, Victoria, and Queensland have little or no clear criterion-based assessment rubrics that may lead teachers to develop more effective practices. Instead, these science syllabuses are heavily weighted with outcomes, and assessment examples are severely marginalised. Yet assessment of learning outcomes is the focus for accountability to the key stakeholders (Brady & Kennedy, 2001). Assessment drives (or should drive) teachers’ programs for learning (Athanasou & Lamprianou, 2002). The outcomes within the syllabus and departmental demand for assessment (e.g., state tests) are not equally matched with clear examples of outcomes-based assessment. It appears the ingredients are available but the recipe is vague. Whether performance based or product based, assessment records need to be carefully designed to reflect students’ achievements aligned with explicit criteria. More explicit directions and proposals for outcomes-based assessment must be embedded in curriculum documents.

References


