THE DEVELOPMENT OF PROBLEM-SOLVING RUBRICS TO DEFINE LEARNING PROGRESSIONS TO SUPPORT THE INCLUSION OF STUDENTS WITH ADDITIONAL LEARNING NEEDS
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Abstract

In a changing society with evolving needs and occupations, problem-solving is increasingly seen as an essential skill for success in many contexts, including school and the workplace. However, students with additional learning needs often lack the necessary support to be successful in this skill domain. The aim of the study described in this paper was to design rubrics for problem-solving that define progressive levels of learning to support the instruction of this cohort of students. A working definition of problem-solving was used to draft observation statements in the form of rubrics that teachers could use to describe their students’ skill development. Workshops were conducted with specialist teachers (n=13) who critiqued and extended these draft rubrics, and mapped them to a learning progression. These materials were then trialed with experienced special education teachers, who reviewed them and generated intervention strategies for students at different skill levels on the derived progression. The outcome of the study was a set of assessment rubrics and level descriptions that teachers could use to support the learning of students with additional needs in a skill domain often dismissed as too demanding to be included in their personal programs.

Assessment rubrics based on teacher observation and judgement

The study described in this paper was grounded on a review of the purpose of assessment, signalling a shift from judging student success or failure towards building a stronger understanding of where students are in their learning journey (Griffin, 2007; Masters, 2013). This has led to increased interest in the design and use of rubrics to describe student learning. For the purpose of this study, rubrics were defined as “a set of scoring guidelines that describe the characteristics of the different levels of performance used in scoring or judging a performance” (Gronlund, 1998, p. 225). The central features of rubrics were thus the ordered categories or levels of performance that comprise a description of the cognitive, affective, and psychomotor skills embedded in competent performance (Griffin). Underpinning this concept of rubrics was a criterion-referenced interpretation in which an individual’s achievement or competence was described in terms of the behaviour they demonstrated or the tasks they performed (Glaser, 1981). The end purpose of the use of assessment rubrics and resulting progression was seen as teachers’ capacity to facilitate targeted instruction appropriate for a student’s level of learning (Griffin, McGaw & Care, 2012; Roberts & Griffin, 2009).

In Australian schools, students tend to progress with their age cohort rather than being retained at a grade or year level if they have not achieved that level’s expected educational standard. As Howes (2012) pointed out, this means that teachers in most classrooms must adapt their teaching to meet the needs of students working across an ability range roughly equivalent to five age- or grade-based curriculum levels. Therefore, for many students, including students with additional needs, targeted instruction without age or year level assumptions is essential (Masters, 2013). In his paper on the design and use of assessment rubrics to guide teachers’ understanding of their students, and to promote targeted teaching, Griffin (1993) responded to critics who devalued the role of teacher judgement in assessment (e.g., Bailey, 1993; McCloskey, 1990; Neisworth & Bagnato, 1988). His contention was that experienced teachers developed a rich store of knowledge about their students, but that this knowledge was often internalised and therefore seemingly automatic. Teachers’ judgement-based assessment of the things they observed their students doing or saying in everyday classroom interaction was often under-valued as too subjective to form the basis of sound instructional decisions. By contrast, Griffin argued that the value of teacher observation and judgement should be
reconsidered as “direct documentation” of students’ learning, and favourably contrasted with the “indirect estimation” (p.3) provided by students’ test performance. Yet, it should also be noted that Griffin’s support for the role and value of teacher judgement was conditional on teachers having a strong knowledge of their students as learners and of the educational construct being taught. It rested, also, on teachers’ use of a sound schema or framework against which to evaluate student performance. In the case of students with additional learning needs, and particularly those educated in mainstream classrooms, the latter stipulation may too often be compromised by teachers’ lack of experience working with students at comparable levels of proficiency (Senate Standing Committee on Education and Employment [Senate Committee], 2016). An argument can be made, therefore, for provision of such a framework in the form of assessment rubrics to guide teachers’ observations and instructional decisions.

This was the purpose of the current study – to develop a set of rubrics to guide teachers’ decisions about how best to teach problem-solving skills to their students with additional learning needs. As a result of a changing society with evolving needs and occupations, problem-solving has increasingly been seen as an essential skill for success in many contexts, including school and the workplace (Glevey, 2006; Griffin et al, 2012). One source of evidence for this is its inclusion in large-scale assessments, such as the Programme for International Student Assessment (PISA), and the prioritisation of the skill in curricula internationally (Organisation for Economic Cooperation and Development [OECD], 2013) and nationally (Australian Curriculum, Assessment and Reporting Authority [ACARA], 2013).

However, a widespread lack of understanding of problem-solving as a teachable skill (Robbins, 2011; Yetter & Lee, 2007), in combination with low levels of teacher confidence and competence when working with students with additional needs (Senate Committee, 2016), meant that two of Griffin’s (1993) necessary conditions for the use of teacher judgement in instructional planning were missing. To date, little is understood about the necessary instructional support for students to be successful in problem-solving skills (Agran & Hughes, 2005; Clarke, Goos & Morony, 2007), particularly for students with additional needs (Agran, Cavin, Wehmeyer & Palmer, 2006; Cote et al., 2014; Cote et al., 2010). A number of factors have influenced this situation. These include the influence of textbooks (Carnine, 1991; Hord & Newton, 2014; Jitendra, 2011), teachers’ attitudes (Lombardi & Savage, 1994; Wehmeyer, 2007), lack of time given the volume of mandated curricula (Lang, Mastropieri, Scruggs, & Porter, 2004), the hierarchical nature of mathematics learning (Fuchs & Fuchs, 2005; Rojewski & Schell, 1994; Thornton & Jones, 1996) and the role of high-stakes assessment (Clarke et al., 2007; Griffin et al., 2012).

With this in mind, and to achieve the end of ensuring equitable opportunities for students with additional needs to learn skills that are the foundation for successful problem-solving, rubrics were developed and trialed with specialist teachers. In this process, the following research questions were addressed:

- What components of problem-solving need to be focused on at school for students with additional needs?
- To what extent can a set of problem-solving rubrics provide a basis for teachers to plan strategies and targeted interventions to teach this skill?

Method

Building a framework to support teacher judgement of student performance

The method adopted for the design of the rubrics was based on a procedure for defining standards- or criterion-referenced frameworks (Griffin, 1993; 2007), which relies on the collaboration of expert teachers to define the relative discriminating power of components of complex observation structures. Such an approach assumes that a construct of interest can be described as a continuum with direction and units of magnitude, and meaningfully defined by cohesive sets of behaviours that represent levels of increasing proficiency. This procedure has been successfully adopted in research that designed and validated criterion-referenced observation frameworks to support targeted instruction in communication and literacy (Woods, 2010; Woods & Griffin, 2012), social processes (Coles-Janess & Griffin, 2009), and personal learning skills (Roberts & Griffin, 2009) for students with additional
needs. As part of an extensive method that includes an iterative process of workshops and review with subject matter experts, piloting in schools, a large-scale trial and calibration of data to develop a valid assessment, this study served as a preliminary step to design problem-solving rubrics for students with additional learning needs.

Participants

Participants (n = 13) were recruited from schools that specialised in the education of students with additional needs, including one school for students with moderate to severe intellectual disabilities, one school that specialised in the education of students with autism spectrum disorder, and two schools for students with mild intellectual disabilities. Teachers were nominated for participation in the study by their school principal, who identified them as leading teachers with expertise in teaching across the curriculum.

Workshops

Experienced special education teachers were invited to attend two full-day workshops in which they proposed, critiqued, expanded upon and trialled a set of draft rubrics for problem-solving skills. The process drew on expert judgement to review the draft rubrics to reach consensus on their suitability for the intended purpose of guiding targeted instruction of problem-solving skills for students with additional needs. This was then tested by a further step in the process, where teachers worked in teams to draft and then agree on teaching interventions that could be implemented for students working at different levels of proficiency as described by the rubrics.

Results and Discussion

Review of the construct definition

The often utilised problem-solving model in schools originated from the work of Dewey (1910) and Pólya (1945) (e.g., Agran et al., 2006; Edeh, 2006; Glago, Mastropieri, & Scruggs, 2009; Kolb & Stuart, 2005; Miller & Taber-Doughty, 2014; Ness & Middleton, 2012). Mayer and Wittrock’s (2006) work on problem-solving formed the theoretical foundation for problem-solving in PISA (OECD, 2013) and Gagné’s (1985) work drew on Dewey’s insights in order to link problem-solving to learning, a fundamental purpose of education. By combining these influential and pragmatic definitions, the following procedural conception of problem-solving was drafted and presented to study participants:

The process undertaken when a student approaches a task, activity or situation for which there is no obvious solution. This process involves utilisation of a method or strategy that can be learned or is already in the student’s repertoire (Mayer, 1992).

The first stage in the process of designing the rubrics was the development of a jointly agreed definition of the educational construct of problem-solving. The intention was to specify the construct in a manner that could be used to develop a set of rubrics through the description of representative skills that could, in turn, be expressed in terms of readily observable student behaviours. In the first workshop, specialist teachers recognised the construct definition described above as broadly consistent with skills they routinely encouraged and sought to develop in their students. There was unanimous agreement that it was a skill central to success in many facets of education. Consensus was reached on the following definition of problem-solving (the changes in wording are indicated in italics):

The process undertaken when a student approaches a task, activity or situation for which there is no obvious solution. This process involves application of a method or strategy that can be learned or is already in the student’s repertoire and evaluation of outcomes (adapted from Mayer, 1992).

It was important to the teachers that it was clear from the construct definition that students be taught to take an active role in the tasks involved in problem-solving. Therefore, application, a term felt to imply choice, was nominated to replace the use of the word utilisation. Evaluation of outcomes was added to the definition after the teachers completed the process of developing the rubrics, as it became increasingly clear that it was a skill fundamental to the process of problem-solving.
Review of strands and capabilities

A set of proposed strands and capabilities, derived from a broad review of the literature on problem-solving instruction, were presented to the specialist teachers, who agreed that these were the critical skills that made up problem-solving (and consistent with the construct definition). This conclusion was reached as the teachers felt the capabilities were representative of a series of linked components within the steps of problem-solving. The resulting strands and capabilities are illustrated in Figure 1.

One difficulty was the need for a further explanation of the distinction between intention and evaluation, as possible overlaps were seen between these two capabilities. Some implications may be that the concepts need to be investigated further or that there is a need to change the terminology. Nevertheless, through further explanation in the process of developing the rubrics, teachers were able to form a clear understanding of these two terms.

Review of indicators of skill and understanding

The capabilities were then broken down further to define behavioural indicators. In the first workshop, the specialist teachers were given the rules for writing indicators for rubrics that specified they should be:

- clear and unambiguous, to support consistent judgement by teachers;
- phrased positively, to describe skills the students could demonstrate rather than the things they could not do or did not do well; and
- that they should contain no comparative terms or value judgements that might be interpreted in different ways by different observers (Griffin, Gillis and Calvitto, 2004).

Teachers were also asked to think about three questions to ensure that the indicators would be meaningful and useful in an educational context:

- Is it a priority skill in this learning domain?
- Is it a teachable skill?
- Can teachers reasonably be expected to be able to observe the skill in the classroom?

The skills that teachers drafted for inclusion in the rubrics are listed in Table 1.

Table 1
List of indicators for inclusion in the rubrics
As Vygotsky (1929/1993) pointed out, measurement of learning should ideally draw attention to those critical transformations in performance quality that mark increasing proficiency for students. In other words, measurement should help us see not only what a student needs to learn (in terms of critical skills and the observable manifestations of those skills), but also how well each of those observable skills is demonstrated as proficiency and understanding grow and improve (Griffin, 2007). The information derived from a set of assessment rubrics should flag to teachers that a student is ready for new challenges or learning experiences. This information should guide teachers as they seek to target instruction for their students, so that teaching and learning programs are pitched at levels that are neither too low nor too high for the student.

To this end, the experienced special education teachers were asked to review and describe three or four possible descriptors of performance quality for each of the indicators identified in Table 1 above. These were written to describe the range of proficiency that teachers expected to observe among the students in their classrooms. For each of the skills, teachers were asked to bring to mind students with different levels of proficiency, and to describe the sorts of observable behaviours they would expect these students to display. This is illustrated in Table 2 below, which presents a set of performance quality criteria drafted for one of the skills: Perceives information. Teachers were asked to articulate the behaviours they would use as markers that a student was ready to move ahead in their learning. In order to have a consistent judgement of how skills progress, they were provided with a chart illustrating Bloom’s Taxonomy (Anderson & Krathwohl, 2001), Gagné’s Conditions of Learning (Gagné, 1985) and Piaget’s Stages of Development (Piaget, 1947/2001).

<table>
<thead>
<tr>
<th>Capabilities</th>
<th>Indicative Skills</th>
</tr>
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</table>
| Representation | • Perceives information  
• Expresses curiosity and interest in their environments  
• Explores the purpose and function of an object (e.g., tools, media, sounds, graphics and technologies)  
• Seeks out objects to support a process  
• Explores an unfamiliar object  
• Organises ideas and concepts of a learning task/activity/experience |
| Intention | • Participates in inquiry-based experiences  
• Persists when a task is challenging  
• Chooses one object over another when given a choice  
• Experiments with different technologies  
• Chooses a preferred outcome  
• States a preference within a learning activity |
| Metacognition | • Applies thinking strategies to engage with situations and solve problems |
| Evaluation | • Accepts or rejects objects  
• Repeats successful actions that result in task completion  
• Stops actions that do not result in task completion |
| Planning | • Predicts outcome(s) of action  
• Manages obstacles  
• Plans action |

Table 2
Performance quality criteria for the skill of perceiving information
The Development of Problem-solving Rubrics.

<table>
<thead>
<tr>
<th>Capability: Representation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indicative Skill</td>
</tr>
<tr>
<td>A. Perceives information</td>
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The final stage of the first workshop was to set out the rubrics in the form of a grid or matrix. The matrix listed indicators along the bottom of the chart and mapped the criteria according to increasing difficulty from the bottom to the top (Griffin, Gillis & Calvitto, 2004). The teachers used a decision-making procedure called pairwise comparison (Guilford, 1954), to judge the relative difficulty of items at comparative heights on the matrix (Roberts & Griffin, 2009).

In the second workshop, the set of rubrics drafted in the first workshop were subjected to review by the specialist teachers. Working with the rubrics set out as a matrix, the group was able to make refined judgements on the relative complexity of certain skills. Discussion revolved around use of terminology such as collaboration which can be challenging to observe in students with additional needs, as it implies an active role being taken by all members of a group. At this stage, the number of recommended changes were very small and final consensus on the levels of increasing proficiency represented by the set of rubrics was reached by the teachers. The final matrix for the capability of Planning is illustrated in Figure 2. This is an example of one of five sets of rubrics developed in the study.
Figure 2. Rubrics for the skill of planning

<table>
<thead>
<tr>
<th>Capabilities</th>
<th>Predicts outcome(s) of an action or choice</th>
<th>Manages obstacles</th>
<th>Plans action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low proficiency</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Predicts possible outcomes in an unfamiliar routine</td>
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<td></td>
<td></td>
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<tr>
<td>Follows a process to manage change or address problem</td>
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<td></td>
<td></td>
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<tr>
<td>Identifies the next step(s) in a familiar routine</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Participates in a multi-step task or activity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Experiences the consequences of action or choice</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reacts to change to routine (e.g., in the environment or way that routine is structured)</td>
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</tbody>
</table>

Mapping the rubrics to a progression

As the next step in the process, draft learning levels were synthesised by collating all of the success criteria from the same (or an immediately adjacent) row of each set of rubrics, and writing summary statements that described an overall level of proficiency. These level descriptions provided a continuum or learning progression on which a teacher could place a student and establish a level of learning (Griffin, 2007).

In the second workshop, the draft learning levels were collectively reviewed and refined until consensus was reached. The specialist teachers agreed that the learning level summaries described skills that were appropriate for the students they teach or have taught and that, in their judgement, the language was clear and easy for teachers to use and interpret. The learning progression derived from the rubrics is shown in Figure 3.
7. After recognising or selecting a relevant goal, the student is learning to extend strategies and organise steps/resources/others in order to generate plans/steps/strategies to solve problems.

6. By predicting and anticipating possible outcomes based on prior knowledge and past experience, the student is learning to experiment with and explore unfamiliar objects and situations.

5. The student is learning to apply knowledge of ideas, concepts or objects and follow rules to solve problems, use technology and participate in a learning activity.

4. The student is learning to focus on and recall thinking processes, ideas, objects or topics and demonstrate understanding by giving reasons for accepting or rejecting objects and for positive or negative outcomes.

3. The student is learning to participate by responding to teacher instruction and copying others in a task/activity/experience.

2. The student is learning to explore objects and the environment and is beginning to be able to indicate preferences.

1. The student is learning to respond in familiar activities, react to stimulus from the environment and others and recognise preferred outcomes.

*Figure 3. The derived learning progression*
Targeting instruction to the learning progression

As a final step, the teachers worked with the learning progression shown in Figure 3 to assign a learning level to their students with additional needs, and then recommend interventions to help them progress from one level of learning on the progression to the next. The teachers had approximately one and a half hours to develop interventions, then discuss and review them as a group. Examples are shown in Figure 4, in which the levels of learning are ordered from the lowest shown at the top of the list to the most demanding level of proficiency shown at the bottom of the list.

Teachers predicted that the interventions would be easy to integrate into their classrooms. They started the process by planning strategies for students from the low to middle range of ability (Levels 1 to 4). They were less confident to recommend strategies for students at higher levels of skill (Levels 5 to 6). They did not generate any strategies for students at the highest level on the progression (Level 7). They also grouped students across two levels on the progression and recommended skills that should be explicitly taught and guided at the lower of the two levels. As students built their skills, teachers commented that they would continue the intervention strategy but with a reduced emphasis on explicit teaching and an increased emphasis on prompts, reminders and support.

<table>
<thead>
<tr>
<th>Level of learning</th>
<th>Examples of teachers’ recommended interventions</th>
</tr>
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<tbody>
<tr>
<td>1. The student is learning to respond in familiar activities, react to stimulus</td>
<td>• Build opportunities to make choices into everyday routines (e.g., offer a choice of items at meal times) and encourage students to engage with objects using their senses (e.g., mouthing, listening, touching).</td>
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<tr>
<td>from the environment and others and recognize preferred outcomes.</td>
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<tr>
<td>2. The student is learning to explore objects and the environment and is beginning to be able to indicate preferences.</td>
<td>• Set up sessions where students can demonstrate intent by place motivating items to facilitate activities around the classroom (e.g., food, iPad) with deliberate hurdles or sabotage.</td>
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<tr>
<td>3. The student is learning to participate by responding to teacher instruction, copying others in a task/activity/experience.</td>
<td>• Conduct pre-organised learning experiences such as role-play and provide opportunities to reflect on activities (e.g., reflect on photos of a problem-solving activity or task)</td>
</tr>
<tr>
<td>4. The student is learning to focus on and recall thinking processes, ideas, objects or topics and demonstrate understanding by giving reasons for accepting or rejecting objects and for positive or negative outcomes.</td>
<td>• Ask targeted and planned questions to encourage active reflection to make connections (e.g., Why was the red block used for the roof? It is triangular.) and provide opportunities to follow instructions or steps (e.g., with technology).</td>
</tr>
<tr>
<td>5. The student is learning to apply knowledge of ideas, concepts or objects and follow rules to solve problems, use technology and participate in a learning activity.</td>
<td>• Provide students with opportunities and resources to reflect on a negative outcome (e.g., reflection sheets, discussion) and plan role-plays that model how to deal with difficult or challenging situations (e.g., teacher role plays a negative response and students discuss how to respond in a better way)</td>
</tr>
<tr>
<td>6. By predicting and anticipating possible outcomes based on prior knowledge and past experience, the student is learning to experiment with and explore unfamiliar objects and situations.</td>
<td>• Give students opportunities to use unfamiliar objects or alternative strategies and explicitly teach how to experiment and reflect on outcomes.</td>
</tr>
<tr>
<td>7. After recognising or selecting a relevant goal, the student is learning to extend strategies and organise steps/resources/others in order to generate plans/ steps/strategies to solve problems</td>
<td></td>
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</tbody>
</table>

Figure 4. Examples of interventions suggested by teachers
Conclusion

This study aimed to develop rubrics to develop a learning progression of problem-solving skills for students with additional learning needs, and to investigate the extent to which teachers could draw on the rubrics and level descriptions as a basis for instructional planning. Despite the prioritisation of skills such as problem-solving in international curricula (OECD, 2013), research into assessment and instructional strategies has not kept pace (Agran et al., 2006; Agran & Hughes, 2005; Cote et al., 2010; Cote et al., 2014). Therefore, there is a clear need to develop materials to support teachers as they assess and plan for problem-solving instruction. To achieve this end, an iterative process was used to develop rubrics in workshops conducted with specialist teachers. The main ideas that emerged from the study were that:

- it was important to carefully consider the range of skills possible for students with additional needs, keeping in mind the cohort and context;
- all behaviours should be described with an underlying purpose; and
- it was essential that descriptions were clear, practical and distinctive with as little overlap as possible.

Performance criteria were placed on a matrix at different heights depending on judgements of relative difficulty, using a process of pairwise comparison (Guilford, 1954). From the matrix, learning levels were derived by collating the criteria at the same or an immediately adjacent proficiency level and writing summary descriptions of the skills. The derived learning progression was then reviewed by the special education teachers to ensure that the language was clear. In the final phase of the study, teachers demonstrated that it was possible to design interventions for students at different levels of learning on the progression. However, their instructional decisions were less fine-grained than their observations of student learning. They did not match teaching strategies to every level on the learning progression, but instead combined two levels and then treated one as an entry level, where explicit instruction would be required, and the subsequent level as a consolidation phase, in which teachers would fade out their level of prompting and support as the student worked towards increasing independence in the skills. They also observed that problem-solving was an integral part of their daily classroom activities. This feedback and the intervention strategies they created, provided evidence that the problem-solving rubrics can provide a basis for teachers to assess, plan and monitor learning for their students.

In sum, this study provided preliminary evidence that there are teachable and observable problem-solving skills that can support the learning of students with additional needs and enhance their opportunities to participate in education and the workplace, and that teachers can use rubrics to guide their instruction of these skills for their students. This supports an argument for further development to fully validate the rubrics through a large-scale trial and calibration of data to serve as an assessment and teaching tool. In order for an educational system to be truly inclusive, all students must have access to all aspects of the curriculum. The current study was based on the assumption that all students can learn, albeit starting from different beginning points and progressing at different rates (Masters, 2013), and that students with additional needs have both a right and a capacity to learn important skills such as problem-solving.

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