Assessment of competency in radiography students – a new approach

Abstract The assessment of the clinical performance and clinical competence of radiography students is problematic for many reasons, including the following:

- Significant variations between clinical centres in how students are assessed
- Internal variations within larger clinical centres, depending on who completes the assessment forms
- Clinical supervisors being uncomfortable with failing poorly performing students
- Different interpretations among supervisors as to what constitutes competence
- Confusion amongst supervisors who accept students from more than one university, due to variations in assessment paperwork.

Materials and methods: A national assessment tool has been designed and implemented in radiation therapy. Other disciplines to develop a national assessment tool in recent times have included speech pathology and physiotherapy. The discussion that follows describes the first stage of a project to develop a national assessment framework, including a national assessment tool, for the diagnostic radiography profession.

The first stage of this project to develop a national assessment framework is a literature search, and this paper is based on the preliminary findings of this search. The aims of the search were to identify:

- The fundamental principles of assessment in higher education
- Factors arising from these principles that must be considered when designing a clinical assessment tool

Articles were sourced using Educational Resources Information Centre (ERIC), and were chosen based on their relevance to the topic. Some were sourced directly from their authors. Each article was summarised, and sorted into major categories using NVivo8 ™ (QSR International Pty Ltd, Doncaster, Victoria, Australia) qualitative data analysis software. These categories were:

Function of education; issues related to assessment; types of knowledge and understanding; constructive alignment; teacher's role; competence; assessment (formative vs. summative and analytic vs. holistic); criterion and standards referencing; professional judgment. This was followed by a summary of the major categories.

Keywords: clinical assessment, competence, education, diagnostic radiography, reliability, validity, standards.

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Introduction

Diagnostic radiography education in Australia is diverse, with courses being offered at the University of Sydney, University of Newcastle, Charles Sturt University, QUT University, Monash University, RMIT University, University of South Australia, and Curtin University of Technology. In addition, a new course has been introduced in Queensland in 2011. Some of the existing courses are three-year courses, necessitating a graduate year after obtaining a degree, while others are four year courses, graduating accredited radiographers. The number of weeks of clinical placement also varies between universities.

Many clinical centres, especially in the eastern states, accept students from more than one university. Clinical educators in these centres have experienced differences in assessment methods, expectations, and requirements of the different universities. This variation in requirements potentially creates difficulties in obtaining reliable and valid assessment of the clinical competency of students.

Undergraduate students from the University of Sydney undergo 25 weeks of clinical placement, one week in Year 1, three six-week blocks in Year 2, and one six week block in Year 3. Postgraduate students undertake 22 weeks of clinical placement, a four- and a six-week block in Year 1, and two six week blocks in Year 2. All of these students undergo mid placement formative (non-graded) assessment, and end of placement summative (graded) assessment in each clinical block. Students attend clinical placement in a mixture of small and large private practices, and small and large public and private hospitals. Both cohorts of students attend placement in the Sydney metropolitan area, and at least one six-week block either interstate, or in a regional centre in New South Wales.

Obtaining consistency in the assessment practices of multiple supervisory staff in the variety of clinical centres accepting our students is difficult, thus compromising valid and reliable assessment of the performance of radiography students undertaking clinical placement in determining their competence to practice. Student radiographers need to be assessed in many different areas, including interpersonal skills, professional attitude and responsibility, organisational skills, practical skills, and occupational health and safety. Some components of student performance are reasonably straightforward for a clinical supervisor to

observe and rate objectively, while others are more difficult and may be subject to individual interpretation.

For equity reasons all students should be assessed in the same way, using the same methods, and against the same standards. Ideally, they would also be assessed by the same person, ensuring reliability, but obviously this is logistically impossible. The problems of assessment reliability with multiple assessors are described by Moffett, Reid and College.[15] Many of the clinical centres who accept students have multiple staff that carry out clinical assessment, meaning that the reality is several hundred different radiographers are involved in the process. This raises the issue of interrater reliability. Different personalities interpret assessment criteria differently, and have different expectations of students' clinical performance. Many clinical supervisors are understandably reluctant to fail poorly performing students, as indicated by Burchell, Higgs, and Murray.[6] Thus students' clinical performance may not be appropriately determined nor appropriate feedback provided and consequently they may find themselves unready for the radiographic workforce on graduation.

The profession of radiation therapy has a national assessment tool used by all Australian universities offering the therapy course. However, there are significant differences in clinical education between the radiation therapy and diagnostic radiography professions, including the number and diversity of clinical centres, and the appointment of dedicated educator roles in many departments in radiation therapy. Dedicated educators or tutors are typically not found in radiology departments. If they do exist, they inevitably have multiple roles to fulfil in addition to student education. Therefore, there is a need to develop an assessment framework for radiography students that is reliable, valid, simple to use, and will provide uniformity across Australia of the standard expected of a graduating radiographer.

Similar projects have been undertaken by the disciplines of speech pathology (COMPASS),[16] and physiotherapy (APP)[17]. These were undertaken with the support of the relevant professional bodies, and have since been adopted nationally, and in the case of COMPASS, internationally There is clearly a precedent for such uniformity in clinical assessment in the allied health professions.

The project of which this preliminary literature review is a part has arisen from the author's observation of these trends, and also discussions with many professional colleagues in both academic and clinical roles. These discussions have revealed continual frustration amongst students and academics alike at the apparent inconsistencies in grades achieved in clinical units of study. Therefore, the aims of this project are to develop and validate an evidence-based clinical assessment tool that brings the reliability and validity of clinical assessment to an acceptable standard, while ensuring that the attributes that make a student a proficient radiographer are accurately assessed. The project will be completed in collaboration with academic centres, the Australian Institute of Radiography, clinical colleagues, and an international reference group of experts.

The literature review which is the subject of this commentary is the first part of a major project to design such a tool for use in Australian universities that offer a course in radiography. The aims of this preliminary review are to determine the fundamental principles of assessment in higher education, and to ascertain the factors that need to be considered when designing a clinical assessment tool.

This review has been divided into the following 10 categories:

- Function of education
- Issues related to assessment
- Types of knowledge and understanding
- Constructive alignment
- Teacher's role
- Competence
- Assessment (formative vs. summative and analytic vs. holistic)
- Criterion and standards referencing
- Professional judgment
- Summary of categories.

Function of education

In considering the function of education, Biggs[1] sees education as not just acquiring information, but as bringing about a change in conception. The educated person will see the world differently because of their education. The process of learning is not just absorbing facts, but structuring the information received, and using it to develop advanced thought processes. Sadler[10] suggests that education should develop and foster the following attributes in a learner: sophisticated cognitive abilities; integration of knowledge; complex problem solving; critical opinion; lateral thinking; innovative action. These attributes can be readily applied to the clinical practice of radiography.

Developing these traits is difficult, but accurately assessing them is even more difficult. In a discussion paper on assessment in higher education, Assessment 2020 [13] the Australian Learning and Teaching Council (ALTC) suggests that assessment *for* learning, rather than assessment *of* learning, should be placed at the centre of subject and program design. Sadler [3] further suggests that the assessment approach adopted should bring about the greatest improvement in student performance through its use. It is therefore essential that the assessment practices used not only measure the quality of a student's clinical performance, but intrinsically facilitate improvement in student performance.

Biggs[4] states that high achievement should be the expectation in a constructively aligned educational system, and illustrates this point by referring to a Bachelor of Education course in which he was involved, in which 37% of students met the criteria for an "A" grade, with a further 40% qualifying for a "B" grade. This reasoning can be extrapolated to the clinical education of radiographers, since the expectation should be to produce high achieving students and graduates. However, in order for high grades to be meaningful, the assessment practices must be valid, and the grades must represent actual achievement.[5]

Issues related to clinical assessment

Anecdotal evidence from the review of clinical assessment forms for student radiographers suggests that the grades awarded on clinical placement are artificially high. Burchell, *et al*[6] suggest that this is a common phenomenon for two reasons: the combination of assessor and mentor roles amongst people working in small groups with a common culture leads to a reluctance to criticise or fail the colleagues with which they work; the nature of the occupational culture in a caring profession may lead to resistance to the idea of judging people "negatively". If this seemingly common inflation of grades is taken into account, a way must be found to address these largely cultural issues. This is not as simple scaling the grades of all students enrolled in the unit of study, as while the grade inflation phenomena is common, it is not universal. Students who are graded without artificial inflation would therefore be unfairly penalised should such scaling of marks be implemented.

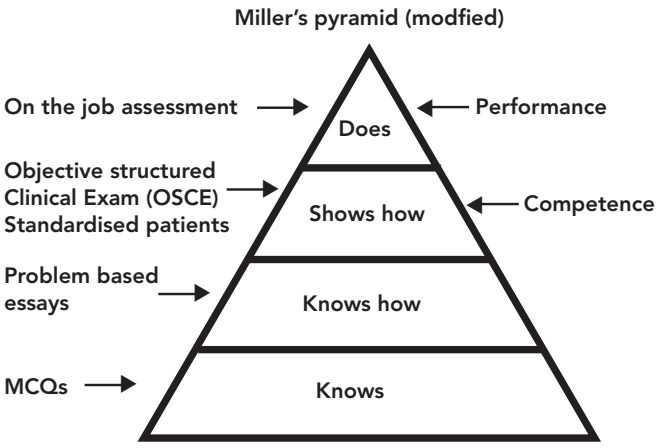

Figure 1: Miller's pyramid (Reproduced from Lake[18]).

Types of knowledge and understanding

Lay people tend to think of knowledge as being an indivisible term, but in fact there are several subsets that go to make up overall knowledge. The same can be said for the understanding of that knowledge. According to Walsh[7], there are three different types of knowledge which can be assessed. These are described below:

Declarative knowledge: knowledge base, "facts and figures"

Procedural knowledge: skills to practically apply declarative knowledge

Conditional knowledge: awareness of appropriate circumstances in which to apply the other types of knowledge

Assessment of the clinical performance of students is largely contained in the latter two, although it is apparent that declarative knowledge is the foundation for procedural and conditional knowledge, and these may flounder if a theoretical knowledge base is absent.

Biggs[4] expands this concept further, explaining that understanding includes a performative aspect. If a student understands a concept properly, they will act differently in contexts involving the content understood, particularly if that context is unfamiliar to them. Therefore, a student demonstrating advanced levels of conditional knowledge is by default demonstrating advanced understanding of basic theoretical concepts. In other words, assessing a student's ability to perform in new or unusual circumstances makes reliable inferences about their grasp of key concepts. This enables the clinical assessment framework to specify the things a student needs to *do* in order to demonstrate particular levels of understanding.

Constructive alignment

Biggs[4] refers to the concept of instructional, or constructive, alignment. Instructional alignment occurs when curriculum and assessment methods are aligned. That is to say that what is measured is what students are supposed to learn in a unit of study, and not something else. To translate this into the context of clinical placement and clinical assessment, students should have clear learning objectives at the beginning of a placement block, and their learning and assessment activities should firstly help them achieve those objectives, and secondly assess how well they have achieved them. These learning objectives should define performance, which demonstrates the type of understanding required.[1]

According to Biggs[4], learners find meaning in their study when they have input into selecting methods of achieving, and cumulatively constructing, their own knowledge base. Different students learn the same skills in different ways, therefore the framework for clinical assessment needs to take different learning styles into account. Biggs[1] suggests two examples of aligned teaching systems that are easily applicable to clinical education: problem-based learning (PBL), and portfolios.

PBL facilitates students demonstrating conditional knowledge, when they are presented with scenarios that test their ability to apply declarative knowledge in untested situations. It successfully integrates all areas of required knowledge and empowers students to construct their own knowledge base by researching answers to problems they are presented with.

Portfolios allow students even greater opportunity to learn in their preferred learning style, as they build up evidence designed to demonstrate competence to practice to their assessor. Both these methods successfully align curriculum and assessment, and facilitate assessment as a means of learning, not just a measure of learning.

Teacher's role

According to Biggs[1], a teacher's job in any higher education field is to organise the students' teaching and learning experiences so that they are more likely to use higher order learning processes.

Miller's triangle[18] (Figure 1) illustrates the types of assessment processes that are applicable for eliciting the various levels of learning in students.

Obviously, in assessing the clinical competence of a student, the levels of most interest are the "shows how", and particularly the "does", levels of the triangle. The teacher's role is to provide learning opportunities for students that develop their skills in actually doing the job. Biggs[1] further states that meaning cannot be imposed or transmitted through direct instruction. Students learn best, not from didactic teaching, but from participating in well designed learning activities. This concept is taken further by Biggs[1] in his concept of three levels of teaching, as listed below:

- Level 1 - What the student is. The purpose of teaching is to transmit information. Variability in student learning is accounted for by individual differences between students
- Level 2 - What the teacher does. Teachers develop an "armoury of skills". The more skills the teacher has, the more productively the student learns
- Level 3 - What the student does. The focus is on the support of student activities that lead to appropriate learning. Learning is not just about memorising facts, concepts and principles, but what it means to *understand* them. The role of the teacher is to design and conduct teaching/learning activities (TLAs) that support this developing understanding

Taking this into account, a framework for assessment of the clinical performance of students that encourages clinical supervisors to operate at Level 3 must be decided upon. This will enable them to engender understanding in students, rather than just the ability to repeat a series of routine tasks. Understanding of this nature can be displayed in areas such as clinical decision making, where students are encouraged to think through the best protocol for a particular clinical history, rather than just `relying on preset protocols. It is apparent that assessment of clinical decision making should be part of the competency assessment framework for radiography students.

Competence

Biggs and Collis (as quoted in Biggs[1]) define competence as firstly a quantitative accrual of the components of a task, and then the qualitative restructuring of these components. There is apparent application of this definition to mastery of the skills required of a radiographer. Most supervising radiographers have seen beginning students who see radiographic theory as a series of disjointed facts, and then watched as these students piece the facts together when given a chance to apply the theory. In order to truly assess competence, the measurement of how well students are able to "restructure the components" is required.

This process is further elucidated by the SOLO Taxonomy (Structure of the Observed Learning Outcome), as described by Biggs[1] which provides a systematic description of how a learner's performance grows in complexity when mastering tasks (Figure 2).

The clinical assessment framework should not only measure which level a student has reached in SOLO, but provide a means for assisting and encouraging them to progress to the "extended abstract" level. It is at this level that a student can truly be considered competent.

Sadler[8] suggests that a learner is considered competent when they demonstrate the understanding of the essential similarities and differences between comparable situations well enough to know not only how to tackle an identical task repetitively, but an "essentially similar" one. This can be equated to competence in a particular radiographic procedure, where the same basic task is being attempted, but with different patient/presentation/circumstances.

Further exploring the theme of what constitutes competence in a student, Burchell, *et al.*[6] ask the question, "How do we distinguish an excellent student from a satisfactory student?" These authors suggest that the four defining characteristics that elevate a student to "excellent" are initiative; adaptability and enthusiasm; carrying out a wide range of tasks (including the mundane); and good interpersonal skills. Assessing competence should therefore:

- Have a structure that provides a sound basis for assessment of competence to practice
- Reflect progression and development through the course
- Explore issues of professional conduct, and develop an appropriate assessment strategy.

Hager, *et al.*[9] refer to the concept of an integrated assessment of competence, defining it as being conceptualised in terms of knowledge, abilities, skills and attitudes displayed in the context of a carefully chosen set of realistic professional tasks. Applying this to the assessment of a student radiographer's clinical performance, we can see that all four of these vital factors need to be present in order for the student to be considered competent.

Assessment

It is apparent that the proposed framework for clinical assessment needs to integrate the concept of constructive alignment.[4] In order to do this, there should be clear statements of objectives for each clinical placement block; the placement block should give students opportunities to demonstrate their understanding of concepts through their performance; assessment must be designed to develop and measure understanding, not just the ability to replicate repetitive tasks. Walsh[7] makes suggestions for performance assessment, which includes problem solving; presentations; vivas; critical incident analysis; individual and group projects; learning contracts. These are all applicable to radiography clinical placement to a greater or lesser degree, and should be considered in the design of our assessment framework.

Solo levels

1. **Prestructural – The task is not attacked appropriately; the student hasnt understood the point**
2. **Uninstructional – one or a few aspects of the task are picked up and used (understanding as nominal)**
3. **Multistructural – several aspects of the task are learned but are treated separately (understanding as knowing about)**
4. **Relational – the components are integrated into a coherent whole with each part contributing to the overall meaning (understanding as appreciating realtioknships)**
5. **Extended abstract – the integrated whole at the relational level is reconstructed at a higher level of abstraction, which enables generalisation to a new topic or area, or is turned reflexively on oneself (understanding as far as transfer and as involving metacognition)**

Figure 2: Structure of the observed learning outcome (SOLO) taxonomy (Reproduced from Biggs[4]).

When designing an assessment framework the issue of grades must be taken into consideration. There are strong arguments supporting the grading position, and equally strong arguments suggesting that pass/fail is the only valid and reliable way to assess clinical performance. Sadler[10] suggests that grades matter because they have been shown to have a substantial affective impact on learners and learning, influencing students' sense of achievement, and their motivation and level of engagement in future courses. The corollary to this is that the absence of grades reduces students' sense of achievement, motivation, and level of engagement.

Sadler[10] identifies the concepts of analytic and holistic or global grading. When analytic grading is carried out, the teacher makes separate qualitative judgments on each of a number of pre-determined criteria (explicit knowledge). In a holistic grading scheme, the assessor progressively builds up a complex mental response to student work or performance, and gives a "global" rating of the performance as a whole (tacit knowledge). The question that must be asked is which type of assessment is most appropriate for the learning of student radiographers, and which is most appropriate for giving a meaningful grade to their performance? Should there be elements of both in the assessment framework?

To answer this question, consider the six observations made by Sadler[10], regarding the application of analytic grading to a complex performance.

1. The overall performance of the student is analysed through the lens of the predetermined criteria. Anything else, relevant or not, is discarded
2. There are often discrepancies between the assessor's opinion of the global performance of the student, and the results of the analytic judgment
3. The assessor may not be able to account for these discrepancies
4. It is assumed that the pre-determined criteria are conceptually distinct, when that may not necessarily be the case
5. It is often not practical to nominate all the criteria that could conceivably be used

6 Different assessors may agree on a holistic rating, but disagree on the performance of individual criteria.

According to the arguments above, it appears that there are a number of reasons why analytic grading is not the entire answer to the grading of performance, and that there must be a better way than what is carried out currently. O'Donovan, *et al.*[11] agree, stating that the current over-reliance on explicit knowledge could be as naïve as past over-reliance on tacit knowledge for the communication of assessment criteria and standards. Bearing this concept in mind, Burchell, *et al.*[6] concluded that in the design of their clinical radiography assessment framework, a two part tool was necessary:

1 Professional judgment, conduct and related areas (holistic assessment)
2 Practical task skills (analytic assessment)

Professional judgement is discussed in more detail later.

Another concept that needs to be considered is that of cumulative assessment, where assessable tasks throughout the clinical placement are added together to give a final grade. This is meant to reduce stress and give a better sampling of student performance. However, the benefits need to be weighed against the costs:

- Students who are slow to develop an adequate concept of quality are penalised. The grades represent a mapping of the route to achievement, rather than a measure of the achievement itself [12]
- Assessment cannot be formative when it is *cumulative*, ie when each attempt or submission is scored, and the scores added at the end of the course[2]
- The term "fidelity" in this context means that the grades awarded actually represent academic achievement, rather than something else. When marks are accumulated across a learning period, students are penalised for inadequate early understanding, even though this might be corrected later. This means that the final grade is not truly representative of the achievements the student has made in the particular course of study.[5]

These comments by Sadler lead to the concept of formative assessment. According to Sadler[5], the definition of formative assessment is any form of non-graded assessment that leads to improved learning. He further states, "Purely formative assessment in which the learning stakes are high but the grading stakes are nil frees up the learning environment." In other words, if students get feedback on their performance with the sole intention of improving their learning experience, the inhibitions to their learning are reduced.

Sadler[2] states that feedback is the key element in formative assessment. The most important aspect of feedback is its effect on student learning, rather than its informational content. Sadler[3] further states that the worth of an assessment system is determined by the amount of improvement demonstrated by students. Sadler[2] suggests that regular and accurate formative assessment for students, in the form of constructive feedback on their performance.

Criterion and standards referencing

Sadler[3] gives us the following definitions of criteria and standards:

- Criteria- characteristics that are potentially useful for evaluating all members of a given class
- Standards- characteristics that relate to appraisals that have already been made.

Criteria are much more focused, and relate to specific aspects of performance, whereas standards are fixed external anchor points. Sadler[5] emphasises the point that decisions on grades should only be made by reference to these fixed external anchor points, rather than by means of comparisons with other students. Hager, *et al.*[9] are more specific about standards in relation to professional competencies, stating that they allow for professional discretion. That is to say, professional competency standards do not prescribe that all professionals will necessarily act in the same way in a given situation. This allows for the application of analytic and holistic assessment techniques to the assessment of whether these standards are met or not.

The fundamental issue here is that when standards based assessment is used, students are measured against the same standard, rather than against a randomly selected and randomly skilled cohort of students.

Professional judgment

Sadler[14] defines professional judgment as the ability of an expert to recognise quality when it is seen, even when such an expert is unable to define or formally explain it in words.

In the past, according to Sadler[10], the professional judgment of experts was not questioned, and they were not generally expected to give a rationale for their judgments. In more recent times, these experts are held accountable for the grades that they allocate. This has been the driving force behind the movement towards analytic grading.[10] However, while valuing the importance of transparency, the value of professional judgment regarding the quality of student performance should not be underestimated. Hager, *et al.*[9] state that professional judgment plays a crucial role in the assessment of competence, and may be viewed as no less reliable than alternative objective assessment.

Sadler[2] adds to the discussion, stating that qualitative judgment involves assessing student performance that is multidimensional rather than sequential. It is not easy, nor even desirable, to categorise such multidimensional work as correct or incorrect. Rather, it should be rated on a "scale of quality". Although teachers may have difficulty in recognising a good performance when they see it, it can be difficult for them to verbalise what it is that they are actually looking for. Their conceptions of quality are largely held inside their heads as tacit knowledge.[2]

Hager, *et al.*[9] state that concerns about the validity of professional judgment are unfounded because it typically has a high degree of reliability and that the already high reliability of assessments of work performance can only be improved by performance criteria from competency standards offering more detailed guidance. Hager, *et al.*[9] state that empirical evidence is available which contradicts the view that professional judgment is less objective than other alternatives.

It can therefore be seen that there is a role for professional judgment in the assessment of clinical competence.

Discussion

The purpose of education is to develop students' understanding of the topic being covered, not just their ability to recite facts. The purpose of assessment in education is firstly, to develop and enhance the learning process, and secondly, to measure the development of understanding of the key concepts. In tertiary education these concepts include generic skills and attitudes. In the context of radiography clinical education, performance is the ability to carry out all aspects required of the profession. It is this performance that is measured when assessing a student's clinical competency, while accepting that not all professional knowledge can be assessed in the workplace. In order to be measured accurately and

appropriately, this performance should be measured against external standards, not against the performances of other students. In this way, there can be a relatively uniform standard of competence in graduates of radiography courses.

All aspects of curriculum, practical work and assessment should be aligned. When this is achieved, formative assessment in the form of feedback will be integral, in order to facilitate students maximising their learning experiences. There will also be a balance of analytic and holistic assessment in the assessment framework employed. Assessment of clinical performance should take into account the professional judgment of experts in the field. This is typically underrated and undervalued, but has been shown to be reliable.

The assessment framework that will be the end result of this project is planned to incorporate the findings of this literature review, along with those of subsequent literature reviewed, and the results of focus groups and interviews with students, and teaching radiography professionals and academics nationally and internationally. Further findings will be compiled and submitted for publication as they come to hand.

Conclusion

The time is right to develop an evidence-based, clinically trialled, reliable and valid assessment tool for diagnostic radiography students, which can be adopted nationally.

This article has outlined preliminary findings of the literature review to date, and some conclusions drawn from it. As the project proceeds, the findings of the literature review will be synthesised with data gathered from focus groups and interviews conducted with diagnostic radiography academics, practitioners and students.

This information will be used to design a draft clinical assessment tool, which will be trialled with radiography students from the University of Sydney. Other universities which offer courses in radiography, and have collaborated in the project, will be invited to participate in the trials at their discretion. The progress of the project will be disseminated in future publications.

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