Testing a Framework of Dimensions of Quality of Knowledge about Teaching and Learning

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Knowledge about teaching and learning can be considered to be an important domain of prior knowledge that learners bring to teaching–learning situations. Traditional evaluations are reasonably successful at identifying “what” students know. However, evaluating “how well” students know has proved to be more problematic, as indicators of “quality” of knowledge have remained relatively opaque through being undifferentiated and/or justified with circular arguments (eg. Deep knowledge leads to better understanding, and better understanding is achieved when knowledge is deep!). This paper proposes a framework of five dimensions of quality of knowledge about teaching and learning, and tests the framework against the interview transcripts of a graduate entry, third (clinical) year medical student and a Certificate III child care student. Reader feedback is sought about the theoretical well-foundedness and potential practical usefulness of the framework of dimensions of quality.

Key words: quality of knowledge; teaching; learning; constructivism, NUD*IST; concept maps;
Introduction

This paper describes my creation of a framework of five dimensions of quality of knowledge and the application of that framework to the knowledge about teaching and learning expressed during focussed interviews with a graduate entry, third (clinical) year, medical student and a Certificate III, community services (child care) student.

Knowledge quality

This research is predicated upon constructivist theory, that posits that students’ existing knowledge forms the cognitive schemata into which new knowledge is networked (Nuthall, 1997).

The strong assumption, then, is that problem solving, comprehension, and learning are based on knowledge, and that people continually try to understand and think about the new in terms of what they already know. (Glaser, 1984 p. 100)

Thus the importance of prior knowledge in domains such as mathematics and science has become increasingly recognised (Chi & Glaser, 1988; Sternberg, 1999), and teachers are urged to employ strategies for eliciting students’ existing conceptions prior to, and during, instruction (for example, Faire & Cosgrove, 1988). Traditional evaluations of students’ knowledge, such as short answer tests and application of learned algorithms to familiar problems, have targeted what students know. However, running parallel to attempts at finding out what students know has been a continuous call for finding out how well students know:

It seems surprising to propose that theories or frameworks or even heuristics for identifying the quality of knowledge seem sparse. Mintzes and Novak (1999) asked, “What does it mean to understand …?” and “How will I know when my students have developed this ability?” (p. 42). Similarly, Woolfolk-Hoy and Tschannen-Moran (1999) observed that [teachers] lack the tools to assess the capabilities and challenges of their students and identify appropriate strategies to match their learning goals with the unique
characteristics of a given group. Once a group learning process is underway, teachers are often ill-equipped to understand the underlying causes of the difficulties that arise and do not have an arsenal of remedies to address particular problems, based on their underlying causes (italics added). (p. 258)

The framework described in this paper attempts to differentiate dimensions of quality of knowledge in the domain of teaching and learning.

Teaching and learning as a knowledge domain

It seems reasonable to propose that knowledge about teaching and learning itself is a domain with which students in western educational institutions have many years of experience and hence, prior knowledge. Shulman (1986) and others (for example, Borko & Putnam, 1996; Calderhead, 1996; Putnam & Borko, 1997) have proposed various categories for classifying and investigating teachers’ knowledge about teaching and learning. Studies in the domains of self-regulation and metacognition have investigated students’ knowledge about learning, particularly their own (Pressley, Van Etten, Yokoi, Freebern, & Van Meter, 1998; Winne & Hadwin, 1998; Zimmerman, 1995). Investigations into the content of students’ knowledge in the form of approaches, conceptions, epistemologies, stance, goals and teacher-student congruence are predicated, either implicitly or explicitly, upon an assumption that a key goal of teaching is to ascertain the conditions that create better quality knowledge. For example, the surface-deep dichotomy clearly prescribes that deep approaches are better (Biggs, 1999). So are higher conceptions of learning (Marshall, Summers, & Woolnough, 1999), congruence between teachers’ and learners’ intentions (White & Gunstone, 1989), and more effective self-regulatory skills and attitudes (Zimmerman, 1995). In sum, the general domain of knowledge about teaching and learning is worthy of investigation because, during learning, such knowledge interacts with knowledge associated with specific subject domains (Shulman & Quinlan, 1996).
Research Objectives

This paper describes two research objectives. First, I attempted to develop a comprehensive framework of dimensions of quality of knowledge that seeks to evaluate how well students know. Second, I attempted to test the framework by seeing whether it would clearly show differences in the quality of learners’ knowledge about teaching and learning.

Significance

The educational community needs to be able to identify what good quality knowledge is so as to, 1) target instruction to the knowledge that students already have, and 2) create situations that enable students to construct good quality knowledge. The framework provides a tool to facilitate investigation into, and understanding of, the quality of knowledge that students hold.

In the following sections I introduce the framework and describe its application to the interview transcripts of two learners, Sally and Rebecca.

Method

Participants

At the time of the research, Sally was enrolled in a graduate-entry, third (clinical) year, medical degree in a community hospital in rural South Australia. Rebecca was enrolled in a community services (childcare) Certificate III in a college of Technical and Further Education in outer metropolitan Adelaide, South Australia.

Interviews.

I conducted in-depth interviews with each participant. During interviews I canvassed 18 focus questions (drawn from my review of the relevant literature) and any other issues that participants raised. More detail about the formulation of the interview questions and the interview procedure can be found in Askell-Williams (2001). Sally’s interview lasted for 90 minutes; Rebecca’s interview lasted for 20 minutes. Both participants were given the
opportunity to fully respond to each of the 18 interview questions. Interviews were audi-
taped and transcribed verbatim.

Results and Discussion

The framework of dimensions of quality

In this section I will introduce the complete framework of dimensions of quality of
knowledge about teaching and learning. I will then discuss each cell of the framework in
more detail, using extracts and interpretations from Sally’s and Rebecca’s interview
transcripts to illustrate the nature of each dimension of quality.

Table 1 contains five dimensions of quality of knowledge drawn from a review of relevant
literature (Anderson, 2000; Biggs & Collis, 1982; Cermak & Craik, 1979; Hogan, 1999;
Pearsall, Skipper, & Mintzes, 1997; White, 1979). The dimensions are scope, structure,
well-foundedness, abstraction and context. Each dimension is represented in two ways, as
represented by the cells of the table. For example *Scope* is represented by the number of
*themes* and the nature of *elaborations* of those themes evident in each transcript.

**Table 1: Framework of Dimensions of Quality of Knowledge about Teaching and
Learning ©**

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>structure</th>
<th>well-foundedness</th>
<th>abstraction</th>
<th>context</th>
</tr>
</thead>
<tbody>
<tr>
<td>scope</td>
<td>themes</td>
<td>hierarchical and heterarchical levels</td>
<td>internal congruence</td>
<td>types of representation in memory</td>
</tr>
<tr>
<td></td>
<td>elaborations</td>
<td>internal &amp; external cross links</td>
<td>external congruence</td>
<td>encompassing concepts/abstractions</td>
</tr>
</tbody>
</table>

**Scope: Themes**

**Definition:**

Quality is evidenced if knowledge is wide ranging.
To ascertain the themes contained in Sally’s and Rebecca’s transcripts I employed NUD*IST (QSR, 1997) data analysis software to code each statement of meaning identified in each transcript. Although the NUD*IST coding trees resulted in substantial data reduction, each tree still ran to many pages—too many to reproduce here. I have therefore selected extracts from the trees created from Sally’s and Rebecca’s transcripts which represent the coding category learning in situated action. These trees are displayed at Figure 1 (Sally) and Figure 3 (Rebecca).
Figure 1: NUD*IST tree of Sally’s Interview Transcript: situated action

Figure 3: NUD*IST tree of Rebecca’s Interview Transcript: situated action
From Figure 1 it can be seen that Sally nominated eight main themes in the category “learning in situated action” (see doctors, have a go, practice, experiences, patient contact, proper setting, osmosis theory, not competing for patient access) and from Figure 3, it can be seen that Rebecca nominated six main themes (just play and talk, learning over time, observe staff, have a routine, book and CCC match, participating). Thus the number of themes discussed by each participant was comparable.

**Scope: Elaboration**

*Definition:* Quality is evidenced by the extent to which themes are developed with further information such as details, examples, cause effect relationships and analogies.

*Exposition:* From Figure 1 it can be seen that Sally provided considerable extra information about many of the themes she discussed. For instance, Sally gave five examples of the theme *experiences*. One of those examples is *see patients*, which in turn has three effects, *including seeing things out of context, gathering information and seeing so much*. These effects are further elaborated. For example, *seeing so much* includes seeing *what’s common*, which builds an awareness of *exceptions*, as well as building *confidence*. In addition, *seeing so much* in a *clinical and procedural setting* builds upon *prior knowledge*.

Figure 3 contains Rebecca’s statements about learning in situated action. A clear distinction can be seen between Figure 1 and Figure 3 in the extent of elaboration that accompanies each theme. It can be observed that Rebecca provided only one to three details per theme. Those details were not further elaborated.

**Structure: Hierarchical and heterarchical levels**

*Definition*

Quality is evidenced if it is possible to discern hierarchical (vertical) or heterarchical (horizontal) organisation of knowledge themes.
To ascertain the structural dimensions of Sally’s and Rebecca’s transcripts I created a concept map to display the apparent organisation of each participant’s complete transcript (whilst sacrificing much detail). The concept maps are displayed in Figure 5 and Figure 7.
Figure 5: Concept Map of Sally’s Interview Transcript

Figure 7: Concept Map of Rebecca’s Interview Transcript
From Figure 5 it can be seen that Sally’s transcript contains eight hierarchical levels, ranging from being a good doctor, to exams being a subset of the knowledge required to be a good doctor, to the themes of levels of medicine and body of knowledge, to the various types of knowledge that contribute to being a good doctor, and strategies for attaining that knowledge. Figure 5 also illustrates heterarchical organisation within hierarchical levels, in particular with the linked constructs be a good doctor and pass exams as well as the number of constructs that exist in parallel under the theme body of knowledge.

From Figure 7 it can be seen that Rebecca’s account of teaching and learning appears to be organised at four levels, first to get a certificate and to be a competent worker, second, the strategies necessary to achieve that as well as her assessment of her progress, third, examples of level two and fourth, some details about level three. Although Figure 7 contains some constructs in parallel at the second and third levels, it is difficult to ascertain from Rebecca’s transcript that these themes are organised heterarchically. Rather, the themes seem to occur in a relatively isolated fashion.

Structure: Internal and external cross links

Definition

Quality is evidenced if it is possible to discern connections between knowledge themes.

Exposition

From Figure 5 it can be observed that Sally’s transcript makes numerous connections between key knowledge themes. For example, Sally creates a reciprocal relationship between passing exams and being a good doctor. These two themes are served by her confident disposition and her willingness to do the basic as well as to do extra study, which in turn is motivated by her high goals. Passing exams and being a good doctor are underpinned by Sally’s body of knowledge, which is in turn founded in a number of sources, including readings, patient contact, PBLs and her mentor. She talks about checking the
curriculum so as to pass exams, as well as self-management with issues such as stress. Sally also links her study of medicine to an external theme, that medicine is a humanity thing.

From Figure 7 it can be seen that Rebecca appears to make fewer connections between knowledge themes. She wishes to attain her certificate so as to get a better job. These themes are underpinned by her strategy to read then answer the question. Rebecca also expresses a desire to be a competent worker, and that this requires her to learn. However, there is no clear link between certification and competency, other than put into practice if possible. Rebecca indicates that she believes she is doing OK. There are a number of isolated themes, such as I like kids, routine and doing it myself.

Well-foundedness: Internal congruence

Definition

Quality is evidenced if it is possible to identify agreement and coherence between and within sets of knowledge, intentions, plans and actions.

Exposition

To investigate well-foundedness I organised each participant’s transcript into a matrix containing four statement types, namely, 1) knowledge, 2) intentions, 3) plans, and 4) actions. Once again, the complete matrix for each participant is too large to reproduce here. Therefore, Matrix 1 and Matrix 3 contain extracts from Sally’s and Rebecca’s transcripts that address a subset of each participant’s knowledge, intentions, plans and actions. The common theme that threads the two matrices together is the intentions column, which describes the two participants’ intentions with respect to certification and professional competency.
### Matrix 1: Sally: certification and professional competency

<table>
<thead>
<tr>
<th>Knowledge</th>
<th>Intentions</th>
<th>Plans</th>
<th>Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>There's different specialties and there's also different, what they call, primary, secondary and tertiary care and Medicine is very hierarchical so a lot of things are seen on levels</td>
<td>I will get the knowledge that I think will make me just a basic, functioning doctor and then I'll get the knowledge that will make me an excellent, good, confident, educated doctor on top of that and then I will get so much experience and so much knowledge that I will do well in my exams.</td>
<td>I wanted to have lots of patient contact, talk to a lot of people. That you get so used to having it from the patient themselves that when you see a patient in real life and they don't say it text book way it doesn't worry you because you've done that. I feel very confident that I know that but I also know it in a proper setting. You're the clinical student. You've come to learn...you don't have clinical knowledge, while in fourth year you do. You don't have any clinical knowledge, you are the kind of oh, ooh, um student at the moment and you come here, you get thrown in the deep end with a big watchful eye on you. Like I feel like the doctors are always checking what I'm doing. And you get your hands dirty.</td>
<td>Hearing a patient describe it: Throw away the text books-you just hear what the patient feels. They say I feel a bit funny and you have to figure out what they mean, get the patient's history, you get used to a patient coming in and having to talk to a patient and work together and put it into a medical model that you can go the next step which is what your general practitioner thinks - primary care. They might refer to specialist care - the next level. So you get that opinion as well. And then there's the expert experts - say a CME evening and we get invited to that as well. Then when I come home and put my text book reading on that and check my curriculum about what they want me to learn about asthma.</td>
</tr>
</tbody>
</table>

You get all these different levels and you have a core problem that's written in the book so it's just a word but you see it in so many different ways that I feel that I'll know a topic inside and out and not just reading it from a book. By the end of the year I will have read the books but I'll also have everything else on top of it. So I have more cognitive sort of links to it and then it'll be, for me that means when I'm writing something about it I feel very confident, it's easy to recall, and it will be just like talking to you then when I'm doing the exam that's how I see the levels helping my learning as well, and the reason I had that link, without coming home and doing the reading in between, which I would still like to do 'cause I need to be able to rattle off all the other things about asthma, the academic things. |

You'll see a patient with a problem at a certain point in management, you can review all of that, you ask your own questions 'cause I actually see patients on my own and then call in the doctor, I will assess what is happening on that day, make a management plan, check that with the doctor, if that patient is then referred to a specialist, you might be in with that specialist the next day and say oh I have a question, I saw this patient, you'll see her in three weeks, it just joggs your memory so you keep learning about that patient. And then you might go to a CME, designed for the GPs about a certain topic but you saw that patient that day. Just by seeing that one gentleman and the effect the GP had and then we admitted him to hospital and then I saw him for a couple of days, I now know what...severe asthma sounds quiet and you need to get them into hospital.
Matrix 3: Rebecca: certification and professional competency

<table>
<thead>
<tr>
<th>Knowledge</th>
<th>Intention</th>
<th>Plan</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oh probably</td>
<td>[could be doing]</td>
<td>better but I'm doing okay at the moment. Yeah, keeping up. [passing] I don't know by how much. I'm doing everything I can.</td>
<td>Just probably just to get the certificate so that I can get jobs that pay more money... Get me better jobs... That's why I'm doing it... It's because I have to or I couldn't get a job.</td>
</tr>
<tr>
<td>I think I'm doing alright in the childcare centre.</td>
<td>Be a competent like worker. So we know what we're doing, don't get into trouble. Things like that. Like if a child hurts themselves and then you can be sued and all sorts of things. So just so that we're all safe. Yeah, and parents are confident in us and things like that.</td>
<td>I suppose we're meant to learn like little things that we need to do to be safe in the childcare centres. You know, for the children and for us, to protect ourselves as well as them. It [course] gives us the information and the knowledge. I mean we can just put it in what we're doing in the childcare centre for practice... If you can put it [competency book] into practice then you do but otherwise you just... do whatever over there. Being able to do like first aid if a child hurts themselves... report abuse, like if we see... just I suppose being able to do it... Participating, making yourself available for the staff. Willing to do things for them. Things like that. Observe the staff, see what they're doing and...</td>
<td>Just make sure the kids don't run away and stuff like that. Just keep an eye on them all the time. Not [thinking] much really. Just play with them and let them talk to you and things like that. I just sat there and did whatever. You have like a prac, then you do that and they'll mark you on it over there. Handwashing. They had a thing in the book about how you have to wash your hands. Do it</td>
</tr>
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</table>

It is possible to read Matrix 1 (Sally) from left to right and to make the assessment that Sally’s account of her knowledge, intentions, plans and actions cohere together. That is, her comments about the levels of medicine, being a good doctor, passing exams, having patient contact and matching practical experiences with readings and discussions with experts are consistent with each other. Interestingly, an inspection of Matrix 3 (Rebecca) suggests that Rebecca’s account also achieves congruence, as it is based upon her assessment that she is doing all right. As Rebecca’s intention is to achieve certification so as to get a better job, if
her personal assessment is that she is *doing all right*, then her plans and actions could seem congruent to Rebecca.

**Well-foundedness: External congruence**

**Definition**

Quality is evidenced if it is possible to discern a match between the participant’s knowledge and the best available knowledge in the relevant knowledge community and/or emerging/new evidence.

**Exposition**

Matrix 1 contains statements that illustrate Sally’s knowledge about the hierarchical levels of medicine, her intentions to gain knowledge that will allow her to be a good doctor as well as to pass her exams, her plans to have lots of patient contact as well as other forms of knowledge acquisition such as readings and discussions, and her recounts of her experiences with patients, readings and discussions with experts. Sally’s statements accord with the published objectives of her course of study and the statements of her supervisors (that I also collected as part of this research program). Sally’s statements also find general accord with extant literature in the fields of knowledge construction, (for example, cognitive links, Bransford, Brown, & Cocking, 1999), and in medical education (for example, integrating information Hmelo & Ling, 2000).

Matrix 3 displays statements from Rebecca’s transcript that illustrate her belief that she is *doing alright*; her intentions to gain certification and be a *competent child care worker*; her plans to learn what is necessary to *keep children safe, to participate, to be willing, to read and answer the question*; and her actions of *keeping an eye on the children, sitting and doing whatever, copying and rewriting*. My assessment is that Rebecca’s statements capture some of what is required to be a competent child care worker and achieve certification. However, when compared to the stated course objectives, her teachers’ accounts of the full range of competencies and attitudes required of child care workers, and extant literature
about constructing knowledge, Rebecca’s account seems impoverished. In particular, *sit there and do whatever, copy and rearrange the words*, and *don’t think* appear to be examples of ill-founded knowledge about strategic action that will result in powerful learning (for example, Bruning, Schraw, & Ronning, 1999).

**Abstraction: Types**

**Definition**

Quality is evidenced if knowledge is represented in a variety of ways.

**Exposition**

To investigate *types* we return to the NUD*IST* trees in Figure 1 and Figure 3. Figure 1 contains statements that indicate that Sally spoke about a variety of types of knowledge gained in a number of different ways. For example, she referred to procedural (*have a go, learn from your mistakes, practice, apply medical model*); experiential (*working with patients, learn from experts, apprenticeship model, osmosis*); conditional (*proper setting, out of context*); metacognitive knowledge (*cognitive links, many exposures to the same issue*); declarative knowledge (*gather information; talk about things, ask questions*); and visual (*see so much*) knowledge.

Figure 3 contains Rebecca’s statements that account for a variety of types of knowledge but gained in substantially fewer ways, including, procedural (*routines, put the information into practice*); experiential (*sit and do whatever, participating*); conditional (*just do whatever*); temporal (*learn over time, pick up little bits*); and visual (*observe staff*).

**Abstraction: Encompassing concepts/abstractions**

**Definition**

Quality is evidenced if it is possible to identify the use of abstractions or concepts or principles to organise knowledge.
Exposition

The concept maps created for investigating *Structure* are also informative for investigating abstraction. Figure 5 (Sally) contains four concepts that appear to collect together a number of lower order themes: *medicine is a humanity thing*, *be a good doctor*, *body of knowledge* and *levels of medicine*. Figure 7 (Rebecca) contains the concept *be a competent worker*.

Context: Applicability to new domains

Definition

Quality is evidenced if knowledge themes are applied to alternative situations.

Exposition

A reading of the text in Matrix 1 and Matrix 3 facilitates an assessment of participants’ transfer of knowledge gained in one setting to knowledge gained in other settings. Matrix 1 contains Sally’s account of learning in a clinical setting, which is carried to learning in other settings such as when working with a specialist, when attending a CME (continuing medical education) session, and for the anticipated event of encountering another presenting with similar symptoms. My assessment is that Sally is demonstrating the (potential) application of her knowledge to alternative situations. From Matrix 3 it can be observed that Rebecca makes reference to taking the knowledge gained in class about hand-washing from the book and then doing it (handwashing) at the child care centre.

Context: Temporal and situational constraints and affordances

Definition

Quality is evidenced if opportunities and/or restrictions imposed by time, place, artifacts and people are recognised.

Exposition

Matrix 1 contains evidence that Sally recognises the situational and temporal constraints upon her learning. She made reference to, *knowing it in a proper setting; don’t have clinical*
knowledge (in fourth year you do); student at the moment; by the end of the year; at a
certain point in management, and; you keep learning. From Matrix 3 it can be seen that
Rebecca also indicated a constraint upon her learning in situated action, when she recounted
that if you can put it (the competencies in the competency package) into practice you can,
but otherwise you just do whatever.

Summary and Conclusions

This paper has introduced a framework of five dimensions of quality of knowledge about
teaching and learning. The framework organises the dimensions into columns which each
contain two indicators of each dimension. The framework has been tested against the
interview transcripts of two learners, Sally (medical) and Rebecca (childcare), and it seems
reasonable to propose that the framework has been successful in identifying more than
simply the content of each participant’s knowledge. The framework has highlighted aspects
of each participant’s knowledge in an attempt to provide a theoretically well-founded, and
operationally useful, method for ascertaining quality in participants’ knowledge about
teaching and learning.

When compared to that of Rebecca, Sally’s explicit knowledge of teaching and learning is
more elaborated. This difference is associated with a structural analysis that shows greater
depth, in terms of levels, and more extensive internal and external connectedness. When
judged against contemporary knowledge about learning, Rebecca’s account shows evidence
that her knowledge of how to be a strategic learner is less coherent with knowledge in the
external community than is Sally’s.

Alongside these differences, there are also similarities in Sally and Rebecca’s profiles. Both
participants appear to ground their reported learning actions in similar sets of beliefs,
intentions and plans concerning competency and certification. Also, both participants
recognise important situational constraints in their learning contexts and the need to apply
their learning to new contexts.
The framework can assist educators to move beyond intuitive judgements to apply more rigour to their analysis of the quality of learners’ knowledge. This in turn will allow educators to target instruction to the specific knowledge needs of learners. When compared with existing frameworks noted in the introduction to this paper, the current framework is evolutionary rather than revolutionary. The framework highlights some dimensions that have previously been subsumed or obscured, such as quantity and correctness. Also, the framework allows for fuller differentiation of other dimensions, such as connectedness and hierarchical and heterarchical structure. Therefore, returning to the introductory comments in this paper, I propose that the framework provides a useful tool for addressing questions about how well students know.

The development of the framework of dimensions of quality is in its early stages and I welcome feedback about issues of theoretical well-foundedness and operational usefulness.

References


