

Competencies, Skills and Assessment

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This paper is an analysis of the challenge of assessing student learning and how that is affected by using descriptions of competencies as a core element when describing the aims of the learning process. Assessment is modelled as a three step process; characterising, identifying and judging, to allow for the following argument: Working with competency descriptions is rightly said to make judging more difficult. This potentially lowers the reliability of the assessment. But competency descriptions also carry a great potential of raising the validity of the assessment by focusing the characterisation part of an assessment process. From a teaching and teachers' perspective, the latter is far more important than the former.

The essence of the following is an analysis of the concepts 'competence' and 'assessment' and their mutual relationship.

I begin by putting forward my understanding of these two concepts as well as the term 'procedural skill', framed by a description of some of the contexts within which these understandings have developed. Doing this is worthwhile for at least two reasons. One is that my experience from research, developmental projects and teaching tell me that the concepts of competence and assessment can be used to support the development of good mathematical education. Another is that the two concepts are both very much on the agenda in the ongoing attempts to reform the teaching of mathematics in Denmark and several other countries. Hence, relating to these concepts on an informed basis is an important part of being able to discuss and take a critical stance towards these reforms.

Subsequently, I argue that working with competency descriptions and working with assessment can support or hamper each other, depending on which parts of an assessment process one is emphasising. The basis of this line of reasoning is the concepts 'validity' and 'reliability', of which I claim the former to be far more important to teachers and teaching than the latter.

A Competency Perspective

My perspective on assessment in mathematical education comes from my involvement in the development of a general analytical approach: To use a set of mathematical competencies to describe what it means to master mathematics and to investigate how such descriptions can and should be used to develop mathematics education and what challenges that brings.

This approach was thoroughly introduced, developed and exemplified in the *KOM project* (KOM is an abbreviation for "competencies and mathematics learning" in Danish). This ran from 2000-2002 with Mogens Niss, from Roskilde University in Denmark, as chairman and I was the academic secretary (cf. Niss & Jensen, to appear, and Niss, 2003).

On the concept of ‘competence’

The definition of the term ‘competence’ in the KOM project (Niss & Jensen, to appear, chap. 4) is semantically identical to the one I use: *Competence* is someone’s insightful readiness to act in response to the challenges of a given situation (cf. Blomhøj & Jensen, 2007a, and Jensen, 2007a).

The choice of this conceptualisation is by no means an attempt to once and for all finish a discussion of what ‘competence’ could or should mean. It is an attempt to capture a number of characteristics of the concept of competence, and a fruitful discussion ought to be about these characteristics rather than about the specific phrasing of the definition (cf. Blomhøj & Jensen, 2003, p. 126-127, from where the characterisation below is taken).

The first of these characteristics is that competence is *headed for action*. I use “action” in a broad sense, as the term “readiness to act” in my definition of competence could imply a positive decision to refrain from performing a physical act, or indirectly being guided by one’s awareness of certain features in a given situation. But no competency follows from being immensely insightful, if this insight cannot be activated in this broad interpretation of the word “action”.

Second, all competencies have a *sphere of exertion* – a domain within which the competency can be brought to maturity (Niss & Jensen, to appear, chap. 9, and Jensen, 2007b). This does not mean that a competency is contextually tied to the use of a specific method for solving a given task. If this was the case, the attempt to define general competencies would have no meaning. Competencies are only contextual in the sense, that they are framed by the historical, social, psychological etc. circumstances of the “given situation” mentioned in my definition of competence (Wedegge, 1999).

Third, competence is an analytic concept with *an inherent duality between a subjective and a social/cultural side* (Wedegge, 2000). Subjective because a competency is always someone’s; competencies do not exist by themselves – what exists are competent people. Social/cultural because the degree to which some actions are “meeting the challenges” (cf. my definition of competence) is always relative to the surroundings adding meaning and legitimacy to the actions (Jørgensen, 1999).

From ‘competence’ to ‘mathematical competencies’

In my opinion these characteristics are good reasons for applying competence as an analytical concept in mathematics education, but in order to transform it into a developmental tool one needs to be more specific.

The straightforward approach – as described in Blomhøj & Jensen (2007a, p. 47) – is to talk about *mathematical competence* when the challenges in the definition of competence are mathematical, but this is no more useful and no less tautological than defining mathematics as the subject dealing with mathematical subject matter.

The important move is to focus on *a mathematical competency* defined as someone’s insightful readiness to act in response to *a certain kind of mathematical challenge* of a given situation, and then identify, explicitly formulate and exemplify a set of mathematical competencies that can be agreed upon as independent dimensions in the spanning of mathematical competence. The core of the KOM project was to carry out such an analysis, of which the result is visualised in figure 1. See Niss & Jensen (to appear) for an extensive characterisation and exemplification of each of the eight mathematical competencies.

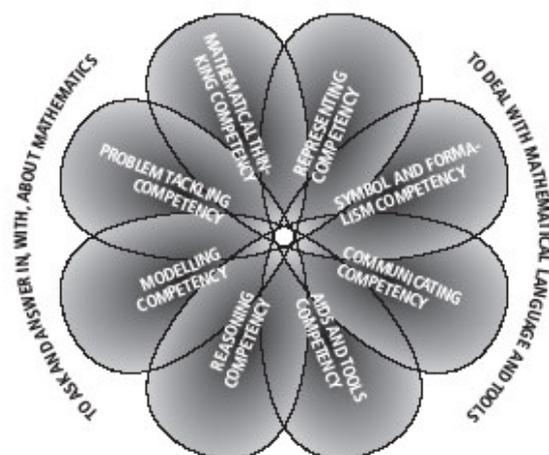


Figure 1. A visual representation – the “KOM flower” – of the eight mathematical competencies presented and exemplified in the KOM report (Niss & Jensen, to appear, chap. 4).

Competencies versus procedural skills

In Danish we have a concept – ‘færdighed’ – that I characterise as someone’s ability to carry out a given act with unambiguous characteristics (cf. Højgaard, 2008, which formed the structural background for this paper). Lacking a better concept, I will translate that into *procedural skills*.

There are two important differences between having developed a competency and having acquired a procedural skill. First, ‘procedural skill’ is a *less complex concept* to apply in education, because the carrying out of the given act in itself expresses the procedural skill, regardless of the background for the ability to act.

Second, ‘procedural skill’ is a *less ambitious concept* to apply in education, because it – cf. the characterisation above – is a matter of carrying out “a given act with unambiguous characteristics”. That leaves out most of what is involved in having developed a competency: Having a sense of what “the challenges of a given situation” are; deciding on a kind of action that can be considered “in response” to these challenges; bringing oneself on the stage when the action are to be carried out, often by making use of a range of acquired procedural skills. In other words: Having developed a competency often incorporates having acquired a range of procedural skills, but it is important to realize that competence involves much more than just the sum of these procedural skills.

Working as a teacher can exemplify the difference between the two concepts. A person with a thoroughly developed teaching competence – someone who is mastering the art of teaching – perfects a large number of procedural skills, some of which are part of the content of the teaching, for example mathematical procedural skills, but also more general things like being able to write in a readable form on the blackboard and handle the technical aspects of different kinds of equipment.

Yet, not even a very long list of such procedural skills gets close to characterising the competence. Instead one can approach the challenge by attempting to characterise the most central sub-competencies – the petals of a teaching competence flower, which was the approach taken in the KOM project as a direct parallel to the characterisation of mathematical competence (Niss & Jensen, to appear, chap. 6).

Modelling assessment as an educational challenge

A set of mathematical competencies as the one in the KOM project has the potential to replace the syllabus as the hub of the development of mathematics education, because it offers a vocabulary for a focused discussion of the aims of mathematics education that can make us feel comfortable for the same reasons that we presently are with the traditional specificity of the syllabus (Blomhøj & Jensen, 2007a).

In Northern Europe, in general, and in Denmark, in particular, attempts are being made to promote such a development. So far mainly in terms of curriculum development with a focus on new ways of describing what many consider to be the heart of teaching – the content. Such reforms create a need for reconsidering a lot of the other issues normally related to educational development; teaching methods, teacher pre- and in-service training, etc. Assessment is probably the most politically hot and didactically challenging of these issues in Denmark, as well as in many other countries in the region.

On the concept of ‘assessment’

I work with *assessment* as a process that involves more or less explicitly carrying through three sub-processes:

Characterising what you are looking for.

Identifying the extent to which what you are looking for is present in the situations involved in the assessment.

Judging the identified.

It is my impression that people often only have judging in their mind when they use the word ‘assessment’, that is they use the two concepts as being synonymous. However, such a usage of the words cannot stand up to closer scrutiny.

Assessment is about taking a systematic and criterion-related approach to the good old question “How are you?” That calls for the counter question “Regarding what?”, which is a shorter way of asking for a characterisation of what one is focusing on and hence looking for. If that is not clear (possibly implicitly) to the persons involved it will be an unfocused discussion with nothing common to refer to. Then one can seek an answer to the question “To what extent?”, that is, start searching – measure/sense/see/hear – in whatever is being assessed for signs that it contains (elements of) what by choice of perspective has been appointed as being good. Only then will it make sense to plunge into a judgement by making a normative description of the quality of what was measured/sensed/seen/heard.

Competency aims and the quality of assessment

What, then, can be said about the relation between using competency aims as a tool for educational development and the possibility of carrying out good assessment? Not surprisingly, that depends on what is meant by “good”. When analysing and discussing that question I find it useful to work with the following commonly used quality criteria (cf., e.g., Niss, 1993):

Validity: Does the assessment highlight what it is supposed to highlight?

Reliability: Is the assessment reliable (independent of who is “the judge”)?

Both these quality criteria relate to assessment as a whole, but they emphasise different parts of the process. Validity is about maintaining focus on what one is essentially attempting to assess, implying an emphasis on the characterisation part of the process when discussing the quality of an assessment according to this criterion. Reliability is about making the judgement as transparent and impersonal as possible, thereby naturally emphasising this part of the assessment process.

When designing a specific assessment it is natural to strive for a combination of high validity and high reliability if they seem to be within reach. That will be the case if the things one is looking for can be characterised and challenged in such a straightforward way that the identification and judgement part of the assessment become simple to carry out.

As an example, that will be the case if multiple choice questions or the challenging of procedural skills – “What is 100 times 8 times 35?” – can capture the ambition. To me that is in a way the essence of the concept ‘procedural skill’ as it was characterised above. It is the kind of ability that is easy to both characterise, identify and judge, because one is dealing with “0-1-situations” where you either can or cannot carry out “the given act with unambiguous characteristics”.

Working with competency aims for the learning process demonstratively pulls in the opposite direction. “Use mathematical modelling to investigate the number of books at the school library.” By posing such a challenge one is using the potential of descriptions of competencies in terms of making explicit some non-trivial ambitions for a given unit of teaching. Thus competency aims strengthen the characterisation part of an assessment and thereby directly contribute to raising the validity.

However, because they express non-trivial ambitions for learning, competency aims also make the identification and judgement part of the assessment process anything but simple to carry out. It is therefore to expect that a combination of high validity and high reliability becomes difficult if not impossible to realize, calling for a balanced and pragmatic approach.

The importance of high validity

When attempting to design and carry out a non-trivial assessment one can approach the challenge of not being able to claim both high validity and high reliability from two opposite directions: Making a demand for high validity the point of departure when attempting to raise the reliability as much as possible, or vice versa.

With these two different approaches in mind I have read several centrally posed sets of tasks for written mathematics exams in Denmark, and I have talked to a number of the members of the commissions authoring these sets of exam tasks. I cannot conclude anything from such an unsystematic investigation, but I can hypothesise and hope it will be possible for me or someone else to carry that into a proper study: Centrally posed exam tasks in mathematics are generally developed with a demand for high reliability as the point of departure, with the degree of validity being a concern of second order.

The main problem of such an approach is that there is a severe danger of ending in a situation similar to looking for one’s lost keys under the lamp-post, solely because that is where the light is: The tasks are being posed with so much “light” on them that anyone working professionally in the field will interpret and judge both questions and all the possible answers in practically the same way, but the student learning being illuminated is only sporadically similar to what the curriculum appoints as “good” and worthwhile striving for.

I – and the great majority of the other mathematics teachers I have talked to about it – take the opposite point of departure. My focus when I work with assessment is to ensure high validity, because of the widely recognised heavy impact from assessment on teaching and learning: If the validity of an assessment is high it can be used to keep the teaching and learning process on the right track, whereas an assessment with low validity easily pulls you off that track.

Taking such a point of departure, competency aims are a potentially very useful developmental tool when attempting to design and carry out an assessment, because – as mentioned above – such aims assist you in the characterisation part of an assessment process and thereby directly contribute to raising the validity (cf. Niss & Jensen, to appear, chap. 9, where specific examples from different educational levels can be found).

When designing assessment, a more procedural version of this point of departure can be to answer questions such as these:

- Which (competency) *learning aims* exist for the unit of teaching I am about to assess?
- How do I *understand* these aims – especially if they are not initially chosen and formulated by me?
- Which kind of *presentations to guide student activity* – tasks, presentation of cases, oral and/or written stories, questions for discussion, etc. – can I find or construct that I believe will be well suited to help the students in developing *toward* the established aims?
- What *signs* in terms of certain kinds of student activity should I pay special attention to in order to *identify* the extent to which our aims are present in the situations assessed?
- How do I *judge* what I have identified?

Some experiences and a recommendation

Guided by questions structured as above, I have worked with competency oriented assessment for some time, theoretically (Jensen, 2007a,b) and – not least – pragmatically as part of my own teaching and curriculum development and in a number of different developmental projects: Focusing on mathematical modelling and problem solving competencies in upper secondary school (Jensen, 2007a), focusing on mathematical problem tackling competency in grade 9 (Blomhøj & Jensen, 2007b), focusing on the whole range of competencies in the KOM project as part of structuring and co-authoring mathematics textbooks for grades K-9 (e.g., Jensen et al., 2002), as well as two ongoing, not yet systematically documented projects focusing on the competencies of mathematics teachers.

My experiences can be summed up in three points. *First*, insisting on high validity, also when working with non-trivial teaching aims, make assessment a both complex and very meaningful challenge.

Second, developing a sound understanding of the crux of a competency is vital for the success of the rest of the assessment process. Having acquired that, working with developing presentations to guide student activity and identifying signs related to that become a natural way to flesh out one's understanding, because due to the nature of the concept of competence all these different parts of the assessment process are about the way the students act in the situation.

Third, the judging part of an assessment process can support good teaching practice if one focuses on a qualitative, formative judgement of whether the students are developing in the desired direction, as opposed to focusing on judging their placing on a (marking) scale.

Summing up: I believe assessment with high validity is a crucial fertilizer for the well being and development of mathematics education. If so, high validity must be a premise when designing an assessment for a specific purpose or situation, and then – from that point of departure – methods for raising the reliability as much as possible must be found or developed. If that is the approach taken when facing the fair and inevitable demand for carrying out good assessment as an integral part of one's teaching, then using mathematical competency aims is a major step in the right direction.

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