Inventories of Basic Dispositions

Views About Science / Mathematics Surveys

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Educational reformists throughout the world have been calling lately for authentic assessment, i.e., for assessment that is integrated with learning and instruction in a way to facilitate student (and teacher) self-evaluation and self-regulation in the direction of meaningful learning of course materials. Meaningful learning is achieved in a given course when individual students develop, in productive ways, a coherent body of *conceptions*, *processes* and *dispositions* that make up the *student profile* targeted in the course. As such, meaningful learning is opposed to rote learning whereby students memorize by heart a bunch of statements and problem solving routines pertaining to various conceptions (concepts, laws, principles and other conceptual entities); statements and routines that students mechanically reproduce in course exams without necessarily understanding what the corresponding conceptions and processes are all about.

The Inventories of Basic Dispositions (IBD), originally developed under the name Views About Science or Mathematics Surveys (VASS / VAMS), are part of a battery of instruments already developed, or being developed, in various fields of science and mathematics, to ascertain to what extent students actually develop meaningful rather than rote learning of course materials. VASS and VAMS target *basic dispositions* (cf. box below) pertaining to *knowing* and *learning* science or mathematics. They serve the following specific objectives:

(a) To ascertain significant *differences* between the views of students, teachers and scientists.

(b) To identify patterns in student views and classify them in general *profiles*.

(c) To measure the *effectiveness of instruction* in *changing* student views and profiles.

(d) To assess the relation between student views/profiles and achievement.

(e) To compare student views/profiles at all grade levels 8-16.

(f) To ascertain differences in the views/profiles of students in the various sciences (Physics, Chemistry, Biology,...) and mathematics.

Evaluation of the quality of student learning and of instruction is a *normative* process, a process that needs to be done relative to clearly defined norms and standards. It involves, among others:

1. Establishing a detailed *taxonomy* of conceptions, processes and worldviews that would make up the profile that students are anticipated to develop following the completion of a given course/curriculum.
2. Setting *criteria* that establish whether individual students have actually developed each element of the anticipated profile, and to what extent they have done so.

In order for the evaluation process to focus on realistic aspects and result in meaningful outcomes, it is better that taxonomy and criteria be *graded*, i.e., that they be about ordered levels of student competency. At least two levels or *thresholds* need to be identified in this respect:

1. *Basic threshold*. This is the most fundamental level. It corresponds to the *minimum standards* of meaningful understanding that *any* student should meet following instruction, irrespective of the initial competence level and interests of the student.
2. *Mastery* or *critical threshold*. This is the highest threshold that students need to cross in order to master all fundamental conceptions and processes in a given course. In an ideal and truly equitable situation, all students willing to invest necessary efforts should be capable of reaching this threshold. In traditional classroom settings, critical threshold usually corresponds to the level of understanding of supposedly A-students.

VASS and VAMS items are designed following Halloun’s Contrasting Alternatives rating scale (CArs). Each survey question presents a given issue about the given course in which students are enrolled, with two viewpoints (a) and (b) that respondents need to contrast on a 5-point scale. For example:

My physics course covers:

	1	2	3	4	5	
(a) abstract themes;	a>>b	a>b	a=b	b>a	b>>a	(b) practical applications.

A respondent might favor one viewpoint over the other, or regard both viewpoints equally. S/he indicates her/his position by choosing one, and ***only one***, of the five responses shown in the middle, between alternatives (a) and (b). Responses 1 and 2 favor, to different extents, viewpoint (**a**) over viewpoint (b). In contrast, responses 4 and 5 favor, to different extents, viewpoint (**b**) over viewpoint (a). Response 3 regards viewpoints (a) and (b) equally.

More specifically, the five response choices mean the following:

1. (a) >> (b): Mostly (a), rarely (b), or Most often (a), seldom (b)

2. (a) > (b): More (a) than (b), or (a) more often than (b)

3. (a) = (b): Equally (a) and (b), or (a) as often as (b)

4. (a) < (b): More (b) than (a), or (b) more often than (a)

5. (a) << (b): Mostly (b), rarely (a), or Most often (b), seldom (a)

In the case of the example above, the five choices would mean the following:

1. My physics course covers *mostly* abstract themes and *rarely* any practical applications.

2. My physics course covers *more* abstract themes *than* practical applications.

3. My physics course covers *as much* abstract themes *as* practical applications.

4. My physics course covers *more* practical applications *than* abstract themes.

5. My physics course covers *mostly* practical applications and *rarely* any abstract themes.

VIEWS ABOUT SCIENCE SURVEY

TAXONOMY

Core-disciplinary aspects *Students need to realize the following aspects of science and to construct their own knowledge accordingly*
1. Nature of science and of anticipated student knowledge: ***N1*** Science is about generic: (a) coherently interrelated conceptions, and (b) patterns of thinking, including problem solving, - rather than about idiosyncratic and isolated, situation-specific terms, statements and procedures. ***N2*** Scientists rely on multiple ways to (a) represent the situation in any problem and (b) solve it; - rather than concentrating on a single representation or a single problem solving strategy. ***N3*** Mathematical representations help: (a) relate scientific concepts in meaningful ways, and (b) express such relationships objectively, - rather than being good for mere number crunching and open for subjective interpretation.
2. Connections: ***I1*** Science and mathematics benefit from each other's knowledge, - rather than being each confined to its own domain. ***I2*** Scientists rely on technology for deploying their knowledge in: (a) meaningful ways and (b) novel areas, - rather than for reproducing paper-and-pencil solutions of traditional textbook problems. ***I3*** Science is relevant to everyone's life, - *and not just to scientists.*

Meta-cognitive aspects

3. *Learning conditions:*

Locus of control:

C1 Science is learnable by (a) anyone (b) willing to make the effort,
- not just by a few talented people.

C2 Achievement depends more on: (a) personal effort, (b) self confidence and (c) perseverance
- than on the influence of teacher, peers or textbook.

C3 Studying science should be an (a) enjoyable, (b) confidence building and (c) self-satisfying experience,
- rather than a frustrating and intimidating undertaking for satisfying curriculum requirement.

Meaningful understanding favors:

C4 Students who come to class with a prepared mind,
- rather than those who study only after the teacher covers materials in class;

C5 Those who seek information from alternative sources,
- rather than those who stick to the textbook;

C6 Those who are (a) tolerant, and (b) open to others' ideas
- rather than those who stand blindly and firmly by their own ideas; and

C7 Those who cooperate with others for knowledge development
- rather than for mere task achievement.

4. *Insightful, meaningful learning* requires one to:

L1 Construct new subject knowledge: (a) on one's own, and (b) delimit its scope,
- instead of assimilating it from an authority and memorizing it as given.

L2 Deploy knowledge following purposeful plans,
- rather than by recalling certain routines learned by rote.

L3 Deploy knowledge in a variety of activities (paper-an-pencil exercises, case studies, etc.),
- instead of concentrating on traditional end-of-chapter exercises.

L4 Continuously: (a) justify, and (b) evaluate one's own work,
- rather than getting satisfied with mere task completion.

L5 Look for the teacher as a mediator of learning
- rather than an authoritative source of information.

L6 Contrast and regulate any discrepancy between one's own knowledge and the target scientific knowledge,
- instead of blindly assimilating target knowledge.

L7 Use assessment for self-evaluation and regulation
- rather than for ranking oneself relative to peers.