Socrates - Comenius 2-1-2006-1

Improving Quality of Science Teacher Training in European Cooperation - constructivist approach (IQST)

# Assessing Science for Understanding - a constructivist approach

Olomouc 2008

## Unit 1

## Purpose and Characteristic of Classroom Assessment

**Objectives:**

- To understand purposes of classroom assessment;
- To define the concept of assessment;
- To characterize the classroom assessment.

### The Nature of Assessment

With the release of the constructivist approach to science teaching, the issues of why, how, and what we, as teachers, assess in our classrooms will become a major challenge in the science teaching and learning. As educators are changing their ideas about what constitutes exemplary inquiry-based learning, and recognizing that science is an active process that encourages higher-order thinking and problem solving, there is an increased need to align assessment.

Assessment can be defined as a sample taken from a larger domain of content and process skills that allows one to infer student understanding of a part of the larger domain being explored. The sample may include behaviours, products, knowledge, and performances. Assessment is a continuous, ongoing process that involves examining and observing student's behaviours, listening to their ideas, and developing questions to promote conceptual understanding. The term authentic assessment is often referred to in any discussion of assessment and can be thought of as an examination of student performance and understanding on significant tasks that have relevancy to the student's life inside and outside of the classroom.

The increasing focus on the development of conceptual understanding and the ability to apply science process skills is closely aligned with the emerging research on the theory of constructivism. This theory has significant implications for both instruction and assessment, which are considered by some to be two sides of the same coin. Constructivism is a key underpinning of the science teaching and learning.

Constructivism is the idea that learning is an active process of building meaning for oneself. Thus, students fit new ideas into their already existing conceptual frameworks. Constructivists believe that the learners' preconceptions and ideas about science are critical in shaping new understanding of scientific concepts. Assessment based on constructivist theory must link the three related issues of student prior knowledge (and misconceptions), student learning styles (and multiple abilities), and teaching for depth of understanding rather than for breadth of coverage. Meaningful assessment involves examining the learner's entire conceptual network, not just focusing on discreet facts and principles.

## The Purpose of Assessment

Critical to educators is the use of assessment to both inform and guide instruction. Using a wide variety of assessment tools allows a teacher to determine which instructional strategies are effective and which need to be modified. In this way, assessment can be used to improve classroom practice, plan curriculum, and research one's own teaching practice. Of course, assessment will always be used to provide information to students, parents, and administrators. In the past, this information was primarily expressed by a "grade". Increasingly, this information is being seen as a vehicle to empower students to be self-reflective learners who monitor and evaluate their own progress as they develop the capacity to be self-directed learners. In addition to informing instruction and developing learners with the ability to guide their own instruction, assessment data can be used by a school district to measure student achievement, examine the opportunity for children to learn, and provide the basis for the evaluation of the district's science program. Assessment is changing for many reasons. The valued outcomes of science learning and teaching are placing greater emphasis on the student's ability to inquire, to reason scientifically, to apply science concepts to real-world situations, and to communicate effectively what the child knows about science. Assessment of scientific facts, concepts, and theories must be focused not only on measuring knowledge of subject matter, but on how relevant that knowledge is in building the capacity to apply scientific principles on a daily basis. The teacher's role in the changing landscape of assessment requires a change from merely a collector of data, to a facilitator of student understanding of scientific principles.

## Characteristics of Assessment

The assessment is learner-centred, teacher-directed, mutually beneficial, formative, context-specific, ongoing, and rooted in good teaching practice. In the context of constructivist approach , assessments need to gauge the progress of students in achieving the three major learning outcomes of constructivist approach: conceptual understanding in science, abilities to perform scientific inquiry, and understandings about inquiry.

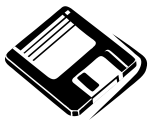
All learners come to a learning tasks with some relevant knowledge, feelings and skills. By school age, students have already attained several thousand concepts and language labels for these concepts. Concepts are playing a primary role of constructivist learning theory. Learners do not store concepts as isolated bits; instead, they form relationships or connections between concepts to form propositions. Meaningful learning occurs when the learners seeks to relate new concepts and propositions to relevant existing concept and propositions in her/his cognitive structure (Mintzes, Novak, Wandersee, 2000).

Teachers have a very challenging role to play in assessment process. They must seek to understand the major superordinate and subordinate concepts of the sciences and integrate these into a complex, integrated, hierarchical structure. Assessment can foster development of the kind of knowledge frameworks that are needed for effective science teaching. So prospective science teachers must seek on their own initiative to build this kind of understanding of their field. Because it is focused on learning, assessment requires the active participation of students. By cooperating in assessment, students reinforce their grasp of the science content and strengthen their own skills and self-assessment.

Constructivist approach to assessment is a formative rather than a summative. Its purpose is to improve the quality of student learning, not to provide evidence for evaluating or grading students. Assessment have to respond to the particular needs and characteristics of the teachers, students and science content. Assessment is context-specific: what works well in one class will not necessarily work in another.

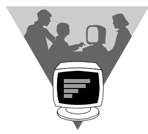
Assessment is ongoing process. Teachers get feedback from students of their learning. Teachers then complete the loop by providing students with feedback on the results of the assessment and suggestions for improving learning.

Most teachers already collect some feedback on their students´ learning and use that feedback to inform their teaching. Assessment is an attempt to build on existing good practice by making it more systematic, more flexible, and more effective. Teachers ask questions, react to students´ questions, monitor body language and facial expressions, read homework, and so on. Assessment provides a way how to integrate teaching and learning process. Assessment is an integral part of these processes.



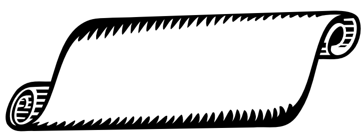
**Tasks (assignments)**

1. How you can explain the concept of assessment in constructivist classroom?
2. How should student learning be assessed?
3. Why students should be assessed in constructivist classroom?



**Case study**

Ms. Novak facilitates science lessons in a number of ways. Students´ background knowledge is informally assessed through observation and conversation. She identifies students´ misconceptions, and design activities to promote basic understanding. When students work in groups, she facilitates learning by watching and listening to them as they make decisions. Some of her questions are: How do you know that this decision is correct? Which can had the greatest temperature change? How does the colour of the material affect its ability to absorb ability? How did you determinate the solution? What problems did you incur while completing the activity?



**Questions to Case Study**

1. Do you think that these questions are relevant to constructivist approach?
2. Can you design the next questions (5 at least) for constructivist classroom?

**Summary**

Assessment can play an important role in the larger “assessment movement” that is discussed in many European countries recently. Constructivist theory requires a different approach to assessment. This assessment needs tools and methods to fit its purposes, and those will not be the same standardized tests. Constructivist classroom assessment requires the development of its own “appropriate technology” – simple tools designed for the task at hand: the understanding and improvement of learning.

**Frequently Asked Questions**

I am a science teacher who is teaching in the first year. I have many difficulties in designing questions for assessment of students from the point of constructivism. How can I improve my ability to design questions?

*Answer the question above*
It is recommended to design these questions in advance on the cards or list. When the students do not understand the question, make a mark and try to change the question.

**Next Reading**

Bransford, J.D., Brown, A.L., Cocking, R.R. (Ed) *How People Learn. Brain, Mind, Experience, and School.* Washington, D.C.: National Academy Press, 2000. First Edition. ISBN 0-309-07036-8.

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Novak, J. (2002). Meaningful Learning: The Essential Factor for Conceptual Change in Limited or Inappropriate Propositional Hierarchies Leading to Empowerment of Learners. *Science Education, 86(4*), 548-571.

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# Unit 2

# A Constructivist Approach in Assessment

**Objectives:**

- To understand the concept of constructivism;
- To apply constructivist theory on assessment;
- To find differences between traditional assessment and constructivist approach to assessment;
- To explain misconcepts in understanding of assessment.

**Constructivism and Assessment**

What kinds of assessments do teachers use in traditional and constructivist classrooms to assess student's learning? If assessments evolve out of instruction, as is expected in inquiry and constructivist-based classrooms, then assessments should reflect what students learn and can do. There is a problem with investigating classroom assessment strategies because teachers' beliefs, practices, and other factors cause teachers to use many different formal and informal assessments.

Three constructs emerge from the literature regarding constructivism and have implications for the learning environment. They are (1) learning is an active process, (2) the learner has prior knowledge, and (3) the learner takes responsibility for their own learning (Yager, 1991; Cobb et al 1992, Magoon, 1977; Hewson & Hewson, 1988). These three ideas are central to this study. These ideas can be operationalized by the following statements:

1. Assessments are in a meaningful context that is relevant or has emerging relevance to students (Brooks & Brooks, 1993).
2. The process of learning does not shut down during assessment (Brooks & Brooks, 1993).
3. Assessments are tailored to specific modules and teaching situations (Zahorik, 1995).
4. Assessments include higher order thinking skills, i.e., application, evaluation, analysis, synthesis (Burry-Stock, 1995; Yager, 1991).
5. Assessments include application of knowledge and comprehension (Zahorik, 1995).
6. A range of techniques is used in assessments (Burry-Stock, 1995; Zahorik, 1995).
7. Assessments focus on the big pictures on concepts and on issues and their accompanying facts and evidence (Zahorik, 1995).
8. Assessment includes inquiry (Brooks & Brooks, 1993; Yager, 1991).
9. Students go beyond initial information levels (knowledge and comprehension) through elaboration doing in-depth analysis of big ideas, issues and concepts (Brooks & Brooks, 1993).
10. Students solve problems in which they extend and re-conceptualize (accommodation) knowledge in new contexts (Brooks & Brooks, 1993; Osborne & Wittrock, 1983; Zahorik, 1995).
11. Students generalize (synthesis) experiences from earlier concrete experiences a to understand abstract theories and applications (Brooks & Brooks, 1993; Osborne & Wittrock, 1983; Zahorik, 1995).

12. Students exhibit knowledge through application (Yager, 1991).
13. Students interact with each other in all circumstances including during assessments (Zahorik, 1995).

Constructivist learning is an active process, and alternative assessment celebrates this active process. Instead of testing for the presence or absence of discrete bits of information, alternative assessment instead provides a means to understand whether students organize, structure, and use information in context to solve complex problems. Assessment is not something that we tack onto learning: it is an essential *ongoing* component of instruction that guides the process of learning. Ongoing assessment uses exhibitions, student explanations of concepts, the writing or any number of other thought-demanding performances to evaluate and reflect on students work.

Assessment can be used to build understanding through reflection and iteration. There is great promise for deeper understanding and appreciation of the creative, generative process we call learning when a student is aware of scholastic expectations and understands how to effectively review and critique his or her own work. This process has three steps:

1. The teacher must help students understand from the outset the criteria by which their work will be judged.
2. Students must document their work process for the duration of the project or unit.
3. Through performance and feedback, students come to understand the complex nature of judging and improving upon one´s work.

In practice, both traditional and alternative assessment of students´ performance should require an understanding of how a particular student came into the learning process, including their cultural background, personal learning style and what they accomplished in relative terms while engaged in the learning process. It becomes a very delicate, finely tuned relationship between assessor and assessed. This balance is easier to maintain when working with alternative practices.

**Assessment and Constructivic Classroom**

Constructivism is basically a theory - based on observation and scientific study - about how people learn. It says that people construct their own understanding and knowledge of the world, through experiencing things and reflecting on those experiences. When we encounter something new, we have to reconcile it with our previous ideas and experience, maybe changing what we believe, or maybe discarding the new information as irrelevant. In any case, we are active creators of our own knowledge. To do this, we must ask questions, explore, and assess what we know.

In the classroom, the constructivist view of learning can point towards a number of different teaching practices. In the most general sense, it usually means encouraging students to use active techniques (experiments, real-world problem solving) to create more knowledge and then to reflect on and talk about what they are doing and how their understanding is changing. The teacher makes sure she understands the students' pre-existing conceptions, and guides the activity to address them and then build on them. Constructivist teachers encourage students to constantly assess how the activity is helping them gain understanding. By questioning themselves and their strategies, students in the constructivist classroom ideally become "expert learners." This gives them ever-broadening tools to keep learning. With a well-planned classroom environment, the students learn HOW TO LEARN.You might look at it as a spiral. When they continuously reflect on their experiences, students find their ideas gaining in complexity and power, and they develop increasingly strong abilities to integrate new information. One of the teacher's main roles becomes to encourage this learning and reflection process.

Contrary to criticisms by some (conservative/traditional) educators, constructivism does not dismiss the active role of the teacher or the value of expert knowledge. Constructivism modifies that role, so that teachers help students to construct knowledge rather than to reproduce a series of facts. The constructivist teacher provides tools such as problem-solving and inquiry-based learning activities with which students formulate and test their ideas, draw conclusions and inferences, and pool and convey their knowledge in a collaborative learning environment. Constructivism transforms the student from a passive recipient of information to an active participant in the learning process. Guided by the teacher, students construct their knowledge actively rather than just mechanically ingesting knowledge from the teacher or the textbook.

Constructivism is also often misconstrued as a learning theory that compels students to "reinvent the wheel." In fact, constructivism taps into and triggers the student's innate curiosity about the world and how things work. Students do not reinvent the wheel but, rather, attempt to understand how it turns, how it functions. They become engaged by applying their existing knowledge and real-world experience, learning to hypothesize, testing their theories, and ultimately drawing conclusions from their findings.

In the constructivist classroom, the focus tends to shift from the teacher to the students. The classroom is no longer a place where the teacher ("expert") pours knowledge into passive students, who wait like empty vessels to be filled. In the constructivist model, the students are urged to be actively involved in their own process of learning. The teacher functions more as a facilitator who coaches, mediates, prompts, and helps students develop and assess their understanding, and thereby their learning. One of the teacher's biggest jobs becomes ASKING GOOD QUESTIONS.

The chart below compares the traditional classroom to the constructivist one. You can see significant differences in basic assumptions about knowledge, students, and learning.

| Traditional Classroom | Constructivist Classroom |
|---|---|
| Curriculum begins with the parts of the whole. Emphasizes basic skills. | Curriculum emphasizes big concepts, beginning with the whole and expanding to include the parts. |
| Strict adherence to fixed curriculum is highly valued. | Pursuit of student questions and interests is valued. |
| Materials are primarily textbooks and workbooks. | Materials include primary sources of material and manipulative materials. |
| Learning is based on repetition. | Learning is interactive, building on what the student already knows. |

| | |
|---|---|
| Teachers disseminate information to students; students are recipients of knowledge. | Teachers have a dialogue with students, helping students construct their own knowledge. |
| Teacher's role is directive, rooted in authority. | Teacher's role is interactive, rooted in negotiation. |
| Assessment is through testing, correct answers. | Assessment includes student works, observations, and points of view, as well as tests. Process is as important as product. |
| Knowledge is seen as inert. | Knowledge is seen as dynamic, ever changing with our experiences. |
| Students work primarily alone. | Students work primarily in groups. |

As is the case with many of the current/popular paradigms, you're probably already using the constructivist approach to some degree. Constructivist teachers pose questions and problems, then guide students to help them find their own answers. They use many techniques in the teaching process. For example, they may:

- prompt students to formulate their own questions (inquiry),
- allow multiple interpretations and expressions of learning (multiple intelligences),.
- encourage group work and the use of peers as resources (collaborative learning)

In a constructivist classroom, learning is . . .

CONSTRUCTED
Students are not blank slates upon which knowledge is etched. They come to learning situations with already formulated knowledge, ideas, and understandings. This previous knowledge is the raw material for the new knowledge they will create.

ACTIVE
The student is the person who creates new understanding for him/herself. The teacher coaches, moderates and suggests, but allows the students room to experiment, ask questions, try things that don't work. Learning activities require the students' full participation (like hands-on experiments). An important part of the learning process is that students reflect on, and talk about, their activities. Students also help set their own goals and means of assessment.

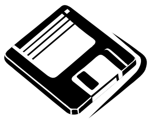
REFLECTIVE
Students control their own learning process, and they lead the way by reflecting on their experiences. This process makes them experts of their own learning. The teacher helps create situations where the students feel safe questioning and reflecting on their own processes, either privately or in group discussions. The teacher should also create activities that lead the

student to reflect on his or her prior knowledge and experiences. Talking about what was learned and how it was learned is really important.

COLLABORATIVE
The constructivist classroom relies heavily on collaboration among students. There are many reasons why collaboration contributes to learning. The main reason it is used so much in constructivism is that students learn about learning not only from themselves, but also from their peers. When students review and reflect on their learning processes together, they can pick up strategies and methods from one another.

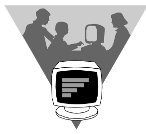
INQUIRY-BASED
The main activity in a constructivist classroom is solving problems. Students use inquiry methods to ask questions, investigate a topic, and use a variety of resources to find solutions and answers. As students explore the topic, they draw conclusions, and, as exploration continues, they revisit those conclusions. Exploration of questions leads to more questions.

EVOLVING
Students have ideas that they may later see were invalid, incorrect, or insufficient to explain new experiences. These ideas are temporary steps in the integration of knowledge. For instance, a child may believe that all trees lose their leaves in the fall, until she visits an evergreen forest. Constructivist teaching takes into account students' current conceptions and builds from there.



**Tasks (assignments)**

1. Can you find any differences between the assessment in traditional classroom and constructivist classroom?
2. Can you see significant differences in basic assumptions about knowledge, students, and learning in constructivist classroom?



**Case study**

Scores of assessment happen every day in every classroom. Usually there are dozens every hour. The teacher asks a question. A student interprets the questions, and responds. The teacher makes a judgement about how well the student understands. All the other students listening to the exchange also interpret what the teacher was asking, and they also evaluate the quality of the response. For many people, in fact, they pale in importance to the many traditional assessment.

**Questions to Case Study**

1. Can you explain why many people (teachers, students and parents) still prefer traditional approach to the assessment?
2. Do you think that it is necessary to change traditional approaches to assessment?
3. How are you going to implement new strategies to assessment?

**Summary**

Benefits of Constructivist Classroom

- Students learn more, enjoyably and are more likely to retain learning;
- Students learn how to think and understand;
- It is a transferable skill to other settings;
- Students have ownership of their own learning;
- It applies natural curiosity to real world situations;
- Promotes social and communication skill within a group setting.

**Frequently Asked Questions**

How can I persuade my students for constructivist?

*Answer the question above*
Students must begin to understand the reason for his/her progress in learning. Try to use strategies which are highly motivated and interested for students. Students would like to be active in the assessment.

**Next Reading**

Novak, J. (2002). Meaningful Learning: The Essential Factor for Conceptual Change in Limited or Inappropriate Propositional Hierarchies Leading to Empowerment of Learners. *Science Education, 86(4*), 548-571.
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# Unit 3

## Planning and Implementing Classroom Assessment Projects

**Objectives:**

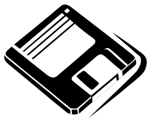
- To develop skills to plan assessment;
- To improve ability to follow plan;
- To develop ability to work productively with others.

**An Introduction to the Classroom Assessment Project Cycle**

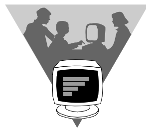
The classroom assessment project has three main phases, and each phase consists of three steps:

| Phase | Steps | Description |
|---|---|---|
| I Planning a classroom assessment project | 1. Choosing the class in which to carry out the project<br>2. Focusing on assessable questions about student learning<br>3. Designing an assessment project | In your initial project focus on class you will teach again<br>Identify single teaching and learning goals and questions<br><br>Map out the path by which you will seek an answer to the assessable question and choose the tools that will help you get that answer |
| II Implementing a classroom assessment project | 4. Teaching the lesson related to questions<br><br>5. Assessing learning by collecting feedback<br>6. Analyzing the feedback | Plan to integrate assessment activity into your regular class activities as smoothly as possible<br>Choose a simple assessment technique<br>Prepare yourself for surprising feedback. Look carefully at both positive and negative results. |
| III Responding to the results of assessment | 7. Interpreting the results and formulating response to improve learning<br><br>8. Communicating the results to students and learning<br>9. Evaluating assessment project´s effect on teaching | Try to understand students´ feedback. Think through how you can respond to their feedback in way that will help the students to improve their own learning.<br>Maximize the possible positive impact of assessment<br>Assess the outcomes and impact your teaching on students learning |

**Tasks (assignments)**

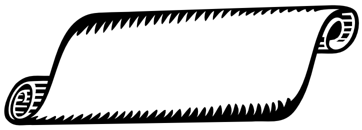


1. Formulate 3 goals (at least) for your project.
2. Suggest some questions related to formulated goals.
3. Design your small assessment project.
4. How many steps does your project have?
5. Discuss you project with your lecturer or with your schoolmates.



**Case study**

A science teacher believed in the importance of teaching problem solving, meta-cognition and learner´s pre-concepts. In planning his first assessment project, however, he came to the surprising realization that he could not identify where he was teaching those skills in the science course he was focusing on. At that point, he decided to devise new lessons to help students to develop those skills.



**Questions to Case Study**

1. Do you think that science teacher used relevant questions to assess those skills?
2. Do you have any experience from your previous school life (as a secondary student) with the questioning to develop problem solving and recognition of pre-concepts?

**Summary**

The guidelines below sum up the best advice, based on experience with classroom assessment.

1. Start with assessable goals.
2. Focus on alterable variables.
3. Build in success.
4. Get students actively involved.
5. Start small.
6. Set limits on time and effort you will invest.
7. Be flexible and willing to change.
8. Work with other teachers who share your interest.
9. Remember that students must first learn to give useful feedback and then must practice doing so.
10. Enjoy experimentation and risk-taking, not just success.

**Frequently Asked Questions** 

How accurately can my students now determinate when, where, and why they have gotten "stuck" when they cannot solve a given problem?

*Answer the question above*
Prepare three or four problems of increasing difficulty. Give students the problem set, along with the instructions to indicate when and where, and explain why they have become stuck when they cannot solve one of the problems.

**Next Reading**

Bransford, J.D., Brown, A.L., Cocking, R.R. (Ed) *How People Learn. Brain, Mind, Experience, and School.* Washington, D.C.: National Academy Press, 2000. First Edition. ISBN 0-309-07036-8.

**References**

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# Unit 4

# Techniques for Assessing Knowledge and Skills

**Objectives:**

- To understand techniques for assessing;
- To develop skills to use different techniques;
- To be able to apply different techniques in teaching practice.

## Background Knowledge Probe

Background Knowledge Probe are short, simple questionnaires prepared by teachers for use at the beginning of the topic, at the start of a lesson, or prior to introducing an important new topic. Background Knowledge Probes are meant to help teachers determine the most effective starting point for a given lesson and the most appropriate level at which to begin instruction.

Before introducing an important new concept, or topic, teacher should consider what students may already know about it. It is recommended to prepare two or three open-ended questions, a handful of short-answer questions, or ten to twenty multiple-choice questions that will probe the students´ existing knowledge of that concept, subject or topic. These questions need to be carefully phrased, since a vocabulary that may not be familiar to students can obscure assessment of how well students know the facts or concepts. Students answer open-ended questions succinctly, in two or three sentences if possible. Teacher encourages students to give thoughtful answers that will help to make effective in instructional decisions.

*Example*

Before the first lesson-demonstration-lab session, the teacher wanted to determine what students might already have learned – whether through unit work or on the experience – about measuring current, voltage, and resistance. To find out, teacher prepared Background Knowledge Probe that contained five illustrations representing the displays of the following instruments: voltmeter, ammetr, ohmmeter, deflection multimeter, and digital multimeter. Each illustration clearly indicated a different reading or readings through the pointer positions and switch settings, or digital readouts shown. Teacher asked students to determine, and write out, the readings for the five instruments shown. The responses to this probe indicated that most students were familiar with digital instrument displays and had some idea what the readings on at least one of the instrument meant. But there were also students who did not use standard vocabulary in their responses and that there quite a range of prior knowledge. A few students had no idea how to respond. To capitalize on the diversity in preparation, teacher decided to start with small group work on the basis their prior understanding.

## Focused Listing

This technique focuses students´ attention on a single important term, name or concept from a particular lessons or class instruction and directs them to list several ideas that are closely related to that focus point. Focused Listing is a tool for quickly determining what students recall as the most important points related to a particular topic. Focused Listing can be used before, during, or after the relevant lesson. As a result, teacher can use this technique to gauge the best starting point, make midpoint correction, and measure the students´ progress in learning one specific element of course content.

*Example*

Physics teacher hands out half-sheet of scrap paper and asks students to write a list of five or so words or phrases that define *work* in physics. After about two minutes, teacher collects their responses. Once teacher has read them quickly, physics teacher sorts the responses into three piles: those that do at least a fairly good of defining *work* in physics_: those that confuse work in physics with work in everyday life; and the rest. Teacher explains and differentiates the two distinct but easily confusable meanings of work. The everyday and the scientific. Can help students learn other key concepts, such as mass, velocity, energy, impulse, and momentum.

## Misconception/Preconception Check

Misconception/Preconception Check also assesses students´ prior knowledge, but with a twist. Its focus is on uncovering prior knowledge or beliefs that may hinder or block further learning. The greatest obstacle to new learning often is not students´ lack of prior knowledge but, rather, the existence of prior knowledge. Most teachers know from experience that it is much harder for students to unlearn incorrect or incomplete knowledge than to master new knowledge in a unfamiliar fields. Consequently, teachers can benefit from discovering early in the term which common misconceptions or preconceptions students have that likely to interfere with the learning in a given lesson.

Teacher starts by identifying some of the most troublesome common misconceptions or preconceptions students bring to instruction. Brainstorming this question with colleagues can be very effective way to generate such a list. Teacher selects a handful of these troublesome ideas and beliefs and focuses Misconception/Preconception Check on them. The next step is to create a simple questionnaire to elicit information about students´ ideas and believes in these areas. It is possible to use multiple-choice format or a short-answer format.

*Example*

The teacher handed out half-sheets of paper and asked students to write their best answers to the following question: What makes the seasons change on Earth? Teacher told to students that any sincere answer was acceptable except “ I do not know”. Students do not write their names on the papers. Later teacher looked through the student responses very quickly, dividing them into the following four piles, based on the type of explanations given: the correct pile, the distance pile, the weather pile, and the others pile. After that teacher picked out the clears, most articulate example from each of fur piles and transcribed those four answers onto a one-page handout, which is distributed to students then. After students had read all four explanations, teacher asked them simply to circle the one correct answer and to turn in the handouts. Teacher quickly tallied the responses. The second time around, the proportion of correct responses was much higher. This is a common effect, occurring because students can more often recognize the correct answer when it is presented to them than they can independently produce that same answer. At that point, the teacher invited several students to explain their choices. Proponents of each of four major positions explained their models of seasonal change. Each student´s assignment was to find out which of the answers really was correct and why. Students present their explanations and teacher offers minor corrections.

## Minute Paper

One-Minute Paper provides a quick and extremely simple way to collect written feedback on student learning. Students respond briefly to some variations on the following two questions: “What was the most important thing you learned during this class?” and “What important questions remains unanswered?” Teacher can quickly check how well students are learning what they are teaching. One-Minute Paper also ensures that students´ questions will be raised, and in many cases answered, in time to facilitate further learning.

*Example*

A few minutes before the end of lesson, teacher asked students to list five most important points from this lesson, along with one or two important questions they had. Then teacher collected the responses and quickly read them making a list of the most important points and questions. Teacher explained the relative importance of these points and their relationships to one another. Teacher also let students know which points were definitely not related.

## One-Sentence Summary

One-Sentence Summary enables teachers to find how concisely, completely, and creatively students can summarize a large amount on information on a given topic. This assessment technique can provide feedback on students´ summaries of just about any information that can be represented in declarative form. This sentence is created on the basis of following questions: Who?, Does what?, To what or whom?, When?, Where?, How?, Why?.

*Example*

After the class with the topic of Assessment Techniques the teacher students are asked to write One-Sentence Summary of this unit. One of the student created the following One-Sentence Summary: Teachers assess their students´ learning regularly during their lessons in their own classrooms, by using Classroom Assessment Techniques and any other appropriate tools and methods of inquiry, so that they can understand and improve teaching effectiveness and the quality of student learning.

## Word Journal

The World Journal can help teacher assess and improve several related skills. First, it focuses on students´ ability to read carefully and deeply. Second, it assesses skill and creativity at summarizing what has been read. And third, it assesses the students´ skill at explaining and defending, in just a few more words, their choice of single summary word. This practice helps students develop the ability to write highly condensed abstracts and to understand large amount of information for more effective storage in long-term memory.

Teacher choices of the short texts that students will be assigned to read. Teacher decides what aspect of that text – main theme, central conflict or problem, core metaphor, which students should focus on. Students should know that the choice of a specific word is less important than the quality of the explanation for that choice.

*Example*

To help students prepare for discussions for lesson, the teacher used the World Journal. The students´ summary words became the starting points for the discussions. Teacher listed a number of those words on the board and then asked students to explain their particular characterizations of the case´s central problem.

## Concept Maps

Concept Maps are drawings or diagrams showing the mental connections that students make between a major concept the teacher focuses on and other concepts they have learned. This technique provides an observable and assessable record of the students´ conceptual schemata – the patterns of associations they make in relation to a given focal concept. Concept Maps allow the teacher to discover the web of relationships that learners bring to the task at hand – the students´ starting points.

A concept map is a two-dimensional, hierarchical node-link diagram that depicts the structure of knowledge within a scientific discipline as viewed by a student, an instructor or an expert in a field or sub-field. The map is composed of concept labels, each enclosed in a box or oval; a series of labeled linking lines, and an inclusive, general-to-specific organization. By reading the map from top to bottom, an instructor can:

1. gain insight into the way students view a scientific topic;
2. examine the valid understandings and misconceptions students hold; and
3. assess the structural complexity of the relationships students depict.

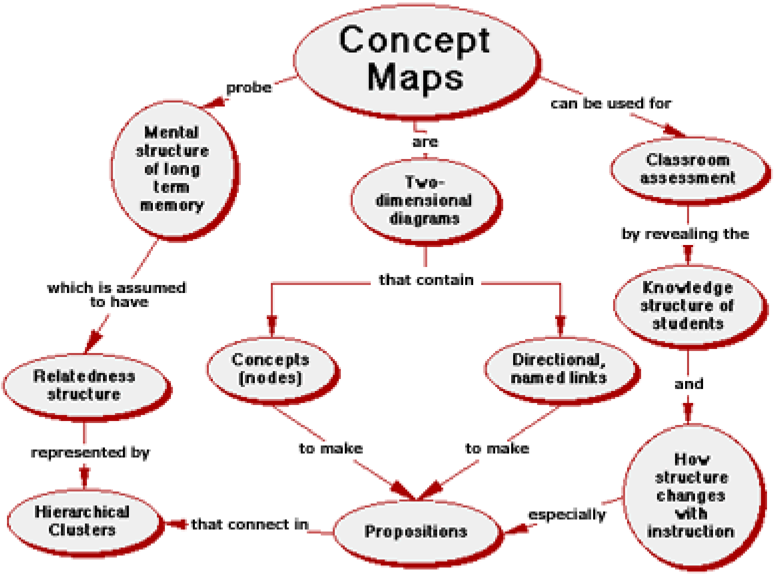



**Figure 1:** Concept Map Of Concept Maps

## Limitations

Concept maps provide a useful and visually appealing way of depicting the structure of conceptual knowledge that people have stored in long-term memory. As a result, they offer a readily accessible way of assessing how well students see "the big picture." They are not designed to tap into the kind of process knowledge that students also need to solve novel problems or for the routine application of algorithmic solutions. Because they probe an individual's or a group's cognitive organization, they are very idiosyncratic and difficult to compare, either among individuals or groups, or across time for the same individuals or groups.

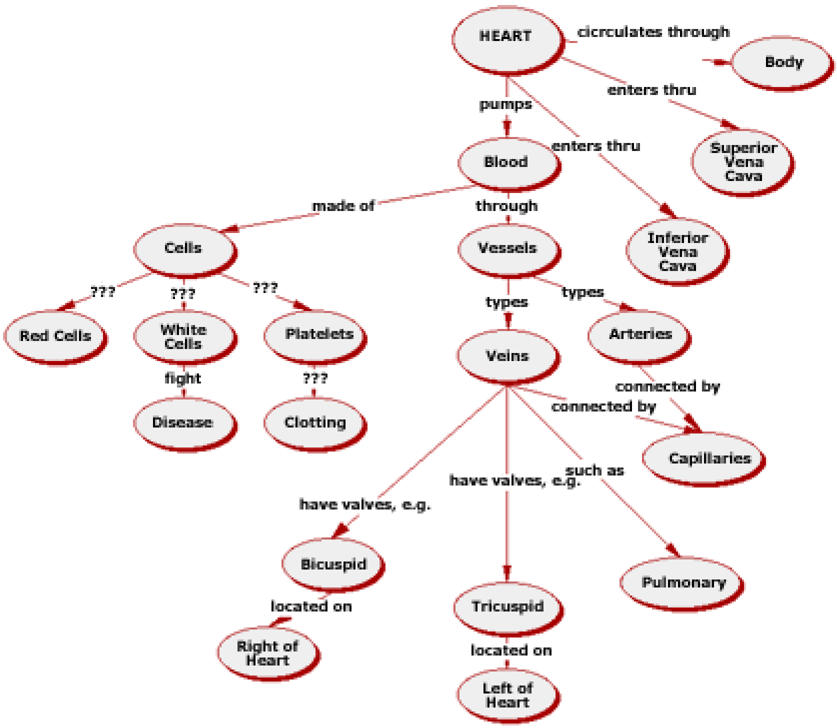



**Figure 2:** Jason's Concept Map on the Human Circulatory System
[From Mintzes, Wandersee & Novak, 1998]

## Teaching Goals

- Learn terms, facts, and concepts of this subject
- Organizes information into meaningful categories
- Synthesize and integrate information , ideas, and concepts
- Think about the "big picture" and see connections among concepts
- Think creatively about this subject
- Improve long-term memory skills for accessible knowledge
- Develop higher-level thinking skills, strategies, and habit
- Use graphics effectively

## Suggestions for Use

*Instructional Tool*

The instructor can present "expert" concept maps to the whole class to highlight key concepts and connections. These should be more detailed and flow from the global maps executed for the course design. Concept maps can then serve as "advanced organizers" (to preview material) and also for review. An instructor can continuously refer to a concept map in class to show how to "grow" the connections, and to keep the instruction focused. Caveat: At first, students will find concept maps very strange and may even try to memorize them, rather than use them as a thinking tool.

This technique also helps the teacher assess the degree of "fit" between the students´ understanding of relevant conceptual relations and the teacher´s Concept Map – which is often a "map" commonly used by members of that discipline. With such information in hand, the teacher can go on to assess changes and growth in the students´ conceptual understandings from instruction. The Concept Map allows them to scrutinize their conceptual networks, compare their maps with those of peers and experts, and make explicit changes.

Concept Maps provide insights into the connections students are making among theories and concepts. At the same time, Concept Maps can be used to assess the connections students make between theories or concepts and information. Before beginning instruction on a given concept or theory, teachers can use Concept Maps to discover what preconceptions and prior knowledge structures students bring to task. This information can help teacher make decisions about when and how to introduce a new topic – as well as discover misconceptions that may cause later difficulties. During and after a lesson, they can use Concept Maps to assess changes in the students´ conceptual representations.

Teacher selects the concept which is used as the stimulus or starting point for the Concept Map. It should be a concept that is both important to understanding the course and relatively rich in conceptual connections. Students brainstorm for a few minutes, writing down terms and short phrases closely related to the stimulus. Students draw a Concept Map based on brainstorming, placing the stimulus in the centre and drawing lines to other concepts. Students determine the ways in which the various concepts are related to each other and write those types of relations on the lines connecting the concepts. Teacher can serve own Concept Map as the master copy for comparison.

*Learning Tool*

Ask students to construct their own concept maps covering a section of the course material from class or the textbook. Most (if not all!) of them will probably never have seen a concept map before, and many have not developed the learning skills needed to construct them. As a result, the instructor will need time (either in class, or perhaps in the lab) to work with groups and individuals. The impact of student-created concept maps is so powerful that it is worth the investment of time!

## Step-by-Step Instructions

- Introduce a concept that is familiar to all students, such as "car", "chair" or "food."

- Have students write down 10 other concepts that they associate with this main concept (*i.e.* for food, "vegetables", "meat", "cereal", "milk", "steak", "carrots"...).
- Ask them to rank the 10 concepts from "most general and inclusive" to "least general and inclusive" or from "most important" to "least important"; this step will require several minutes.
- Tell students to write the "most general" or "most important" concept near the top of a large piece of paper (*e.g.*, posterboard or butcher paper are excellent, but regular notebook paper will suffice). Have them enclose this "superordinate concept" in a box or oval. Use pencils instead of pens! (Post-its® are excellent for this step.)
- Explain that you want them to connect concepts from their list, one pair at a time, with directional links; and most importantly, to label the linking lines (*e.g.*, Carrots → vitamin A (linking word is, "contain") OR meat →iron (linking words are, "is a good source of"). Continue this process until all concepts appear on the map.
- Give students plenty of time (20-30 minutes). Encourage them to include a lot of branching and many levels of hierarchy. Put special emphasis on cross-linking concepts in one area of the map with those in other areas. Suggest that they may add as many additional concepts as they wish to make their maps unique and personally meaningful. Remind them that the boxes or ovals should contain only one or two words. Emphasize that "neatness doesn't count" and that they may re-draw their maps as often as they wish.
- Circulate around the room as students construct their maps. Be supportive but not directive. Remind students that a concept map is an distinctive representation of their understanding, and that individual components on their maps may or may not be scientifically accurate, but there is a large set of ways to organize and represent what they know. Encourage creativity and stress that there are no one "correct" answer.
- Select several students to share their maps with the class. You may need to make a transparency to display the maps in large classes. Focus attention on appropriate connections between concepts. Remind students that concept maps may be a very helpful way to study; they can be used to condense many pages of textbook verbiage into a succinct summary of what the author presents.
- In the next class, introduce a central concept from your course (*e.g.*, "star", "cell", "energy", "matter") and ask your students to construct a concept map on this topic. Collect the maps and review them, but don't grade them. You may want to suggest ways the maps could be improved.
- Return the maps to the students and suggest that they rethink some of their ideas. We have used different colored pencils for each iteration so students may depict and emphasize how their ideas change over time. The same map may be used for several class periods, and students may be encouraged to add to, delete, reorganize or even begin anew whenever they need to do so.

**Variations**

*Collaborative Concept Mapping*

Sometimes the frustration levels can be very high when concept mapping is first introduced, especially in large classes of relative novices. To counter some of this anxiety and to encourage students to reflect on their own thinking, ask groups of 3 or 4 students to work together on a concept map. This exercise is often a very rewarding and rich learning experience as peers argue, debate, and cajole each other. The result is a genuine effort to negotiate the meaning of scientific concepts, attempting (as scientists do) to reach consensus, or to stake out different points of view. The power of the process resides in the interpersonal sharing of ideas, which are made explicit to the instructor.

*Fill-in Concept Mapping*

You construct a concept map and then remove **all** of the concept labels (keep the links!). You then ask the class to replace the labels in a way that makes structural sense. Best done with small classes; a good way to introduce a new topic.

*Select and Fill-in Concept Mapping*

You create a concept map and then remove concepts from the nodes (about one-third of them). These deleted concepts are placed in a numbered list on the map and students choose among them. Scoring can be as simple as "percent correct." Instructors of large classes may use multiple-choice type scanning sheets. The assumption of this technique is that as students' thinking approximates that of the instructor, the closer their connected knowledge is "expert-like." The key is to select nodes that are at different levels of the hierarchy and have nearby or antecedent links.

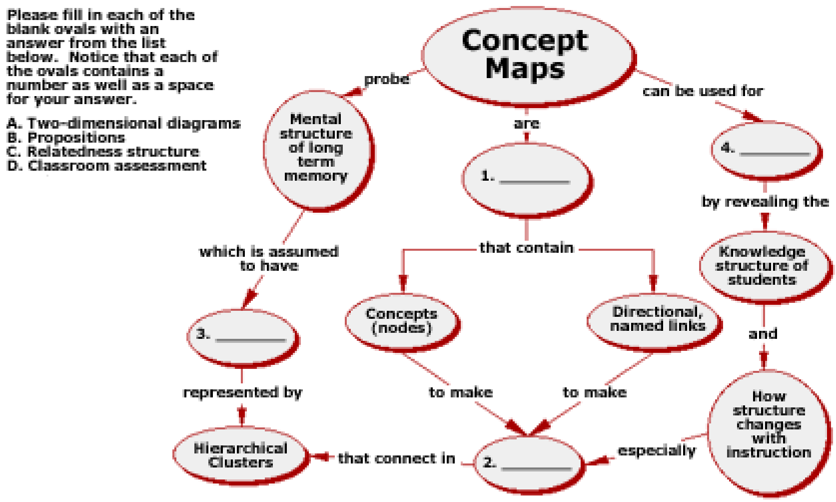



**Figure 3:** Select and Fill-in Concept Map on Concept Maps
[See Figure 1 for the "answers"]

*Selected Terms Concept Mapping*

You provide a list of concept labels (10 to 20) and ask students to construct their maps using only these labels. The focus here is on the linking relationships, and the evolution of structural complexity of students' knowledge frameworks.

*Seeded Terms Concept Mapping*

In this approach, also known as "micromapping" (Trowbridge and Wandersee, 1996), you furnish a small set of concept labels (5 to 10) and invite students to construct a concept map using these, and an equal number of labels drawn from their own knowledge of the topic.

*Guided Choice Concept Mapping*

Here you present a list of some 20 concept labels from which students select 10 to construct their maps. When done over a period of time, the instructor focuses on which concepts appear and which disappear. The assumption is that these changes represent significant restructuring of the students' knowledge frameworks.

**Pros and Cons**

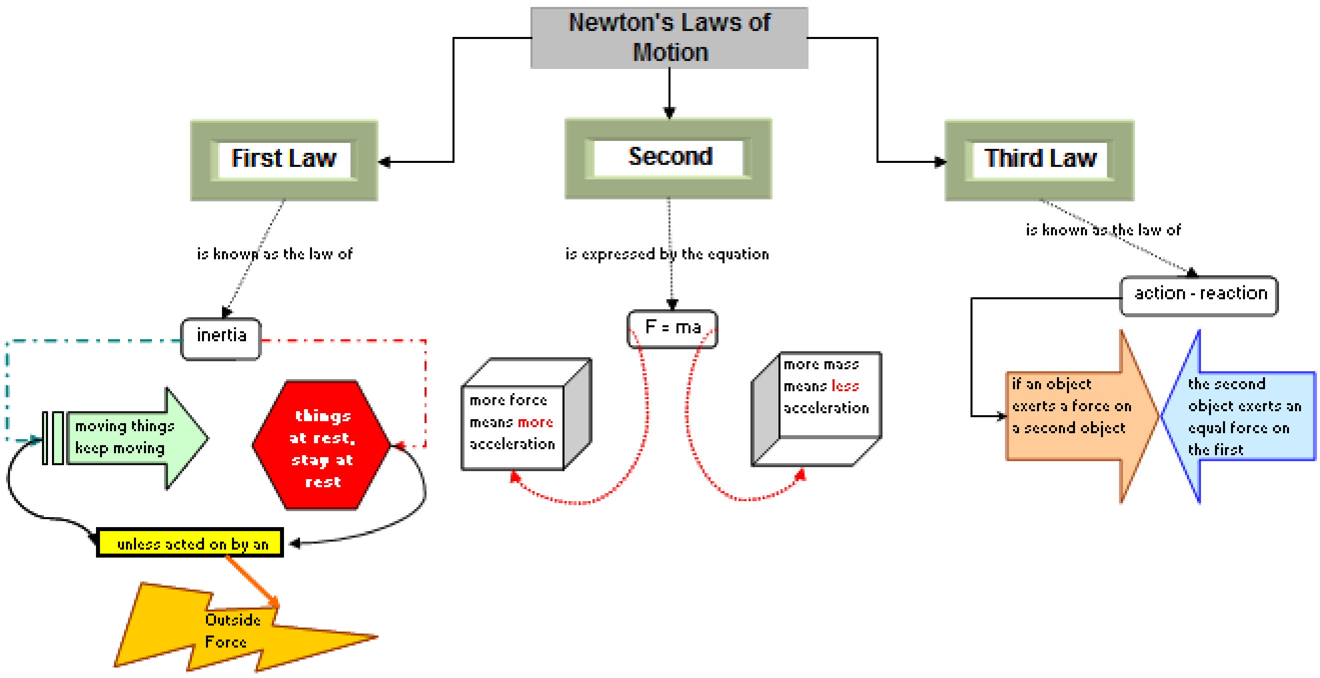
- Concept maps help students focus on the "big picture", enabling them to devote more of their time to conceptual understanding rather than rote learning
- Concept maps force students (and instructors!) to make valid connections among concepts
- They provide a low tech (cheap!) vehicle that enables students to represent graphically their knowledge, and to share it with the instructor and other students
- They shift the emphasis from inert, static knowledge to contextually-embedded knowledge; from isolated facts to theoretical frameworks of related concepts
- In addition to their role as assessment tools, concept maps offer a useful way to help students "learn how to learn"; they also serve as useful vehicles for course development and as graphic organizers before, during and after instruction

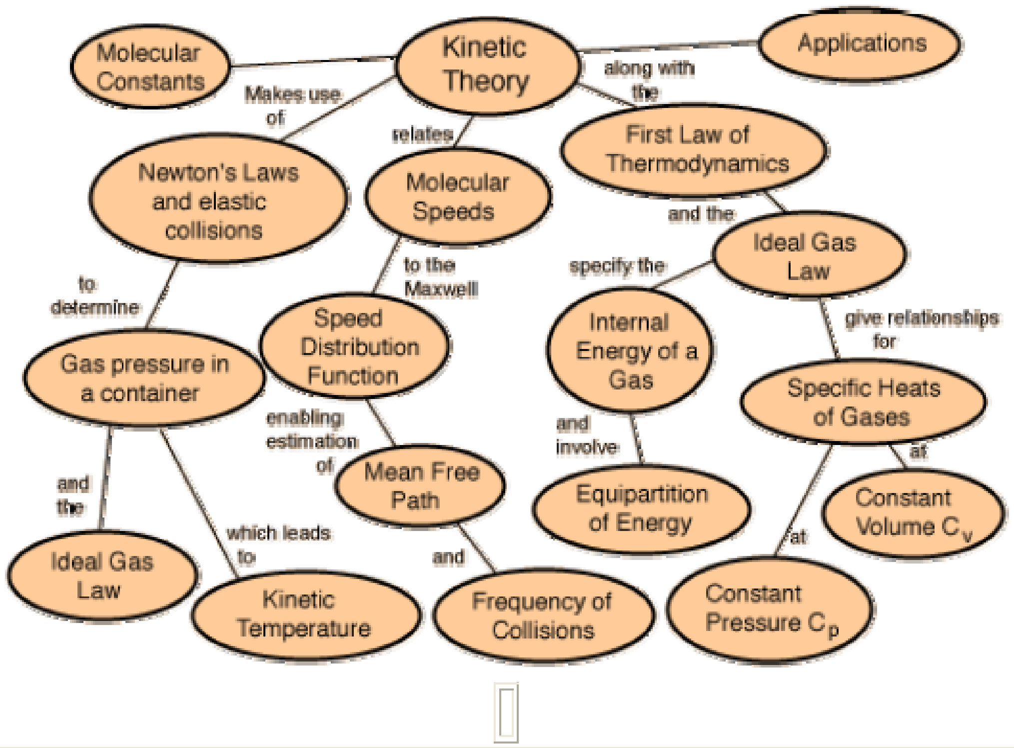
However:

- Comparisons among students are more difficult because concept maps tend to reveal the idiosyncratic way that students view a scientific explanation, as a result...
- Evaluation can become more time-consuming for the instructor, especially in large classes, unless some variation (such as Select & Fill-in) is adopted
- If you score maps, you must use a consistent (and tested) scheme
- Students who have developed a strong facility for rote learning of verbal knowledge sometimes find concept maps intimidating
- Constructing concept maps is a demanding cognitive task that requires training

*Example*

The teacher asked students to draw a Concept Map centered on Darwin´s theory of natural selection. The map was to connect Darwin´s theory with its predecessors, contemporaries, competitors, and descendants. Teacher urged the students to use their imaginations in representing the relationships but to stick to the facts in characterizing them.


Newton's Laws of Motion
First Law
Second
Third Law
is known as the law of
inertia
is expressed by the equation
F = ma
is known as the law of
action - reaction
moving things keep moving
things at rest, stay at rest
unless acted on by an
Outside Force
more force means more acceleration
more mass means less acceleration
if an object exerts a force on a second object
the second object exerts an equal force on the first


Molecular Constants
Kinetic Theory
Applications
Makes use of
along with the
relates
First Law of Thermodynamics
Newton's Laws and elastic collisions
Molecular Speeds
and the
Ideal Gas Law
specify the
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Internal Energy of a Gas
give relationships for
Gas pressure in a container
Speed Distribution Function
Specific Heats of Gases
enabling estimation of
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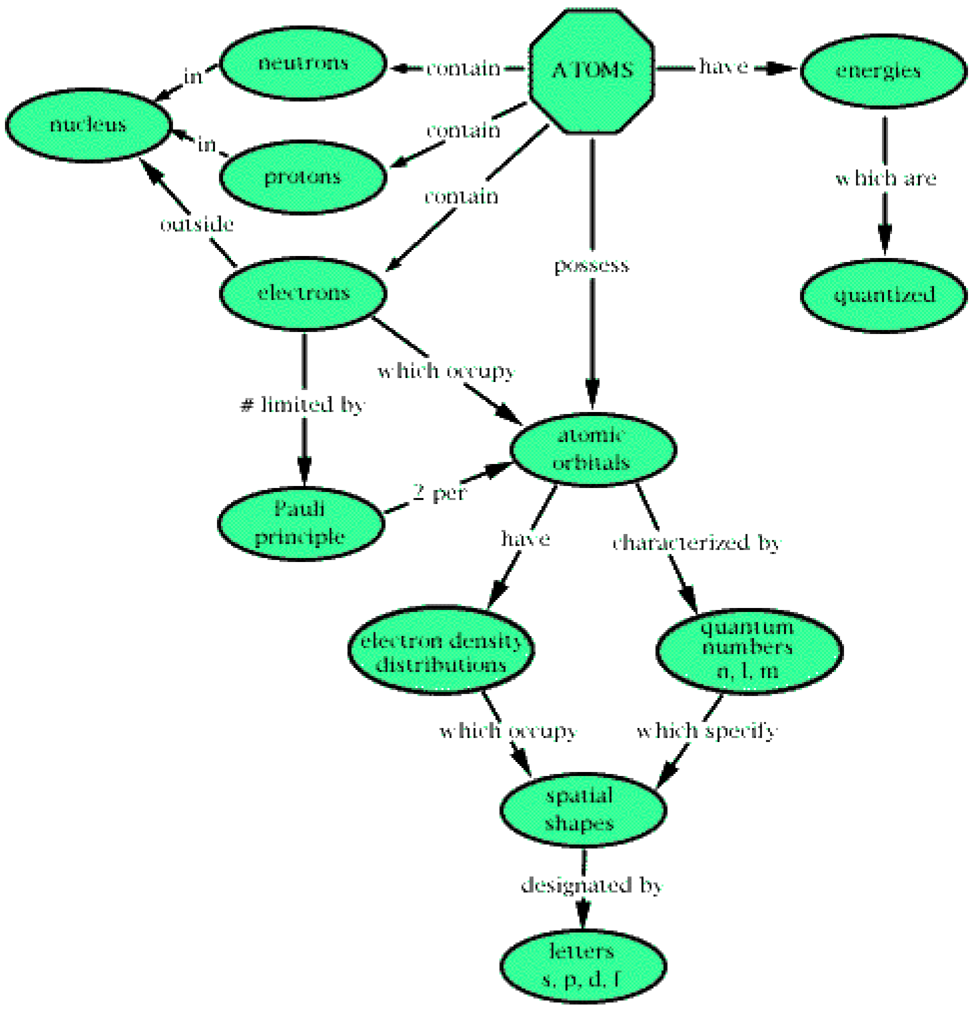
ATOMS
contain
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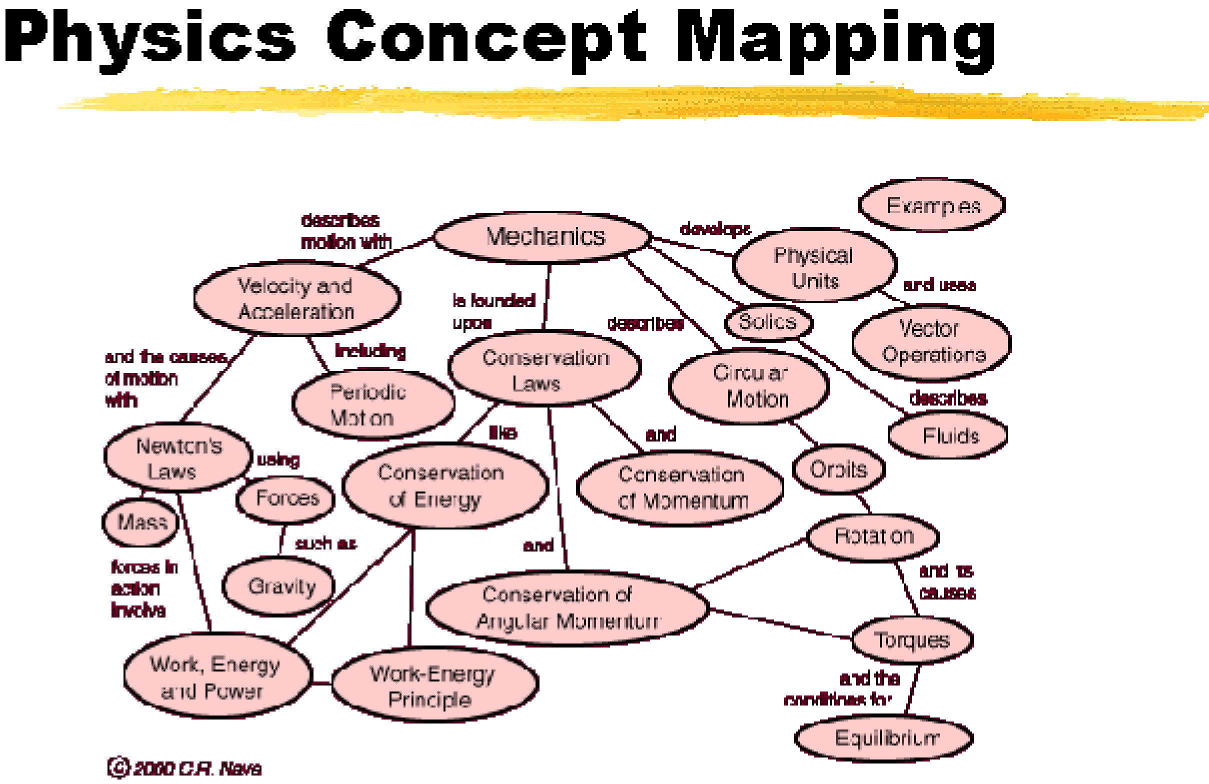
designated by
letters s, p, d, f




**Links**

- Mintzes, J.J web page: http://www.uncwil.edu/people/mintzes
- National Association for Research in Science Teaching (NARST). web page: www.narst.org
- The software package Inspiration aids in creating concept maps. It is easy to learn and use. http://www.inspiration.com
- University of Minesota Digital media Center. http://dmc.umn.edu
- Institute for Human and Machine Cognition (IHMC) CmapTools: http://cmap.ihmc.us

## Annotated Portfolios

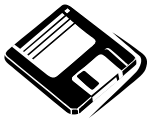
Assessment of portfolios is a common and well-accepted practice. Annotated Portfolios used for assessment contain a very limited number of examples of creative work, supplemented by the students´ own commentary on the significance of those examples.

Annotated Portfolios provide the teacher with a limited sample of students´ creative work, along with the students´ explanation of that work in relation to the content or goals. In this way, the technique allows teachers to assess students´ skill at making explicit connections between their creative work and the content. In other words, it helps teachers see how well students can apply what they have learned and how well they can explain those applications. Annotated Portfolios prompt students to show and tell their teachers - and themselves – how their creative and self-evaluative skills are developing.

Annotated Portfolios allows students to express their conceptions of problems or topics. It requires students not only to select work samples that are personally meaningful but also to interpret the meaning of those sample for others. This technique allows students to choose the work on which they will be assessed, the teacher gains insights into what they value and appreciate. In some fields, this technique also helps students prepare to present their work to prospective employers.

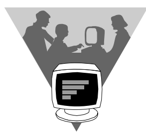
*Example*

The physics teacher required students to make Annotated Portfolios of materials they had created during school year. Specifically, each student put together a folder containing materials from the lessons (projects, labs, tests, reports, presentations, solved problems,…) along with an explanation of the principles applied in these materials.



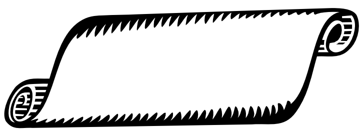
**Tasks (assignments)**

1. Which techniques for assessing knowledge and skills of students will suit to you the best and why?
2. Try to apply one of the techniques for assessing knowledge and skills on real situation in the classroom.
3. Apply one chosen techniques for assessing knowledge and skills on a specific topic with the regards to scientific content.



**Case study**

The science teacher made a decision to assess students on the basis the portfolio. Students put to portfolio different materials: labs, problem solving tasks, presentations, reading, tests, and so on. It was not easy to assess these portfolios. He could not mark students.



**Questions to Case Study**

1. Which mistakes teacher made in the use of portfolio for students´ assessment?
2. Is it possible to use only portfolio for students´ marking in sciences?

## Summary

Assessment techniques presented in this chapter provide information on skills and competencies identified in the latest development in cognitive assessment, but the techniques are familiar and useful to the average science teacher.

## Frequently Asked Questions

How I can make right choice of the techniques for assessing knowledge and skills? How many techniques for assessing knowledge and skills I should be able to use?

*Answer the question above*
The right choice of the techniques for assessing knowledge and skills depends on the science content, goals, and abilities of students. Teachers should manage the highest number of strategies.

## Next Reading

Mintzes,J.J., Wanderee, J.H., Novak,J.D. (Ed) *Assessing Science Understanding. A Human Constructivist View.* San Diego: Academic Press, 2000. ISBN 0-12-498365-0.

## References

Angelo T.A., Cross, K.P. *Classroom Assessment Techniques.* San Francisco: Jossey-Bass Publisher, 1993. Second Edition. ISBN 1-55542-500-3.

Mintzes, J.J., Wandersee,J.H. & Novak, J.D. (1998). Teaching science for understanding: A human constructivist view. San Diego, CA: Academic Press.

# Unit 5

# Techniques for Assessing Learner Attitudes, Values and self-awareness

**Objectives:**

- To understand constructivist approach of assessing learner attitudes, values and self-awareness;
- To develop an openness to new ideas;
- To help prospective teachers better understand and promote the development of students´ attitudes and values;
- To develop constructivist manner of teaching;
- To develop respect for others.

**Assessing Students´ Awareness of Their Attitudes and Values**

In constructivist classroom students need to be actively involved in their own learning. This constructivist approach includes four types of knowledge and some techniques and strategies for monitoring understanding. The types of knowledge are: (1) self-knowledge, including an understanding of one´s own learning preferences, abilities, and constructivist style; (2) knowledge of the learning tasks; (3) knowledge and prior understanding and (4) knowledge and understanding of useful constructivist strategies.

**Classroom Opinion Polls**

Students often have pre-existing opinions about the material that they will encounter in the lessons, and those opinions – when they are unsupported by evidence – can distort or block the instructional message. By uncovering student opinions on specific issues , teacher can better gauge where and how to begin teaching about those issues – and what the roadblocks are likely to be. Teachers can use this technique to prepare students to discuss a controversial issue or to assess their opinions after they have studied the material. Polling can also be used as a pre- and post-assessment device, to determine whether and how students´ opinions have changed in response to class discussions and assignments.

*Example*

Teacher previews the material that should be teach, looking for questions or issues about which students may have opinions that could affect their learning. Teacher chooses one or two issues. Teacher explains the exercise to students and gives them a couple minutes to respond. The teacher used the following statements to assess students´ views on nuclear energy:

If you found a great house at a great price, close to work and schools, that was within five kilometrs of a nuclear power plant, I would (circle only one):

a. Be absolutely willing to consider buying it, and not worried about the plant;
b. Be somewhat willing to consider buying it, but concerned about the plant;

c. Be very sceptical about buying it, and worried about the plant;
d. Be absolutely unwilling to consider it because of the plant.

**Self-Confidence Surveys**

In many instances, individuals who are generally self-confident may lack confidence in their abilities or skills in specific context – for example, in their skills or ability to speak in public. When teachers know the students´ level of confidence, and what affects that confidence, they can more effectively structure assignments that will build confidence.

*Example*

Teacher focuses on skills or abilities that are important to success in science. Teacher makes up questions to assess students´ self-confidence in relation to these skills or abilities. Teacher creates a simple survey form for gathering the data. Survey response are to be anonymous. Class is break into small groups. Students discuss and compare their responses.

This survey is to help both of us understand your level of confidence in your science skills. Circle the most accurate response for each.

| Kinds of Problem | Rate | Rate | Rate | Rate |
|---|---|---|---|---|
| Understanding of electric charge | None | Low | Medium | High |
| Understanding of electric current | None | Low | Medium | High |
| Using Ohm´s Law in problem solving | None | Low | Medium | High |
| To create electrical circuits | None | Low | Medium | High |
| Comparing electric circuits | None | Low | Medium | High |
| Using electrical power and energy in society | None | Low | Medium | High |

**Interest/Knowledge/Skills Checklists**

Interest/Knowledge/Skills Checklists are brief, teacher-made versions of the commercial interest and skills inventories. Teachers create checklists of topics covered in science course. Students rate their interest in the various topics, and assess their levels of skill or knowledge in this topics. Teacher lets students know why he/she asking them to assess their interests, skills, knowledge. Students need to know that their answers may have an influence on the teaching.

*Example*

Please, circle the letter after each item below that best represents your level of skill or knowledge in relation to that topic. The letters stand for the following responses:

N No skills, no knowledge
B Basic skills and knowledge
F Functionally adequate skills and knowledge
A Advanced level of skills and knowledge

| | | | | |
|---|---|---|---|---|
| Energy and work | N | B | F | A |
| Swinging energy | N | B | F | A |
| Designing own experiment | N | B | F | A |
| Temperature and heat | N | B | F | A |
| Thermal Pollution | N | B | F | A |
| Measuring thermal energy | N | B | F | A |
| Using thermal energy on the move | N | B | F | A |
| Creating convection currents | N | B | F | A |
| Using heat to do work | N | B | F | A |

**Self-Assessment**

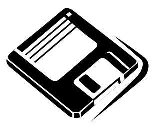
Self-assessment prompts students to describe their general approaches to learning and understanding. Teacher develops two or three questions that will assess students´ students abilities. Students can discuss in groups their answers.

*Example*

1. In the topic Waves, Light, and Sound list the terms which were the easier for your understanding.

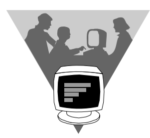
2. In the topic Waves, Light, and Sound list the terms which were the most difficult for your understanding.

3. In the topic Waves, Light, and Sound list the experiments you can use.



**Tasks (assignments)**

1. Which technique for assessing learner attitudes and values seems for you to be the most useful in your teaching?
2. Try to choose one of the presented technique and suggest some questions related to the topic you are going to teach in the class.
3. Design small project for assessing students´ attitudes and values.
4. Discuss your project in your working group.



**Case study**

Student teacher during teaching practice in school applied technique Knowledge/Skills Checklists mentioned above in the class. He/she found that students mostly do not understand terms energy and work, and temperature and heat. He/she tried to explain these concepts again but the results were not better. He/she used the same questions in the checklist.

**Questions to Case Study**

1. Do you think that student teacher used the relevant technique?
2. Do you think that he/she  the right questions?
3. Can you suggest another questions?

**Summary**

In constructivist classroom students need to be actively involved in their own learning. This constructivist approach includes some techniques and strategies for monitoring understanding.

**Frequently Asked Questions**

Can my students accurately assess their understanding of  science concepts? Is important for my teaching to know how deeply they understand these concepts?

*Answer the questions above*
Students are able to assess their understanding of the science concepts. Constructivist teacher should know how students understand these concepts. On the basis of this knowledge he/she can choose teaching methods, problems to be solved or experiments to be done.

**Next Reading**

Mintzes,J.J., Wanderee, J.H., Novak,J.D. (Ed) *Assessing Science Understanding. A Human Constructivist View.* San Diego: Academic Press, 2000. ISBN 0-12-498365-0.

**References**

Angelo T.A., Cross, K.P.  *Classroom Assessment Techniques.* San Francisco: Jossey-Bass Publisher, 1993. Second Edition. ISBN 1-55542-500-3.

# Unit 6

## Assessing Learner Reactions to Instructions

**Objectives:**

- To cultivate a sense of responsibility for science teacher students to constructivist assessment;
- To develop management skills of prospective teachers;
- To develop skills using materials, tools and technology;
- To learn to evaluate methods and materials in science assessment;
- To develop the skill in using different techniques.

### Techniques for Assessing Learner Reactions to Instructions

Much of the controversy over student evaluations of teaching concerns their use in making promotion and tenure decision – an issue that will not be addressed here, since our interest is in helping teachers design, collect, and use student reactions to improve their own teaching. Students are in a good position to evaluate the impact of the teaching on their own learning. But are the reactions of students reliable, valid, and useful for the purpose of improving teaching, course materials, assignments and activities, and – consequently – useful for improving learning?

The questions of the validity of student judgements is more difficult and controversial. Here the questions is: “Are students really good judges of effective teaching?” The answer is probably that students are the best evaluators a teacher can get on some matters and not very credible judges on others. Teachers usually find some characteristics that are ranked high: concern for students, knowledge of subject matter, stimulation of interest, availability, encouragement of discussion, ability to explain clearly, enthusiasm, and preparation. We belive that it is possible to effect significant improvement in teaching through obtaining feedback from students.

### Electronic Mail Feedback

The teacher poses a question to the class, via electronic mail about his or her teaching, and invites student responses. Students respond to the E-mail question wit a personal, though anonymous, message sent to the teacher´s electronic mailbox. Teacher writes one or two questions in which he/she asks for students´ reactions to some aspect of teaching. E-mail message is sent to all students with clear instructions on the lenght and type of response he/she is seeking and the deadline for responding.

*Example*

The science teacher sent the following question: “What is one specific, small change I could make that would help you learn more effectively in the topic Exploring Motion and Forces?

Next day after deadline teacher read e-mails, analyzed the feedback, and wrote an e-mail response to the class, letting them know which suggestions he/she would act on, which he/she would not, and why.

**Group Instructional Feedback Technique**

This technique has many names and many variations, but they all centre on getting student responses to three questions related to their learning in the class. However they are worded, these three questions basically ask, “What works? What does not? What can be done to improve it?”

*Example*

The veteran physics teacher agreed to try this technique after he had convinced his colleague from chemistry to act as the “visiting assessor”. These were the prompts they agreed on:

1. Give one or two examples of specific things your teacher does that really help you learn molecular physics.
2. Give one or two examples of specific things your teacher does that make it more difficult for you to learn molecular physics.
3. Suggest one or two specific, practical changes your teacher could make that would help you improve your learning in the class.

The physics teacher told the students what was going to happen and asked them to cooperate. He assured them that their responses would remain anonymous, and he urged them to give honest, thoughtful feedback. Twenty minutes before the end of the next lesson, the chemistry teacher arrived, and the physics teacher introduced him and left. The “visiting assessor” quicly explained what he was doing and why, and how the process would work. He asked students to take about five minutes to write answers to all three questions on cards and then to take five minutes to discuss their answers in a small group. He then asked the groups to share only those responses that they heard from several members. He quickly listed common responses to the first two questions and then asked the students to indicate whether they agreed with each response by raising their hands. The chemistry teacher simply estimated the percentages of students raising their hands each time and wrote that rough estimate on the board. In this way, the whole class saw how much agreement there was on a few common “helpful” and “not helpful” points. The chemistry teacher summarized this information and shared it with the physics teacher.

**Group-Work Evaluations**

Group-Work Evaluations forms are simple questionnaires used to collect feedback on students´ reactions to cooperative learning in constructivist classroom. Group-Work Evaluations can help students and teachers see what is going well in learning groups, so that potentially destructive conflicts in groups can be discovered and defused. Group-Work Evaluations are most helpful in lessons where students regularly work in small groups.

*Example*

Science teacher decides what she wants to know about the group work and composes a few questions to get this information. The teacher used the the groups to solve problem.  In the end of lesson students got the simple evaluation form:

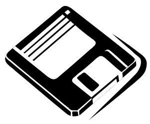
1. Overall, how effectively did your group work together on this problem?
   Poorly   Adequately   Well   Extremely well

2. Out of the five group members, how many participate actively most of the time?
   None   One   Two   Three   Four   All five

3. Give one specific example of something you learned from the group that you probably would not have learned working alone.

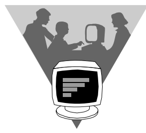
4. Give one specific example of something the other group members learned from you that they probably would not have learned otherwise.

5. Suggest one change the group could make to improve its performance.



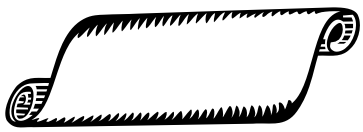
**Tasks (assignments)**

1. Can be your students good evaluators  of your teaching?  Why?
2. Try to design evaluation sheet for students to evaluate science teacher.
3. Which techniques suits to you the best and why?



**Case study**

Students of grammar school (17 y old) got e-mail from science teacher which in she asked students to write a few brief sentences in answer to the following question: “If you were the teacher of this class, what would you do to make physics lab assignments more useful?” She was surprised that only a few students (5 from 30) send to her replay in two next days. Quality of their answers was very low. She was very unhappy with the result of this approach of students.



**Questions to Case Study**

1. Did science teacher make any mistake in the application of the technique?
2. Try to suggest a little bit better application and modify her question.

**Summary**

Much of the controversy over student evaluations of teaching exists. Students are in a good position to evaluate the impact of the teaching on their own learning. But are the reactions of students reliable, valid, and useful for the purpose of improving teaching, course materials, assignments and activities, and – consequently – useful for improving learning? The questions of the validity of student judgements is more difficult and controversial. Here the questions is: "Are students really good judges of effective teaching?" The answer is probably that students are the best evaluators a teacher can get on some matters and not very credible judges on others. We believe that it is possible to effect significant improvement in teaching through obtaining feedback from students.

**Frequently Asked Questions**

Shall I apply any technique assessing student reactions on my science instruction?

*Answer the question above*
Yes, it is very useful tool for evaluation of your teaching. You can get important feedback from your students.

**Next Reading**

Mintzes,J.J., Wanderee, J.H., Novak,J.D. (Ed) *Assessing Science Understanding. A Human Constructivist View.* San Diego: Academic Press, 2000. ISBN 0-12-498365-0.

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