

# **SEISMO-LAB**

**Template for the Development of a Technology-  
Enhanced Educational Scenario Template**

**The 5E Instructional Model  
(Constructivist Model)**

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# 1 Development of an Educational Scenario Template

## 1.1 Description of the Educational Scenario Template in Narrative Format

Describing an Educational Scenario Template	
<b>1. Title of the Educational Scenario Template</b>	The 5E Instructional Model
<b>2. Educational Problem</b>	<p>Main problems:</p> <ul style="list-style-type: none"> <li>a) lack of students engagement</li> <li>b) theoretical and abstract teaching</li> <li>c) textbook based instruction</li> <li>d) no demonstration infrastructure available</li> <li>e) students misconceptions</li> <li>f) lack of embedded assessment methods</li> </ul>
<b>3. Educational Scenario Template Objectives</b>	<p><b>Knowledge</b> The students should be able to know and understand specific concepts and the analogies between them.</p> <p><b>Skills</b> The students should be able to:</p> <ul style="list-style-type: none"> <li>• Explore the research procedures themselves</li> <li>• Perform research efforts that are taking place as a structured discovery within the frame of organised teaching</li> <li>• Generalize or transfer ideas to other examples used as illustrations of the central concept</li> <li>• Apply previous knowledge</li> </ul> <p><b>Attitudes</b> The learners should be able to:</p> <ul style="list-style-type: none"> <li>• Acquire an appreciation for basic Science Education matters through the exposure in similar topics</li> <li>• Develop interests, and initiate and maintain a curiosity toward the materials</li> </ul>
<b>4. Characteristics and Needs of Learners</b>	<p><b>Cognitive</b> The students have less than average knowledge level to mathematics and geometry. Limited knowledge of science subjects.</p> <p><b>Psychosocial</b> Based on statistics less than 50% of the students have a significant interest in science</p>

Describing an Educational Scenario Template	
	<p>(both boys and girls). A small number of them (about 15%) will follow careers in science (Sjøberg &amp; Schreiner 2005; PISA, 2006).</p> <p><b>Physiological</b> The average age of students is 15 years.</p> <p><b>Needs</b> Learners need more participatory schemes of instruction. Learners have to be involved in the process and act as members of a team.</p>
<p><b>5. Educational Approach of the Educational Scenario Template</b></p> <p>(a) Description of the Educational Approach rationale (b) Parameters that guarantee the implementation of the Educational Approach</p>	<p>(a) The 5E instructional model (Bybee 1997, BSCS 2006, Bybee et al., 2008) is a general instructional model that incorporates many elements of other models. An important instructional aspect of the 5E model is that students must be dissatisfied with the current conception, and the new conception must be intelligible, plausible, and fruitful.</p> <p>A science teacher introduces a new concept, and students are unable to reconcile the new concept with current knowledge and experience. The teacher then provides experiences and information that helps students make sense of the new conception. As students consider and try to incorporate the new conception, they must see that a world in which the conception is true is generally reconcilable with their worldview. Finally, students must see that there are instances where there is good reason to supply the new conception—namely, it works and it helps explain things.</p> <p>The following are general strategies based on the constructivist view of learning:</p> <ul style="list-style-type: none"> <li>• Recognize students' current conceptions of objects, events, or phenomena.</li> <li>• Present situations slightly beyond the students' current conceptual understanding. One could also present the student with problems, situation conflicts, paradoxes, and puzzles.</li> <li>• Choose problems and situations that are challenging but achievable.</li> <li>• Have students present their explanations (concepts) to other students.</li> <li>• When students are struggling with inadequate explanations (misconceptions), first help them by accepting their explanations; second, by suggesting other explanations of the same phenomena or activities designed to provide insights; and third, by allowing them time to reconstruct</li> </ul>

**Describing an Educational Scenario Template**

	<p>their explanations.</p> <p>Students redefine, reorganize, elaborate, and change their initial concepts through interactions among the environment, classroom activities and experiences, and other individuals. Individual learners interpret objects and phenomena and internalize the interpretation in terms of their current concepts similar to the experiences being presented or encountered. In other words, changing and improving conceptions often require challenging the current conceptions and showing them to be inadequate.</p> <p>From a science teacher's point of view, the instructional and psychological problem is to avoid leaving students with an overall sense of inadequacy. If a current conception is challenged, there must be opportunity, in the form of time and experiences, to reconstruct a more adequate conception than the original. In short, the students' construction of knowledge can be assisted by using sequences of lessons designed to challenge current concepts and provide opportunities for reconstruction to occur.</p> <p>The 5E instructional model has five phases: Engagement, Exploration, Explanation, Elaboration, and Evaluation. Each phase has a specific function and is intended to contribute to the learning process.</p> <p>(b) Regardless of the specific instructional model, helping students to develop more adequate scientific concepts is an important goal of science teaching. It is also a difficult task. An assumption of the 5E model is that using sequences of lessons designed to facilitate the process described above will assist in students' construction of knowledge. Another assumption is that concrete experiences and computer-assisted activities will assist in the process of constructing knowledge.</p>
<b>6. Learning Activities:</b>	
Phase 1: Engagement	<p><b>Minds-on, Hands-on Experience</b></p> <p>Teacher engages students in the learning task. Students, mentally focus on a problem, situation, or event while the teacher helps them to make connections between past and present learning experiences.</p>

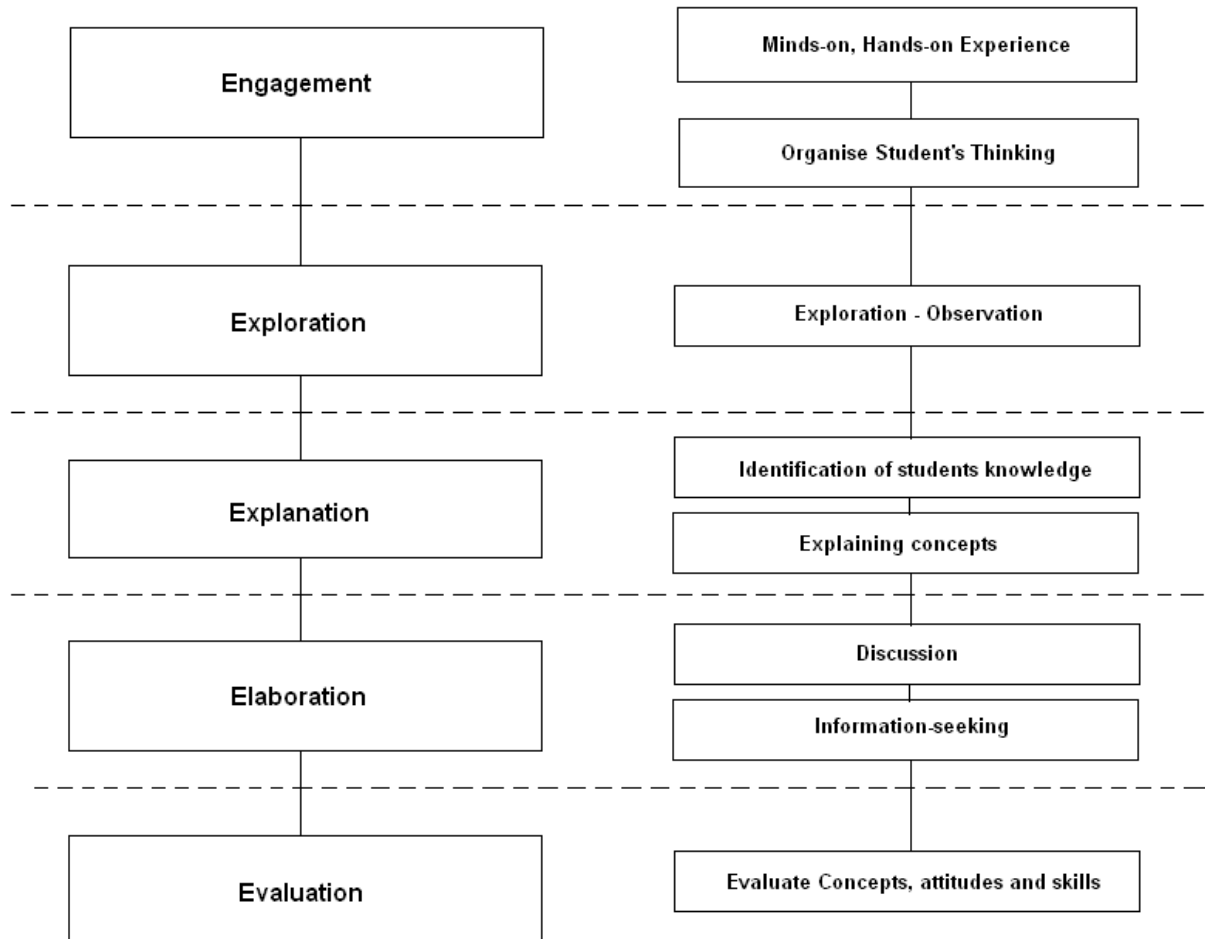
<b>Describing an Educational Scenario Template</b>	
	<p><b>Organise Student's Thinking</b> The teacher organizes students' thinking toward the learning outcomes of current activities. These activities make connections to past and future activities.</p>
Phase 2: Exploration	<p><b>Exploration – Observation</b> Students have time in which they explore objects, phenomenon, events, or situations. As a result of their mental and physical involvement in the exploration activity, students establish relationships, observe patterns, identify variables, and question events.</p>
Phase 3: Explanation	<p><b>Identification of students knowledge</b> The teacher directs student attention to specific aspects of the engagement and exploration experiences. Students are asked to give their explanations. The teacher based on students' explanations clearly connects the explanations to experiences in the engagement and exploration phases.</p> <p><b>Explaining concepts</b> The teacher introduces scientific or technological explanations in a direct and formal manner. He/she presents scientific concepts, processes, or skills in a simple, clear, and direct manner, and move on to the next phase.</p>
Phase 4: Elaboration	<p><b>Discussion</b> Students discuss in order to express their understanding of the subject and receive feedback from others and the teacher.</p> <p><b>Information seeking</b> This discussion results in better definition of the task as well as the identification and gathering of information that is necessary for successful completion of the task.</p>
Phase 5: Evaluation	<p><b>Evaluate concepts, attitudes and skills</b> Students assess their understandings and abilities while teachers evaluate student progress toward achieving the educational objectives.</p>
<b>7. Participating Roles:</b>	<p><b>Students</b></p> <ul style="list-style-type: none"> <li>• Establish an interest in, and develop an approach to, the learning task.</li> <li>• Complete activities directed toward learning outcomes.</li> <li>• Describe their understanding, use their skills, and express their attitudes.</li> <li>• Present and defend their explanations and identify and complete several experiences related to the learning task.</li> <li>• Examine the adequacy of their explanations, behaviours, and attitudes in</li> </ul>

Describing an Educational Scenario Template	
	<p>new situations.</p> <p><b>Teacher</b></p> <ul style="list-style-type: none"> <li>• Identifies the learning task.</li> <li>• Facilitate and monitor interaction between students and instructional situations, materials, and/or courseware.</li> <li>• Direct students learning by clarifying misconceptions, providing vocabulary for concepts, giving examples of skills, modifying behaviours, and suggesting further learning experiences.</li> <li>• Provide an occasion for students to cooperate on activities, discuss their current understanding, and demonstrate their skills.</li> <li>• Use a variety of formal and informal procedures for assessing student understanding.</li> </ul>
<b>8. Tools, Services and Resources</b>	<p><b>Tools:</b></p> <p><b>Hardware</b></p> <ul style="list-style-type: none"> <li>• Computer</li> <li>• Projector</li> </ul> <p><b>Software</b></p> <ul style="list-style-type: none"> <li>• Text, image, audio or video viewer</li> <li>• Database</li> <li>• VLE</li> </ul> <p><b>Resources:</b></p> <p>Problem statement, figure, graph, slide, simulation, experiment, table, self assessment, exercise, questionnaire, exam</p>

**Table 1: Description of the Educational Scenario Template**

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## 1.2 Graphical Representation of the Flow of Learning Activities



**Figure 1: Flow of Learning Activities for the 5E Instructional Model**



## 1.3 Description of the Educational Scenario Template in Common Terms

### 1.3.1 Engagement

Phase 1 Engagement	Type	Technique	Interaction	Roles	Tools/Services	Resources
Minds-On, Hands-On Experience	Experiential Investigating	Experiential Experiment	Who Class Based Medium Face to Face Timing Synchronous	Facilitator, Individual Learner	Hardware Computer, Projector Software Text, image, audio or video viewer, VLE	other
Organise Student's Thinking	Information Handling Gathering	Information Handling Brainstorming	Who Class Based Medium Face to Face Timing Synchronous	Facilitator, Individual Learner	Hardware Computer, Projector Software Text, image, audio or video viewer	other

**Table 2: Engagement**

### 1.3.2 Exploration

Phase 2	Type	Technique	Interaction	Roles	Tools/Services	Resources
Exploration						
Exploration - Observation	Experiential Exploring	Experiential Practicing	Who Class Based Medium Face to Face Timing Synchronous	Facilitator, Individual Learner	Hardware Computer, Projector Software Text, image, audio or video viewer, VLE	other

**Table 3: Exploration**

### 1.3.3 Explanation

Phase 3 Explanation	Type	Technique	Interaction	Roles	Tools/Services	Resources
Identification of students knowledge	Communicative Critiquing	Communicative Structured Debate	Who Class Based Medium Face to Face Timing Synchronous	Facilitator, Individual Learner	Hardware Computer Software Database, VLE	other
Explaining Concepts	Communicative Presenting	Communicative Arguing	Who Class Based Medium Face to Face Timing Synchronous	Presenter, Individual Learner	Hardware Computer Software Database, VLE	other

**Table 4: Explanation**

### 1.3.4 Elaboration

Phase 4 Elaboration	Type	Technique	Interaction	Roles	Tools/Services	Resources
Discussion	Communicative Discussing	Communicative Structured Debate	Who Class Based Medium Face to Face Timing Synchronous	Facilitator, Individual Learner	Hardware Computer Software Text, Image, Audio or Video Viewer, VLE	other
Information Seeking	Communicative Presenting	Communicative Arguing	Who Group Based Medium Online Timing Synchronous	Facilitator, Group participant	Hardware Computer Software Text, Image, Audio or Video Viewer, VLE	other

**Table 5: Elaboration**

### 1.3.5 Evaluation

Phase 5 Evaluation	Type	Technique	Interaction	Roles	Tools/Services	Resources
Evaluate Concepts, Attitudes and Skills	Information Handling Analysing	Communicative Structured debate	Who Class Based Medium Face to Face Timing Synchronous	Facilitator, Individual Learner	Hardware Computer Software Text, Image, Audio or Video Viewer, VLE	other

**Table 6: Evaluation**

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## 2 References

BSCS (Biological Sciences Curriculum Study) (2006). The 5E instructional model: Origins and effectiveness. Colorado Springs, CO.

Bybee R.W., Powell J.C., & Trowbridge L.W., (2008). *Teaching Secondary School Science: Strategies for Developing Scientific Literacy* (9th Edition). ISBN-13: 978-0-13-230450-4

Bybee R.W., (1997). *Achieving Scientific Literacy: From Purposes to practices*. Portsmouth, NH: Heinemann.

PISA (2006). *Science Competencies for Tomorrow's World, Volume 1: Analysis*, ISBN: 9789264040007

Sjøberg, S. & Schreiner, C. (2005). How do learners in different cultures relate to science and technology? Results and perspectives from the project ROSE. *Asia Pacific Forum on Science Learning and Teaching*, 6, 1-16.

### 3 Annex

The vocabulary used for the Learning Activities description in common terms, is explained in the following table:

Annex		
Dimension	Type and Value	Description
<i>Type</i>	Experiential: Investigating	The student mentally focuses on a problem, situation, or event.
	Information Handling: Gathering	Gathering data for solving a problem
	Experiential: Exploring	Students give priority to evidence, which allows them to develop explanations that address scientifically oriented questions.
	Communicative: Critiquing	Critique on a specific subject
	Communicative: Discussing	Discussion among the participating roles
	Communicative: Presenting	Presentation of a specific subject/issue/concept
	Information Handling: Analysing	Analysing a concept or a problem
<i>Technique</i>	Experiential: Experiment	Designing, Setting up and Performing experiments
	Information Handling: Brainstorming	Open discussion on a specific issue.
	Experiential: Practicing	Hands-on activities, measurements.
	Communicative: Structured Debate	A structured debate based on evidence from observations
	Communicative: Arguing	A verbal dispute
<i>Interaction</i>	Who: Class based	In the context of the classroom
	Who: Group based	In the context of the groups
	Medium: Face to Face	Face to face interaction of the participating role with others or content
	Medium: Online	Interaction via the use of Internet
	Timing: Synchronous	Synchronous interaction of the participating role with content
<i>Roles</i>	Individual Learner	The individual learner
	Group participant	A student participating in a group of students
	Facilitator	The teacher in a role of facilitator of the learning process

Annex		
	Presenter	The teacher presents the outcomes of a discussion/debate
<i>Tools/ Services</i>	Hardware: Computer	An electronic, digital device that stores and processes information
	Hardware: Projector	A hardware device that enables an image to be projected onto a flat surface
	Software: Text, image, audio or video viewer	A software tool for displaying text, images, audio or video
	Software: Database	Educational Digital Library (e.g. DSPACE Library)
	Software: VLE	Virtual environment which engage users in learning activities (e.g. COSMOS portal)
<i>Resources</i>	Problem Statement	Document for defining a problem
	Figure	A figure is any graphic, text, table or other representation that is unaligned from the main flow of text
	Graph	Pictorial representation of information
	Slide	Hypermedia document
	Simulation	An application that imitates a physical process or object by causing a computer to respond mathematically to data and changing conditions as though it were the process or object itself
	Experiment	An action or operation undertaken in order to discover something unknown, to test a hypothesis, or establish or illustrate some known truth
	Table	An arrangement of information in columns and lines
	Self assessment	An assessment or evaluation of oneself, one's actions or attitudes by oneself
	Exercise	Document for practicing a skill or understanding
	Questionnaire	A list of questions by which information is sought from a selected group
	Exam	Document for testing, the knowledge or ability of students
Other	It can be any of the following resources: Problem statement, figure, graph, slide, simulation, experiment, table, self assessment, exercise, questionnaire, exam	

**Table 7: Learning Activities Description**