

## Ascertaining What the Students Already Know

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**Abstract:** The work, presented in this paper, focuses on the ascertainment of the students' prior knowledge, which constitutes the first step of an integrated assessment framework. An experimental study was conducted for the application and the evaluation of this step in a real classroom environment. The experimental results are encouraging, indicating the effectiveness of the designed assessment activity to serve the ascertainment of what the students already know with respect to the assessment tools that were utilised and combined.

### Introduction

Assessment is a process of drawing inferences about what students know on the basis of evidence derived from observation of what they say, do or make in selected situations (Pellegrino et al., 2001). The assessment functions may vary, ranging from a need to identify the students' prior knowledge to a need to draw conclusions about their understanding of the subject matter. Ausubel (1978) mentioned, "The most important factor influencing learning is what the learner already knows. Ascertain this and teach him accordingly".

Considering the assessment as an integral and essential part of the instruction, we defined an integrated assessment framework, forming the basis for the development of a web-based adaptive assessment environment. The framework provides guidelines for the design of assessment activities, which may address various assessment functions and utilize alternative assessment tools. It comprises a three-step process consisting of (i) Ascertaining the Students' Prior Knowledge - Activating Knowledge, (ii) Promoting Knowledge Construction & Identifying Conceptual Changes - Constructing & Enriching Knowledge, and (iii) Assessing Knowledge Construction - Refining Knowledge. The environment aims to (i) support the assessment process in the context of the framework, (ii) support different forms of assessment in combination to each other such as self-, peer-, and co-assessment, and (iii) provide adaptive capabilities as far as the adaptation of the assessment process and the guidance of the students at the assessment process are concerned. The work presented in this paper, focuses on the ascertainment of the students' prior knowledge, describing an experimental study that was conducted for the application and the evaluation of the first step in a real classroom environment. The study addressed specific assessment functions utilizing specific assessment tools (i.e. free response questions, questions based on short cases and concept maps (Novak & Gowin, 1984)), aiming to give implications concerning the utilized assessment tools, and subsequently the implementation of the first step of the framework, in the context of the web-based assessment environment.

The paper is structured as follows. The next section gives a brief description of the assessment framework. In the following, the context of the experimental study is presented. The results concern the effectiveness of the designed activity to serve the ascertainment of the students' prior knowledge with respect to the assessment tools that were utilised. The paper ends with the concluding remarks and our future plans.

### An integrated Assessment Framework

Birenbaum (1996) mentioned that the development and the changes in the learning society have generated the so-called *assessment culture*, which emphasizes the integration of instruction and assessment, as an alternative to the *testing culture*. In this context, we defined an assessment framework to be used in the assessment process (Gouli et al., 2003). The three steps of the framework form a basis for the design of the assessment activities aiming to serve various assessment functions during the instruction process (Table 1). Although, there is an inherent ordering among the three steps, the ordering does not preclude cycles. Taking into account the incremental nature of the knowledge construction and according to the complexity of the taught content, several cycles through various combinations of the steps may be performed. Moreover, the steps may be applied independently or combined in different ways according to the assessment functions to be served.

<b>The Assessment Framework</b>		
1 <sup>st</sup> step	<b><i>Ascertaining the Students' Prior Knowledge</i></b> The assessment activity aims to enable the teachers to ...	<b><i>Activating Knowledge</i></b> The assessment activity aims to enable the students to ...
	(i) elicit the students' prior knowledge, (ii) introduce the students to the new concepts, (iii) identify the students' initial performance level (knowledge and skills) as far as the new concepts are concerned, and (iii) diagnose the students' unknown concepts, incomplete understanding, false beliefs and naïve renditions of the concepts under consideration.	activate their existing knowledge.
2 <sup>nd</sup> step	<b><i>Promoting Knowledge Construction &amp; Identifying Conceptual Changes</i></b> The assessment activity aims to enable the teachers to ...	<b><i>Constructing &amp; Enriching Knowledge</i></b> The assessment activity aims to enable the students to ...
	(i) promote the students' knowledge construction (provision of feedback, support of collaboration, support of exploratory learning, etc), (ii) monitor/assess the students' progressive changes during the instruction, and (iii) encourage the active involvement of the students in the knowledge construction process.	monitor how their learning progresses, and whether their knowledge is revised and/or enriched with and incorporates effectively new knowledge.
3 <sup>rd</sup> step	<b><i>Assessing Knowledge Construction</i></b> The assessment activity aims to enable the teachers to ...	<b><i>Refining Knowledge</i></b> The assessment activity aims to enable the students to ...
	(i) capture the growth in the students' overall conceptual understanding, and (ii) identify how students' knowledge has been constructed after the completion of the instruction.	(i) refine their knowledge (promotion of higher order cognitive skills such as critical thinking and reasoned judgment), and (ii) draw conclusions about the degree of achieving the expected learning outcomes.

**Table 1:** The three steps of the framework serving various assessment functions

The assessment functions under consideration are accomplished through assessment activities, which may include one or more assessment items addressing specific assessment objectives/learning outcomes. A variety of assessment tools may be employed to implement the assessment items such as (i) various types of questions like free-response questions, questions based on short cases, multiple choice questions, true/false questions, and (ii) concept maps. Each of these tools has specific characteristics and may serve various assessment objectives/learning outcomes and functions. The selection and the combination of the appropriate assessment tools depends on various factors such as the nature of the subject matter, the assessment objectives/ learning outcomes, and the context in which the assessment function is carried out.

As far as the ascertainment of the students' prior knowledge (the 1<sup>st</sup> step of the framework) is concerned, the accomplishment of the addressed assessment functions may contribute to the specification/ organization and promotion of the student-oriented instruction by taking into account the students' beliefs, and to the development of an appropriate scaffolding framework, which may guide/support the students in the development of effective mental models. The designed assessment activity may include assessment items like (i) true/false questions asking the students to identify the definition of a concept, (ii) free response questions asking the students to compare two concepts, (iii) a "partial recall framework" concept mapping task (Tsai et al., 2001) asking the students to fill the blanks concerning the relationships between two concepts, (iv) a "concept list" concept mapping task asking the students to construct a map by using an available list of concepts, (v) questions based on short cases asking the students to distinguish the important concepts from the unimportant ones, etc.

The assessment framework was applied and evaluated during the spring-semester of the academic year 2001-2002, in the context of the postgraduate course of "Distance Education and Learning", at the Department of Informatics & Telecommunications of the University of Athens (Gouli et al., 2003). All the students (a total of 51) participated in the three-step assessment process. During the course/study, the students attained a number of "traditional" lessons and the teaching process was supported by a web-based course-management system, offering several facilities such as access to the educational material, submission of the course assignments, management of the assessment tests (construction of tests and submission of answers), and participation in discussion forums. Also, the students had at their disposal all the necessary educational tools to perform the assessment activities (e.g. the Inspiration tool was used for the construction of the concept maps).

## Applying and Evaluating the “Ascertainment of the students’ prior knowledge”

For the application and the evaluation of the 1st step of the framework, we developed an assessment activity aiming to serve the aforementioned goals (Table 1). The assessment items, included in the activity, were implemented by utilizing as assessment tools (i) *the free response questions* aiming to activate the students’ prior knowledge and subsequently to identify the students’ unknown concepts and false beliefs by engaging them in the process of mentioning concepts, and/or defining relationships between given concepts, and/or comparing concepts, and/or reasoning their responses, (ii) *the questions based on short cases* aiming (a) to introduce two fundamental concepts - “Distance Education” and “Open Education” - of the subject matter through relevant texts, (b) to activate further the students’ prior knowledge by providing a scaffolding framework, especially in cases that their prior knowledge was partially or not at all retrieved in the context of the free response questions, and (c) to enable the students to reconsider their previous answers/beliefs given to the free response questions, and (iii) *the concept mapping tasks* aiming to identify the students’ beliefs (i.e. unknown concepts, incomplete understanding and false beliefs) concerning the concepts of the subject matter and their relationships, and to assess cognitive skills such as the students’ ability to analyse/synthesize concepts.

More specifically, the assessment activity included 20 assessment items utilizing the free response questions, and the questions based on short cases, as well as 6 assessment items utilizing concept mapping tasks (3 “partial recall framework” tasks, 2 “free-construction” tasks and 1 concept mapping task performed in two different ways (i.e. one group of students performed the “concept-list” task while the other group performed the “free construction”/“concept-list” task)). We believed that the combination of these assessment tools, supportive and supplementary to each other, could serve effectively the goals and the assessment objectives of the activity.

The experimental results, which are rather qualitative, concern the effectiveness of the assessment activity, designed on the basis of the 1st step of the framework, to serve the ascertainment of what the students already know with respect to the assessment tools that were utilised and combined. It has to be mentioned that the context of the assessment activity proved to be effective as far as the activation of the students’ existing knowledge is concerned, enabling the investigation of the addressed assessment objectives.

Results concerning the Ascertainment of the Students’ Prior Knowledge. Analysing the students’ responses on the assessment items, we identified (a) *the unknown concepts*, by observing missing concepts on their answers to the free response questions and on the concept maps, (b) *their incomplete understanding*, by examining the relationships between two or more concepts, which were represented on the concept maps, and (c) *their false beliefs*, (i) by pin-pointing relations on their concept maps, between two or more concepts denoting false propositions, and/or (ii) by the inclusion of invalid concepts in their responses, and/or (iii) by the inclusion of a proposition (in case of the concept maps), which was not false and/or by the inclusion of valid concepts (in case of the other assessment items), which were characterized in both cases as false due to the omission of other relevant propositions and/or concepts.

Results concerning the Effectiveness of the Assessment Tools. The combination of the three assessment tools proved to be effective, indicating the supplementary and the supportive role of each other. All the tools supported, at a different degree, the activation of the students’ prior knowledge, the introduction of the fundamental concepts to the students and the ascertainment of what the students already know.

More specifically, the *free response questions*, gave us the opportunity to have a better gauge of what the students already know, as the majority of them answered to the questions extensively, articulating and reasoning their beliefs, especially to those questions concerning known concepts. The *questions based on short cases*, enabled us to introduce two fundamental concepts to the students and to assess their ability to infer important concepts and to reconsider their previous answers/beliefs. It seems that the short cases enhanced the activation of the students’ prior knowledge (55% of them answered to the corresponding questions) in comparison to the corresponding free response questions (20%). The scaffolding framework of the short cases helped the students, especially those that were not able to answer to the relevant free response questions, to specify more correctly and precisely the context of the concepts (most of them reconsidered their beliefs).

The *concept mapping tasks* gave us the opportunity to get an insight into the students’ knowledge structure by providing an explicit and overt representation of the concepts and the propositions the students hold and by showing the students’ beliefs through the externalised expressions of the propositions. More specifically, the “*partial recall framework*” task revealed the students’ beliefs concerning the relationships between the given known concepts. The “*concept-list*” task was not quite effective for the elicitation of the students’ prior knowledge, because the majority of the students, who belonged to this group task, ignored their responses to the previous assessment items and tried to represent on their maps almost all the given concepts, sometimes without understanding completely their meaning. The

“free-construction” and “free-construction/concept list” tasks allowed higher flexibility over the students’ knowledge structure and enabled us to assess the students’ relatively higher cognitive level skills such as organising, analysing and synthesising concepts. The “free-construction/ concept-list” task had the most effective/positive result as it helped the majority of the students to check their thinking, to correct their errors, and to restructure their concepts represented on the maps.

Implications about the implementation of the 1<sup>st</sup> step. The above experimental results drew implications about the implementation of the 1<sup>st</sup> step in the context of the web-based adaptive assessment environment in terms of the assessment activities to be supported and the adaptive capabilities to be provided. Regarding the assessment activities, we concluded to utilize the free response questions in activating the students’ prior knowledge and the questions based on short cases in introducing the new concepts to the students and giving them the chance to reconsider their answers/beliefs. As far as the concept mapping tasks are concerned, we believe that the “partial recall framework” task is more appropriate for the investigation of the students’ beliefs concerning the relationships between the given known concepts, while the “free-construction”/“concept-list” task can be effective in the ascertainment of what the students already know. In the context of the environment, the concept mapping tasks will be supported by an appropriate concept mapping tool, which is under development. Although, the combination of the aforementioned assessment tools served effectively the assessment functions under consideration, the utilization and the evaluation of other assessment tools such as the multiple choice questions and the “partial recognition” concept mapping task (Tsai et al., 2001), are required.

As far as the adaptive capability of the environment is concerned, the experimental results revealed some suggestions, which may make the whole process more meaningful and less tedious for the students by adapting the number and the level of the difficulty of the assessment activities/posed assessment items according to each student’ performance. For example, the questions based on short cases proved to be more effective in the activation of the students’ prior knowledge than the free response questions. Therefore, in case the students respond unsatisfactorily to a couple of free questions, they may omit answering to the rest and proceed to the relevant questions based on short cases. Also, if the students have little experience in constructing concept maps, they may be initially engaged in concept mapping tasks utilizing the “partial recall” task. The adaptive questions and/or the adaptive testing techniques may support the adaptivity of the assessment process (Gouli et al., 2002).

## Conclusions

In this paper, we present an experimental study concerning the ascertainment of the students’ prior knowledge. The context of the assessment activity, that is the assessment items that were developed and the assessment tools that were used contributed effectively to the ascertainment of what the students already know, including faulty and/or incomplete knowledge structures. The assessment tools that were utilised and combined, proved to be effective as far as the goals and the assessment objectives of the assessment activity are concerned, indicating the supplementary and the supportive role of each other. Our future plans include the completion of the implementation and the evaluation of the web-based adaptive assessment environment supporting the assessment functions under consideration.

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