Assessment Strategies for Learning Regulation to be Included in the Development of a Computer-based Assessment System

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Abstract: The present paper introduces a work-in-progress about an adaptive computer-based assessment system called SPEBC. Our main aim is to provide a system, which helps Mexican teachers to incorporate background knowledge into the design of assignments and classroom activities. SPEBC will provide initial, formative and summative assessments activities. The assessment strategies to be included are: Knowledge and Prior Study Inventory, factual questions and essays. SPEBC will generate multiple-choice and open-ended questions adapted to the learners' background knowledge. The contribution of the present work is: SPEBC will generate personalized assignments and will incorporate voting devices to register the learners' answers in. Moreover, the personalization approach is based on the generation of personalized responses using for each set of answers a different kind of external representation. Furthermore, the approach to be used in the implementation of some assessment strategies will be focused in the development of an ontology using Concept-oriented Programming.

Introduction

Assessment is a subject, which concerns to everybody: learners, teachers and the society in general. Socially, assessment is focused in its summative function to determine the students' learning progress about a given topic. However, less attention is paid to assessment as a regulation process, being this function a crucial element in learning achievement (Black, 2003). Assessment means to be aware of the learners' specific needs and the elaboration of teaching-learning tasks, which allow overcoming detected problems (Boekaerts, 1999). Assessment as a regulation process goes a step further than grading learners (White & Mitchell, 1994). There are three moments in the assessment process: at the beginning –initial-, during the instruction –formative- and at the end – summative-. All of them have as main goal the compilation of data in such a way that teachers and learners can take decisions about their teaching-learning process.

The main aim of the present research is to implement an adaptive computer-based assessment system for the assessment of Chemistry lessons in Mexican public Junior-high schools. The proposed system is called SPEBC (Sistema Personalizado de Evaluación Basada en Computadora) (Aguilar, et. al, 2006). SPEBC will support teachers in the assessment process as regulation. With this system, teachers will have more data to take decisions in real time. Also, SPEBC would support teachers in generation of personalized assignments for students, taking into account the diversity that is usually found among them. The development of this kind of systems is necessary to support the use

of new technologies in the teaching-learning process, and this is an important issue in Mexico, where teachers often have classes of more than 30 students.

The design of SPEBC tries to overcome the difficulties or problems found in previous research. One of these problems is that most of them provide only multiple-choice questions and some teachers argued that open-ended questions reflect a deeper understanding about a given topic (Sharkey & Murnane, 2006). We think that a system, which provides alternative assessment strategies, can be a good solution to solve this problem. SPEBC will include a variety of assessment strategies such as: factual questions, Knowledge and Prior Study Inventory (KPSI) (Tamir & Lunetta, 1978) and essays.

There are previous works on the development of computer-based assessment systems such as those of Peat & Franklin (2002) which provides results related to a large first year biology class. These materials included multiple-choice questions such as: weekly quizzes, a mock exam, quiz sections in tutorials and special self-assessment modules (SAMS). SPEBC includes a variety of assessment strategies as well, but additionally provides assessment tools classified as initial, formative and summative assessments. More over, SPEBC will generate multiple-choice questions and open-ended questions. On the other hand, Alfonseca (2005) proposes the evaluation of open-ended questions adapted to each learner. SPEBC will generate factual questions through the generation of personalized multiple-choice questions and essays and factual questions as open-ended questions. Furthermore, SPEBC will be used with a classroom communication system (Sharma & Khachan, 2005), and this will allow teachers to do the assessment process in real-time. A comparison among previous systems and SPEBC is introduced in Table 1.

Authors	**Type of System**	**Adaptive**	**Multiple choice questions**	**Open-ended questions**	**Classroom Communication System**
Peat M & Franklin S. (2002).	Computer-based Assessment	NO	YES	NO	NO
Alfonseca (2005)	Computer Assisted Assessment	YES	NO	YES	NO
SPEBC (Proposed System)	Computer-based Assessment	YES	YES Factual Questions KPSI	YES Essays Factual Questions	YES

Table 1: Characteristics of previous systems and characteristics of the proposed system.

This paper is organized as follows: the second section introduces the assessment process as learning regulation. The third section presents the automation of the assessment instruments to be included in SPEBC. Finally, conclusions are given in the fourth section.

Assessment as Regulation

Assessment as learning regulation, used to encourage metacognitive strategies, must be integrated during the whole teaching process. This is because the aim of learning regulation is to allow the detection of the students' learning difficulties and to find forms of overcoming them in an autonomous way, generating personal learning strategies (Boekaerts, 1999). Additionally, assessment strategies must be varied, attending to the concerned subject matter content and the moment in which they are applied. We decided to include: initial, formative and summative assessments. Initial assessment is done in order to gather diagnosis and prognosis information. Formative assessment is done in order to obtain information about the regulation of the teaching-learning process, identification of the obstacles that can be found in the learning process and the detection of topics that need to be reinforced. Summative assessment is done in order to determine whether or not a learner masters a given domain at the end of the course. It is important to emphasize that the difference among several kinds of assessment strategies is based on the assessment objectives. Moreover, an assessment strategy can be used in different moments of the teaching-learning process and fulfill perfectly different purposes (Jorba & Sanmartí, 1996).

Automation of Assessment Strategies

The present section introduces a variety of assessment strategies that will be included in the development of SPEBC. Factual questions and Knowledge and Prior Study Inventory (KPSI) are multiple-choice questions and therefore the system will grade them automatically. Some other factual questions and essays are open-ended questions and therefore teachers will grade them. The hardware required by SPEBC is: a classroom communication system (Sharma, et al., 2005) and/or learners' computers. By using a classroom communication system, teachers will be able to deliver questions. By using their voting devices, learners will be able to send the number of answers in. By using their computers, on the other hand, learners will also be able to respond to personalized on-line assignments.

Figure 1 shows a general design of SPEBC and figure 2 shows in detail the design of the Questions and Answers Generator Module. The key characteristics of the funcionality of this module (See Figure 2) are: Teachers will have to request the generation of a KPSI, factual questions, and/or essays. The factual questions generator will generate the questions to be included in KPSI or in an assignment consisting of factual questions. This module will interact with the ontology matching module in order to identify meaningful tokens such as names, places, models, etc. These data will be saved on the domain ontology database. The factual questions generator will also access the representations database, in order to generate personalized responses. Three kinds of representations (Giere & Moffat, 2003) for each knowledge content will be saved on the representations database. The output of the factual questions generator will be the generated questions and answers and these will be saved on the Q and A database. The Q and A database will also contain essays and KPSI inventories. The essays generator will interact with the ontology matching module in order to identify the technical words to be included in the essays. The KPSI generator will obtain the questions to be included in the assignment from the Q and A database. These questions are going to be previously generated by the factual questions generator and saved on the Q and A database. The representations maintenance module will allow to capture and record of representations on a database. The outputs of the factual questions generator, KPSI generator and essays generator will be the input for the pedagogical module. The pedagogical module controls the selection of questions and help teachers in the planning of the generation of assignments. The outputs of the pedagogical module are the assignments.

Factual Questions and Answers Generator

Factual questions are those, which assess the learner's understanding of facts and processes. It is important to evaluate this because facts are important for thinking and problem solving (National Research Council, 2000). By generating these kinds of questions, we are trying to gather information about different levels of understanding about entities, processes, causes, and conditions of chemical events.

The factual questions generator divides the generation process into the generation of questions and the generation of personalized responses. The questions generation process is done as follows: Having as an input a text file, which contains the subjects to be studied in a text format, SPEBC will be able to generate questions in natural language. SPEBC will generate closed-domain questions dealing with knowledge under the specific domain of a course of Chemistry for a first-grade junior-high school. SPEBC uses text documents as its underlying knowledge source and combines various natural language processing techniques to extract and construct questions. Syntactic, semantic, and context processing will be done in order to generate questions. These techniques include: named-entity recognition (Humphreys, et al. 2000), coreference resolution (Humphreys, et al. 2000), and rules, which match the Spanish grammar patterns.

SPEBC will generate the answers for multiple-choice questions. One right and two incorrect responses will be generated. In order to generate personalized responses, we divided the personalization factors into: knowledge and learners' personalization factors. The knowledge personalization factors are:

1. Required knowledge: This refers to the knowledge that a learner should know before studying a given topic.
2. Representation: This refers to the way in which the knowledge is introduced to the learners. For example, the representation of the concept of water can be given in natural language, through a draw of the water molecule or using its chemical formula (Giere & Moffat, 2003). Figure 3 shows an example of types of representation to be included in SPEBC. We classified these representations into writing, image and formula, respectively.

The learners' personalization factor to be included in the design of SPEBC will be the background knowledge. This personalization factor allows modeling the learners' knowledge. Required knowledge and background knowledge refers to the same knowledge but they can be seen from the point of view of the knowledge and from the learner.

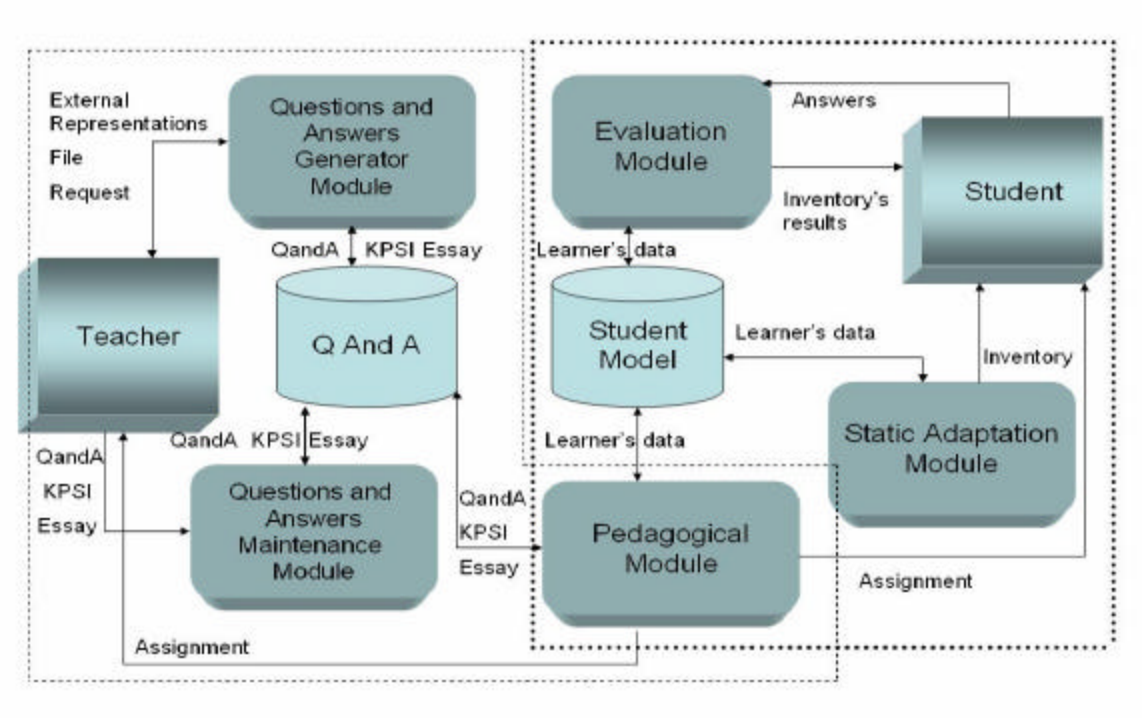


Figure 1: Design of SPEBC (Adapted from Aguilar, et al., 2006)

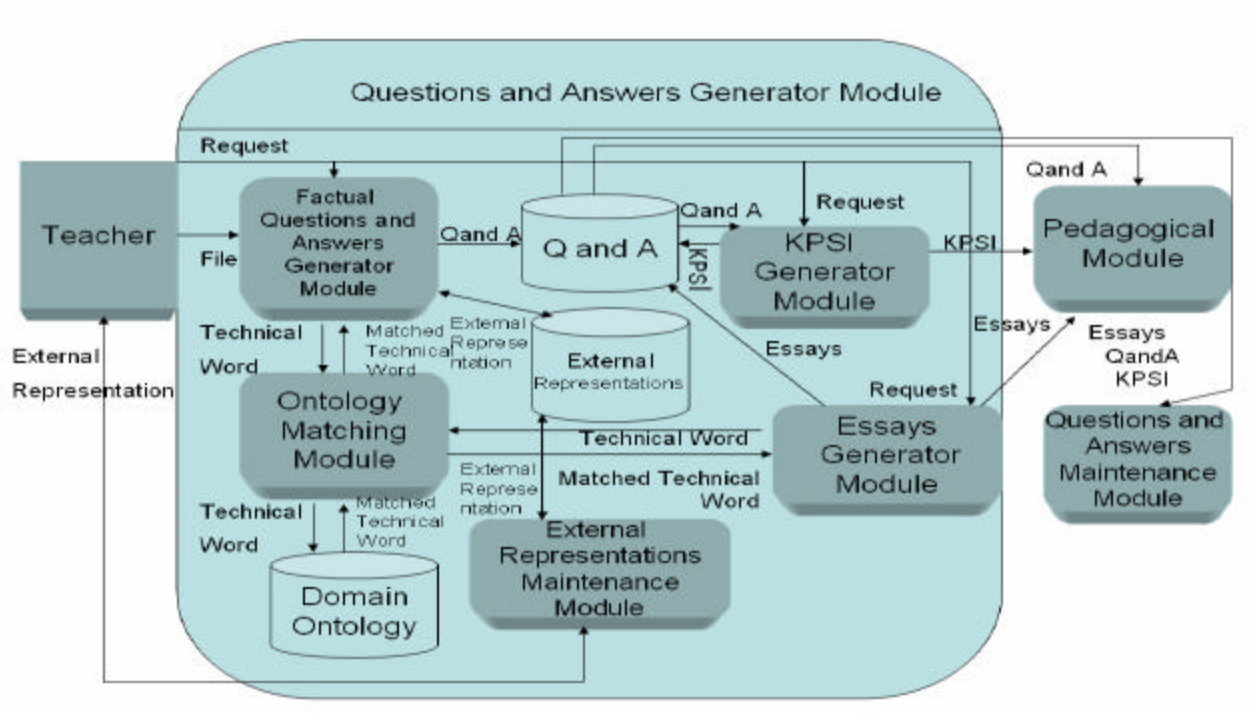


Figure 2: Design of the Questions and Answers Generator Module

At this point of the present research, we are going to assume an straightforward relation between required knowledge and background knowledge, and we will use different representations to personalize the responses to multiple-choice questions (See Figure 4).

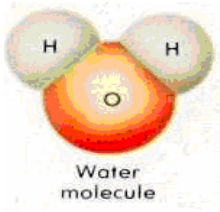
Water  H_2O

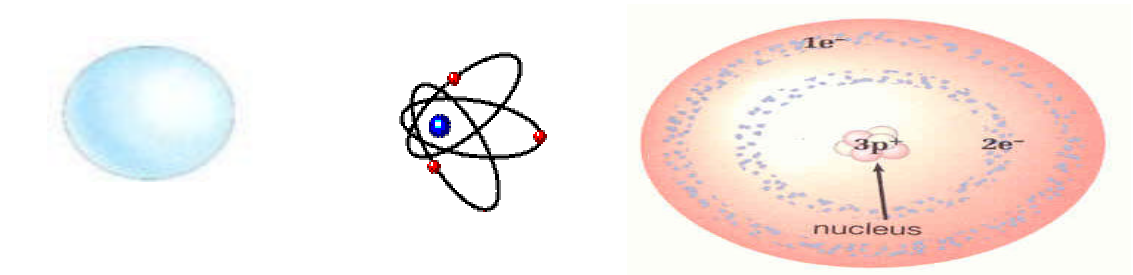
Figure 3: Different Representations of the Water concept

Responses to questions which start with what, how, why, and which will be personalized. The answers to the questions, which start with who, when, and where, are not going to be personalized because the answers are more specific. The personalization process of the responses consists on introducing the learners' responses in three different forms of representations (See Figure 4). These representations will be saved on a database, and there are two ways of incorporating the responses to multiple-choice questions, these are: manually and automatically. The manual process consists of the input of each response using a keyword for a given representation, SPEBC will process the questions and the keywords of the responses and it will paste the related representation. And the automatic process consists of the generation of multiple responses. When factual questions are generated the correct response is also generated. In order to generate two wrong answers, SPEBC will search in the representations database related keywords and would substitute these keywords with their correspondent representations.

Concept-oriented Programming (Savinov, 2006) is an available alternative to implement a computer-oriented representation of the world. We are referring to such world model as ontology. This implementation approach pursues the determination of the construction of the ontology and content. Ontology generally describes: individuals, classes, attributes and relations. Concepts integrate individuals of the ontology. Concepts are classified into types, which define the ontology's classes, and attributes and relations are described in each concept.

Generated Question

Which one is the Dalton's atomic model?



Response 1 Response 2 Response 3

Figure 4: An example of multiple-choice questions and answers personalization

KPSI Generator

Knowledge and Prior Study Inventory (KPSI) (Tamir & Lunetta, 1978), is a self-assessment inventory, which allows assessing the learners' prior knowledge. This inventory helps teachers to gather information about the learners' perception about their own understanding level with regard to the topics that will be taught. This inventory will also help learners to understand the learning objectives to be reached in the teaching-learning process. KPSI will

be used as an instrument to assess learners understanding before and during the teaching-learning process. It will be introduced to the learners as multiple-choice questions. Questions to be included in a KPSI will be factual questions and therefore these will be generated.

Essays Generator

Essays instruments will be included in SPEBC in order to encourage learners to develop their ideas about some topics. This will foster the development of learners' writing and arguing skills. SPEBC will have as an input a text file, which can be a textbook, a paper, etc. From this text file, SPEBC will select some technical words that will be given to the learners in order to write an essay. Concepts, which will integrate the ontology, will allow the matching of technical words defined in the text file given as an input with the technical words defined in the system.

Conclusions and Further Research

One of the aims of the present research is to support teachers in the assessment process as regulation, and this eventually, may have an impact on students' metacognitive skills. We think that SPEBC will be a new factor that will influence the educational process. The challenge for teachers is the incorporation of SPEBC in such a way that this new actor can be a real support in the improvement of the teaching-learning process. Some of the challenges to be faced in the development of SPEBC are the generation of questions and personalized answers based on the grade of difficulty, its design and its implementation. Further research will be focused in completing the implementation of the first prototype of the factual questions generator. Two versions will be implemented, one version will generate factual questions and answers without the adaptation of background knowledge and the second version will include the adaptation process. We will do the evaluation of the system effectiveness by establishing a comparison between these two versions. At the same time, we will evaluate the challenges and opportunities generated in the classroom, when different assessment strategies are used. We expect that all this information we will allow us to generate some useful proposals for teachers.

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