# Computer Assisted Assessment (CAA) and Electronic Problem Based Learning

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**Abstract:** The very rapid change in the entire life influences the systems that control our behavior, skills and knowledge. The evolution of our education methods is one of the main indicators in this change. The educational systems have been influenced by these rapid changes over the time and technology is increasingly used in learning settings. Assessment as one of the parts of the learning system is exposed the same changes. In this paper, a new approach is presented for e-assessment after discussing the challenges in e-assessment in Mathematics related fields.
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## 1- Introduction

Using computers to assist assessment tasks is an interesting research topic for decades; however, developments have mainly transferred traditional assessment approaches environments. Moreover, in order to automatically grading students' assignments, types of assessment approaches have been further limited (Elliot, 2005).

Consequently, the rapid increase of using technology in learning settings expedites also the need for new technology-based assessment. Our life has been influenced by a revolution in the field of information and technology. As a result, peoples' mentality has changed significantly in the recent years. Consequently, pedagogy has become affected and educationalists have also started redesigning educational systems. Learning is no more divided; there is no separation between schools' education and workplace experience. Acquiring knowledge is a continuous learning process. Learning is a continuous process over lifetime, it is a lifelong process. Therefore a new paradigm for assessment in lifelong learning is becoming important. Changing education from memorizing facts to higher levels of comprehension and synthesis requires building and assessing critical-thinking skills. According to (Haken, 2006), measuring knowledge is important but is not enough. The academic programs should work on building and assessing students' critical-thinking skills. In general, assessment has different strategies according to its purposes. The two main basic types of these strategies are formative and summative assessment.

Formative assessment is part of the learning process; this assessment is used to give feedback to both students and teachers in order to guide their efforts toward achieving the goals of the learning process. Where, summative assessment is performed at the end of specific learning activity; and used to judge the students progression and also to discriminate between them (Bransford, 2000). According to Bennett, 2002), technology is an essential component of modern learning system. As a result, technology is also increasingly needed for the assessment process to be authentic. E-assessment can be distinguished as Computer Based Assessment (CBA) and Computer Assisted Assessment (CAA) which are often used interchangeably and somewhat inconsistently. CBA can be understood as the interaction between the student and computer during the assessment process. In such assessment, the test delivery and feedback provision is done by the computer. Where CAA is more general, it covers the whole process of assessment involving test marking, analysis and reporting (Charman, 1998). The assessment lifecycle includes the following tasks: planning, discussion, consensus building, reflection, measuring, analyzing and improving based on the data and artifacts gathered about a learning objective. The type of useful assessment method depends on the learning objectives. These objectives have been classified in Bloom's Taxonomy into six levels: knowledge, comprehension, application, analysis, synthesis and evaluation (Bloom, 1956). Consequently, a variety of exercises which assess the different objectives' levels should be applied. E-assessment systems can be classified according to the nature of the users' response to the test items into, fixed response systems and free response systems (Culwin, 1998). Fixed response systems which also referred to as objective forces the user to have a fixed response by selecting an answer from a pre-prepared list of solution alternatives where, in the free response systems non-objective, unanticipated answers formulate the user's response. In such type of systems skills like programming, essays writing and metaskills are assessed rather than fact or knowledge assessment which represents the main domain of the first type. Additionally, portfolios can also be used to assess learning outcomes. Moreover, according to (Chun, 2002), portfolios represent the highest point of students' learning, what they collect, assemble and reflect on samples are represented in their portfolios. E-assessment is not only applicable for individuals, but it is also used for groups. Assessment of groups, also referred to collaborative assessment, is used to assess the participation of individuals in group work and their behavior of how they collaborate with each other to solve problems.

Computers have been used for decades to assist assessment. TICCIT (Time-Shared, Interactive, Computer-Controlled, Information Television) (Hayes, 1999) which has been started in 1967 is another example of a large-scale project for using computers in education. The history of e-assessment can also refer to the use of computers to automatically assess the students' programming assignments (Douce, 2005). Authors of (Forsythe, 1965) presented another system for automatically assessing programming exercises written in Algol. The system was used by the students of a numerical analysis course at the University of Stanford to assess their programming exercises. The system was responsible of data supplying, running time monitoring and keeping a "grad book" for recording problems. Guetl in (Guetl, 2007) introduced the e-Examiner as a tool to support the assessment process by automatically generating test items for open-ended responses, marking students' short free text answers and providing feedback.

Motivations and rationales of using e-assessment instead of paper-based assessment in higher education are discussed in this section. According to Charman and Elms (Charman, 1998), the practical and pedagogic rationales are the main motivators for adopting e-assessment in higher education.

Increasing number of students supervised by the same staff resources causes an increase in the staff workload. Accordingly, time spent by the teachers to assess students is also increasing. Therefore, a step toward the e-solutions becomes a real need. Although many e-learning environments have been developed in universities to overcome the workload problem, most system have not adequately solved the assessment tasks. Therefore, reducing time and efforts spent on students' assessment is a strong rationale to use the e-assessment technology (Charman, 1998).

In this paper, after reviewing the e-assessment and Computer Assisted Assessment (CAA) in Section 2, we focus on the self-assessment in the electronic learning in Section 3. Then we present our new method in the rest of Section 3. It runs as software that has different pages for students and staffs for making quizzes and assessment. The last section is included the conclusion and some proposed future works.

## 2- E-assessment and problem based learning

As with any pedagogic approach, it is important to align learning outcomes, teaching and learning activities and assessment tasks, particularly where the intention is to encourage deep, rather than surface, approaches to learning (Biggs, 2003). This, Biggs argues, requires criterion, rather than norm, referenced assessment, adopting a much more holistic and divergent approach, involving significant peer and self-assessment, all features which enquiry and problem-based curricula increasingly reflect. Woods, who uses Problem-based Learning in his chemical engineering courses at McMaster University in Canada, defines assessment as "a judgement based on the degree to which the goals have been achieved based on measurable criteria and on pertinent evidence" (Woods, 2000: 21).

Jafarabadi et al. (Jafarabadi 2012) and (Jafarabadi, 2011) are presented a novel approach in electronic Problem Based Learning. Assessment has also to move beyond factual recall to the application of knowledge and skills to increasingly complex situations, involving a range of intellectual and practical activities in a variety of contexts. Assessment should therefore reflect the professional contexts in which our students are likely to find themselves in the future, showing how they cope with acting and thinking like a nurse, physicist or historian and the lifelong learning skills needed to continue to develop in these changing professional areas. Many lecturers claim that their students will not do any work unless it is being assessed – by which they often mean that it is awarded a mark. However, as Knight (2001) notes, assessment for summative purposes is viewed as being of such high stakes that those being assessed see it as being in their own interests to emphasize what they know or can do - however limited or poorly - and to cover up as much as possible what they do not know or cannot do. In enquiry and Problem-based Learning, where students have to make statements about what they already know and can do and where there are gaps in their knowledge and competence, assessment needs to be developed which encourages learners to be open and honest. So, whereas Knight suggests that it is through formative assessment that students can disclose their shortcomings, in enquiry and Problem-based Learning learners may be rewarded summative for identifying learning needs and reflecting on areas for further development without these being seen as personal shortcomings. As we will see later, it is through peer, self and collaborative assessment that students are able to make judgments about how *well* they are learning and not just how much they have learned.

Macdonald and Savin-Baden (2004) list some of the forms of assessment that have been used successfully with enquiry and Problem-based Learning and which also move away from the need to have outcome-based examinations. To summarize, these include: group presentations, individual presentation, tripartite assessment, case-based individual essays, case-based care plans, portfolios, triple jump, self-assessment, peer assessment, viva voce examinations, reflective (online) journals, reports, patchwork texts, examinations and electronic assessment.

Self-assessment involves students judging their own work. It may include essays, presentations, reports, and reflective diaries. However, one of the difficulties with self-assessment is the tendency for students to make judgments about what they meant rather than what they actually achieved. Boud has defined self-assessment as the involvement of students in identifying standards and/or criteria to apply to their work and making judgments about the extent to which they have met these criteria and standards (Boud, 1986: 12).

It has been a long time since the society started thinking of transferring assessment to computer-based environments. Since 1960's several steps towards achieving this goal have been taken. But unfortunately, e-assessment has been criticized for imitating the conventional assessment. The author in (Elliot, 2008) argues that e-assessment system's designers imitate traditional assessments. He also stresses that these systems only support limited number of exercises types. E-assessment is also criticized that it still assumes that students have to retain the context related information in their memories.

## 3- E-PBL and Self-Assessment

As we discussed earlier, in electronic problem-based learning (e-PBL) the learner must use computer (as a facilitator) and other facilities of the system for learning. The initial or lower levels of Bloom's Taxonomy are the simplest in terms of learning process; they just involve the learner to gain information and knowledge from the system. This information can be stored in a database and retrieved from it whenever required. For instance, if during a learning process the student is required to recall and use a well-known trigonometry equation, all he/she must do is to retrieve it from the database via a search technique. This case is equal to asking the system about the capital city of a particular country. During this procedure, the system does not perform any special type of mathematical processing. Therefore, these levels of the taxonomy are not the main focus of this paper.

As we move to the higher levels of Bloom's Taxonomy, the questions of students may require a considerable amount of calculation which their answer can no longer be found in the database. A simple example of this situation is the answer to this multiplication operation 256*42. Facilitator systems in e-PBL can manage and perform such type of tasks once a connection is made between a calculator and the e-PBL system. However, the existing e-PBL systems (Souman 2010, Woods 1994), still have major deficiencies in mathematic related topics and cannot carry out all the possible operations that learners need from the system. As mentioned previously, the purpose of this paper is to present a method which enables learners to become self-directed and gain deeper understanding using the e-PBL systems.

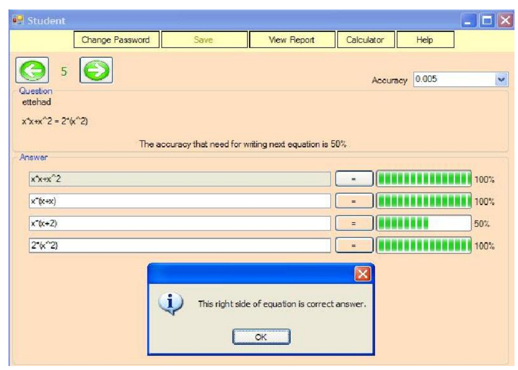


Figure 1. Student page: solving an equivalency problem

In the new proposed method, once the student reads the problem he/she must be able to find the answer on his own and without any help. He/She might be able to solve the problem independently or share it with other students and put it into discussion. Also, while using the e-PBL system, the student can share his findings and thoughts with others under supervision of the facilitator. Another important technique which helps students to solve problems in e-PBL is to change the existing problem into one equivalent to it. In fact, the main concern in this method is the ability of e-PBL system in recognizing and operating the equivalent mathematic formulae. In other words, the system cannot use the database or a calculator in such cases. Therefore, the main objective is to apply an interface in such systems so they can carry-out operations of any subject similar to

MATLAB or Maple software.

For instance, once the student enters any mathematic expression equivalent to $(x + y)^2$, the system must be able to recognize them. This expression is equivalent to infinite number of other expressions which are not supposed to be stored in the database. $(x + 2y - y)^2$, $(x^2 + 2xy + y^2)$, $(3x - 2x + y)^2$, and $(x^2 + y*y + 2xy)$,… are all equivalent to $(x + y)^2$. It might be presumed that by standardizing the format of inputs, we can overcome this problem and there will be no need for a new method. However, the problem arises when the expressions become more complicated. For example, for a simple expression such as $(\text{Sin}2x + \ln x^3)$, the student can find numerous equivalent expressions which their correctness must be carefully examined. This way the new proposed system will completely overcome the existing problems and improve speed and accuracy of e-PBL systems as well as making them more capable.

In the designed system which is being introduced in this paper, there are three levels of accessibility. Figure 1, shows one of the special pages of the learner where he/she is being active in solving a problem which is equivalency. Even the learner has provided a wrong solution in a specific step of problem solving and it is being reported that the level of accuracy of the answer is 50% of the both sides of equation. This system enables the student to solve the problem and also enables the student to independently interact better with the computer which acts as a facilitator. Figure 3 shows a page which is related to the tutor where he/she would be engaged in designing the quiz and specifying the attributes of the quiz (Figure 2). The system would require more than routine and normal information about the system from the tutor (which is custom in the normal traditional method). It is with the help of this information that the intelligence of the system is being guaranteed.

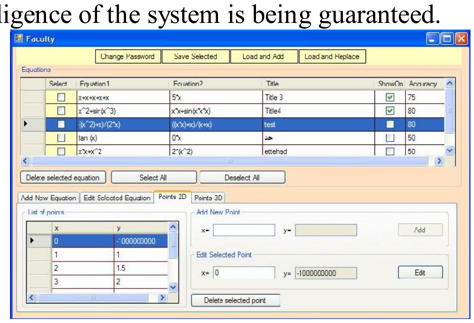

Figure 2. Faculty page: Designing a quiz

The major aim in this research is to propose a strategy to improve the quality of PBL based electronic systems that specially used in learning of mathematics fields. After proposing the strategy and develop the test system, we implemented this method and applied in two high schools and colleges. With executing this software that was trained to mathematic teachers, we provided a questionnaire and gave it to the students. The questionnaire included 18 questions in separate classes, that each has four options called: “Fully adverse”, “Adverse”, “Consistent” and “Fully consistent” and we matched numbers 1 to 4 to these options. Also, we explain that an empty field in questionnaire means that “I have no idea!” and matched to zero. After using the software, the questionnaires were completed and evaluated in statistics. The mean of each question’s mark is shown in Table 1. The mean index of each question that is a number greater than 2 shows the legality of method for that question that in most of cases is true.

**Table 1: Results for the first eight questions.**

| | SEX | Q1 | Q2 | Q3 | Q4 | Q5 | Q6 | Q7 | Q8 |
|---|---|---|---|---|---|---|---|---|---|
| Mean | 1.59 | 2.82 | 2.52 | 2.63 | 2.66 | 2.55 | 3.04 | 2.84 | 2.42 |
| Std. Error of Mean | .071 | .129 | .126 | .110 | .111 | .142 | .132 | .141 | .129 |
| Std. Deviation | .497 | .905 | .875 | .761 | .760 | .974 | .908 | .986 | .895 |
| Variance | .247 | .820 | .766 | .580 | .577 | .948 | .824 | .973 | .801 |
| Minimum | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Maximum | 2 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| Sum | 78 | 138 | 121 | 126 | 125 | 120 | 143 | 139 | 116 |

The next question in this sampling is that: Can these attained results generalize to the whole of society. Following this question we use the $\chi^2$ test. By considering the assurance percentage 0.95 (and also semantically level equal 0.05) and by using 49 questionnaires we gain to Table 2 that the final result for $\chi^2 \geq 7.8$ will be equal to 29.939. By considering the assurance percentage that we used, because this is greater than 7.8, the result can generalize to whole of the society.

Table 2: Residuals for four types of answers.

| | Observed N | Expected N | Residual |
|---|---|---|---|
| Fully adverse | 4 | 11.8 | -7.8 |
| Adverse | 12 | 11.8 | .3 |
| Consistent | 27 | 11.8 | 15.3 |
| Fully consistent | 4 | 11.8 | -7.8 |

Test Statistics

| | |
|---|---|
| Chi-Square | 29.939 |
| df | 3 |

## 4 Conclusion

In this paper we have provided a system in e-learning and specially e-assessment with the help of which the depths of learning (as per Bloom’s Taxonomy) in Math Related problems in the field of E-learning systems are being increased. Also with the usage of those, stronger e-PBL systems can be developed which would enable the life span of the learnt topics can be increased.

The provided system is being coded for three levels of administrator, tutor and learner and being tested regarding certain problems of mathematical experiments in a college and a high school. We have shown the validation of our approach by using the system in Mathematics student groups in a high school and a college. One can use it to e-assessment in other fields.

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