Methodology for the Elaboration of Quizzes using Propositional Logic Calculus in an E-Learning Environment

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ABSTRACT

This paper introduces the use of propositional logic calculus in the elaboration of educational quizzes to assess the level understanding of students in a specific theme of their courses. The technique introduced in this paper goes beyond multiple-choice quizzes. The technique requires several steps like a) to give a phrase, b) to re-order words of the given phrase in order to form a propositional logic formula, c) to make use of background knowledge for performing substitutions, d) to answer questions from one of the person in the team, e) to change synonyms/antonyms (if this is feasible), f) to perform actions in order to give value to both or at least one operand of the logic formula and g) to conclude the final answer of the logic formula (true or false) depending of the logic values of the operands in the logic formula. As a working example, the author shows a quiz for universal history, however, the same technique could be used to assess students in different courses.

KEYWORDS

Background Knowledge, Educational Quizzes, E-Learning, Knowledge Substitution, Propositional Logic Calculus, Tests Categorization, True Table Semantics

INTRODUCTION

E-learning has become popular between organizations as a means of saving time and reducing costs in training of employees and also, the fact that e-learning allows organization’s members to learn at their own convenience. However, one of the challenges of E-learning is to hold the attention of the learners and keep them engaged without the benefit of face-face interaction. Tutors have to select the right type of quizzes for their evaluations, in order to keep learners on their toes and monitor retention and learning progress. So, which type of quiz should be chosen? Educational quizzes are popular as a tool in E-learning as they are used to test knowledge in a specific subject. Although, the use of quizzes came before E-learning and they were used as a mean of having entertainment while testing mental skills.

In the literature, there are a variety of quizzes in well-defined categories ranging from multiple-choice, true-false, matching quizzes and so forth. However, we believe a combination of several techniques used in the elaboration of quizzes could bring benefits to learners. So, we propose to use (in the elaboration of an educational quiz) propositional logic calculus, background knowledge, knowledge substitution, true-false paradigm and evaluation of the formula using the true table semantics. Our proposed technique (used in the elaboration of the quiz) does not follow the multiple-choice style. It makes use of propositional logic formulas, reasoning and background knowledge. The quiz use phrases which then are written as logic statements by participants. Then, the output of the formula is the logic value of several connected propositions using the logic connectives {or, and, not}. In order to clarify our methodology, we have defined a working example defining a quiz in universal history.
and theme the First World War. The working example covers the theme of WWI but we believe that our methodology could be used in computer science courses.

The main contribution of this paper is to propose a methodology for the elaboration of quizzes using propositional logic formulas. Our proposed methodology has the promise to go beyond the type of quizzes already used by educators in E-learning. The methodology requires an understanding of propositional logic. Furthermore, we believe that our suggested quiz methodology could help to evaluate in great deal the knowledge and reasoning capabilities of students when solving problems.

The paper is organized as follows: Firstly, we describe related work. This section shows related work from two streams, related work from the viewpoint of student’s evaluation and related work in propositional logic calculus. Secondly, we present a working example using our proposed methodology. The working example quiz is in the subject of universal history and theme the First World War. Thirdly, we present our methodology by explaining each of the steps in the methodology. Fourthly, we show a preliminary evaluation. Finally, we state our conclusions and future work.

**RELATED WORK**

This section is presented by showing two streams of related work. Firstly, it shows the assessment of students using different kind of test and secondly, it presents a brief overview of propositional logic calculus.

**Student Assessment**

Tests are the most common tool used by instructors to evaluate students in a course (Brown, 1991; Buchanan & Rogers, 1990; Clift, & Imrie, 1981; Geiger, 1991; Gronlund & Linn, 1990; Jacobs & Chase, 1992; Jedrey, 1984; Lowman, 1984; Milton et al., 1986; Murray, 1990; Svinicki, 1987; Toppins, 1989; Weimer, 1989). In fact, tests are an indicator if students are learning what the instructor is expecting to be learnt in each of the topics of the course (Bloom, 1956; Boniface, 1985). Additionally, tests could help students to structure their efforts and to find weakness (McKeachie, 1986; Crooks, 1988; Wergin, 1988). In other words, tests could be beneficial to students as they can help students to reinforce their learning by providing indicators of which topics and skills they have not mastered. Additionally, instructors get feedback about how successfully; they are presenting the learning material to students (Fuhrmann & Grasha, 1983).

There are several categories of tests, namely multiple-choice tests, true-false tests, matching tests and essay tests among others (Liska & Simonson, 1991). We describe briefly some of them in turn. However, a detailed description of each type of tests can be found in tools for teaching (Gross, 2009):

- **The multiple-choice**: Tests are used to evaluate simple and complex knowledge. The students could answer this kind of test quickly and also these tests can be scored easily using Web platforms like Moodle;
- **True-False**: Tests are less effective than other type of tests. Some instructors ask students to justify their answer in two sentences (Savitz, 1985);
- **Matching-tests**: Effective way to design tests as students need to recognise relations in words and definitions, events and dates, categories and examples and so forth. This is the most visual test where students are presented with a picture along with a list of terms. The task of the students is to match the terms with the corresponding parts of the picture. For example, in a biology class students have to match labels with different parts of the human body. Another, example is to match labels to a piece of equipment;
- **Essay-tests**: They allow instructors to evaluate the ability of students in several aspects like for example, if students can organize, integrate, interpret material and express themselves in their own words. Essay-tests allow evaluators to comment in student’s quality of their thinking and the depth of their understanding of the specific topic. The problem with essay-tests is that grading could be subjective and sometimes inconsistent (Ericksen, 1969; McKeachie, 1986);
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