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Measuring individual learning performance in group work from a knowledge integration perspective

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ABSTRACT

Evaluation is an important part of the teaching–learning process, and it becomes more difficult when individuals are developing a joint project and individual marks have to be assigned to the group members. Different strategies can be used to perform this task. In this work, an approach that combines the global group results and the individual performance is presented. This approach makes use of a semantic framework to rank the individual participation of each group member and to compare their results with those they should have obtained to achieve the final mark. An experiment performed in real settings is also reported in this paper.

1. Introduction

Learning is a social behavior; it only happens during group interactions [9]. Group work is a fact of life in the corporate workforce [2], and group work learning is considered crucial nowadays. As a result, some academic institutions make explicit mention of it in their assessment policies, e.g. the University of Wollongong in Australia. Many companies also use social learning groups to promote organizational effectiveness and the formation of knowledge communities [9]. In [26], three good reasons for group learning are presented. First, individuals can learn from each other and benefit from activities that require them to articulate and test their knowledge. Group work provides an opportunity for individuals to clarify and refine their understanding of concepts through discussion with peers. Second, group work can help to develop skills sought by employers. At this point, it should be noted that employers hire individuals and not groups, so individual performance must be taken into account when working in group. Third, group work may reduce the workload for assessing, grading and providing feedback to individuals if groups are globally evaluated. In [45], the author states that evaluation is an integral part of the learning process, so special attention must be paid to it. The essence of evaluation is to obtain useful data for the individuals, the teacher and the institution. In this sense, evaluation should be continuous, and individuals should get quick feedback.

Different strategies for group assessment have been proposed [43]. One option is shared group marking, in which all the group members receive the same mark, but other strategies for individual marking can be found: allocated task, individual report, examination, average and individual mark, distribution of pool marks, individual weightings, peer evaluation, etc. Grading individuals in group work has controversial aspects. First, individuals are concerned about the possibility that the mark does not reflect their own effort. Second, individual work should be evaluated, since students get individual degrees. Third, grading group performance requires the teacher to be clear about how groups satisfy the course objectives.

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In this work, we are interested in providing individual marks to each member of the group. Our approach is based on two pedagogical criteria: (1) teacher feedback should consist of reinforcing points of agreement but it should also include inconsistencies and differences [40]; and (2) assessment of group work should be done several times during the assignment [45]. A combination of group and individual performance can be used. The advantage of this approach is that it is perceived as fair, although it might require additional work for staff.

This study follows two cooperative learning principles: positive interdependency, and individual exigibility. This first establishes that the success of each individual is directly related to the success of the group. The goals and tasks are common, so all the members *learn together*. Each member is then fundamental in the cooperative learning process. On the other hand, individual exigibility means that the work of an individual is helpful for the other members. Each member is therefore able to learn about all topics included in the group assignment. Our cooperative learning evaluation framework will assume these principles, so good group members will have acquired all the knowledge possessed in the group.

On the technological side, the Semantic Web aims at adding semantic information to web contents in order to create an environment in which software agents will be capable of doing tasks efficiently [4]. The basic properties of the Semantic Web allow for meeting learning requirements: quickness, just-in-time and pertinent learning [35]. Semantic Web technologies are commonly accepted for different purposes in the e-Learning community [11,29]. However, the assessment of individual performance in cooperative work has not been addressed to date by using such technologies. One of the basic technologies for the Semantic Web is ontology. An ontology can be defined as a formal, and explicit specification of a shared conceptualization [23]. In this work, ontologies will be the knowledge representation technology, and performance measurements will be based on ontology-related activities.

Our approach is based on the assumption that students are assigned a task to be solved in group, and that an ontology, representing the knowledge acquired by each individual along the assignment, can be obtained. Hence, the group result is obtained by merging the ontologies of the group members. An automatic ontology merging approach, which has been proved useful for different problems (see Section 2) is used. This merging approach is capable of detecting and solving similarities and inconsistencies, so that some feedback might also be generated for the learners.

The structure of this paper is as follows. Section 2 contains the description of the technical foundations of this work. The framework for evaluating individual performance will be presented in Section 3. Finally, some conclusions will be put forward in Section 4.

2. Technical foundations

In this section, the technical foundations and previous works are introduced to facilitate understanding.

2.1. Ontologies

In recent years, there has been a great interest in ontologies for representing knowledge, and it has become basic for Knowledge Management [27], the Semantic Web, Bioinformatics, e-Learning, Business to Business Applications, and so on [6]. Ontologies have also been used in medicine to represent medical models [36] and knowledge in diagnostic systems [38]. Ontologies present two main advantages for practitioners: the knowledge contained in an ontology is shareable and reusable, so the same ontological content can be used in different tasks and applications. In this work, ontologies are represented by sets of concepts holding that: (1) every concept is defined through a set of attributes, so the presence of axioms between these attributes is not considered; (2) concepts can be inter-related through different semantic relations. Representing ontologies as sets of interrelated concepts is widely accepted (see for instance [3,6]). The ontological model used in this work can be summarized as comprising: (1) concepts, which are the entities of the application domain; (2) the concepts' attributes; (3) relationships that can be established among concepts; and (4) structural axioms that can be established according to the particular application domain.

One of the main problems is the construction of ontologies. There are several methodologies [7,12,15,21,28,31,32,34], although none can be considered standard. In this work, we assume that students are capable of building their own ontology, and any methodology can be used for it. On the other hand, a cooperative methodology is used for combining the ontologies of the students in order to get the group ontology. The integrative methodology proposed in [19] is used. This methodology has already successfully been applied in different domains: (a) Intensive Care Units [37], to develop an ontology-based system for monitoring patients; (b) biological application domains [20]; (c) biomedical domains such as "diagnosis and plagues in tomatoes" and "diagnosis and diseases caused by protozoa" [17,18] with an academic purpose. The framework was used for integrating ontologies in the second and third domains and for managing intelligent alarms in the Intensive Care Unit application domain.

2.2. Cooperative learning and ontologies

In this work the group ontology is built by reusing students' ontologies through integration processes. As stated in [5], cooperative modeling processes tend to reach stability, so after a series of iterations, the group knowledge would become stable. The result of the cooperative learning process will depend on various parameters [19]: