ANALYSIS OF HOW WELL A CONCEPT MAPPING WEBSITE CONFORMS TO PRINCIPLES OF EFFECTIVE ASSESSMENT FOR LEARNING

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Abstract. The aim of this paper is to analyze how well a website that we developed (conceptmapsforlearning.com) conforms to principles of effective assessment for learning. The concept maps for learning website is the integration of a user management system and a concept mapping system. The user system is created by using PHP language whereas the concept map system is developed by using Adobe Flash software. The user management system consists of four different users: administrator, expert, operator and student. According to Greenstein (2010), there are three basic principles of formative assessment: student focused, instructionally informative and outcome based. It is concluded that the concept maps for learning website conforms well to principles of effective assessment for learning. Nonetheless, a few further developments are recommended for the website, such as inclusion of an online discussion forum.

1   Introduction

Concept maps are graphical representations of individuals' conceptual knowledge structures. Briefly, every concept map has nodes and labeled lines (Ruiz-Primo, 2004). The nodes represent concepts in a particular field. The lines demonstrate the relational links between concept pairs. Moreover, any label on a line explains why these two concepts are related. Provided that there is no line between two concepts, they are not very meaningfully related as compared with other concept pairs.

Novak (1990) classifies the usages of concept maps in education into four categories: for instructional design, as a meaningful learning activity, for curriculum planning, and as an assessment tool. In terms of an assessment tool, concept maps can be used as a summative assessment tool or a formative assessment tool (Yin, Vanides, Ruiz-Primo, Ayala, and Shavelson, 2005).

Regarding formative assessment, or assessment for learning, there are several definitions of it in the literature. Perhaps the most suitable definition for this study is stated by Trumpower and Sarwar (2010). According to their definition, assessment for learning is to assess student performance and provide feedback during the process as well as to act on the provided feedback in a way that benefits that student's learning. With this regard, Greenstein (2010) has identified three basic principles of effective formative assessment – it is student focused, instructionally informative and outcome based. More specifically, effective formative assessment provides individualized feedback and support to students, and encourages self-assessment; it aligns assessment with standards and instruction, is embedded in instruction, and guides instructional decisions; and it provides clear, actionable feedback based on explicitly stated goals/criteria that can help close the gap between what a student currently knows and desired learning outcomes. These three basic principles and associated elements are incorporated into a rubric used in this paper in order to critique whether a website that we have developed conforms to the principles of effective assessment for learning (see Table 1 through 3).

2   Brief presentation of concept maps for learning website

The website is the integration of a user management system and a concept mapping system. The user management system is created by using PHP language whereas the concept mapping system is developed by using Adobe Flash software. The user management system consists of four different users: administrator, expert, operator and student. System administrators identify a set of domain concepts around which they intend to build a concept map. Next, a set of domain experts is invited to rate the degree of relatedness between all pairwise combinations of the identified concepts. These ratings are then averaged across experts to construct one referent (i.e., "master") concept map using the Pathfinder scaling algorithm. All links in the master concept map are supplemented with text, videos, problems, and examples to illustrate reasons why and how the linked concepts are related. After the master concept map has been developed, operators (typically teachers, but may also include researchers) are able to invite their students to create their own concept maps of the same set of concepts and receive feedback. Students create concept maps in the same way as experts (i.e., by rating the degree of relationship amongst all concept pairs). They then receive feedback by viewing their resulting concept map as compared with the master concept map. They are also encouraged to reflect on any discrepancies, as well as engage with the supplemental text, videos, problems, and examples for any links that they misunderstood (by using the mouse to click on any "missing" links)(see Figure 1).
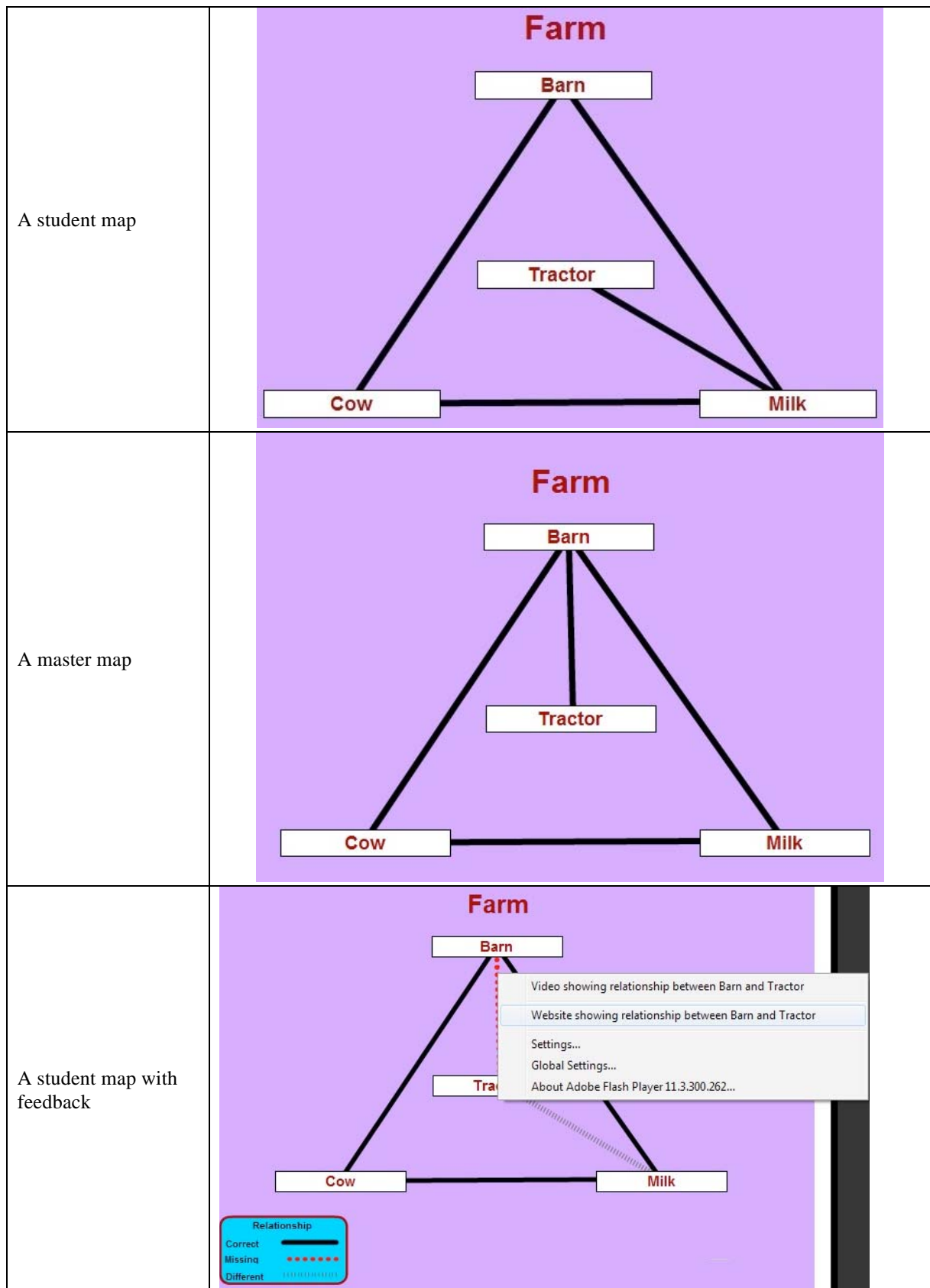
A student map	
A master map	
A student map with feedback	

Figure 1: Feedback provided to the student

Operators are able to browse both their students' concept maps with feedback and associated score cards. A score card contains a quantitative measure of the "goodness" of the student's concept map. This measure is

equal to the number of correct links divided by the sum of the number of different links and the number of links on a master map. The resulting measure ranges from 0 to 1, with a value of 1 indicating perfect agreement.

Regarding technical requirements of the concept maps website, it works with every operation system supporting any web browser with Adobe Flash Player. A mouse must also be used for taking advantage of the feedback function.

3   Analysis of how the web site is suitable for effective assessment for learning

Whether or not the web site is suitable for effective formative assessment is illustrated in the following case study adapted from Greenstein (2010) and applied to use of the web site:

A curricular standard for 10th grade Biology requires that students understand the chemical basis of all living things. In her classroom, Ms. Jefferson wants to track her students' progress toward the specific objective of describing, comparing, and contrasting the molecular structure of proteins, carbohydrates, and fats. She begins by stating the aim of the unit and order of assignments. Afterwards, she divides students into groups and asks each group to come up with concepts related to proteins, carbohydrates, and fats. After getting all the concepts from the students, Ms. Jefferson asks several other Biology teachers to rate the relatedness of those concepts associated with proteins, carbohydrates, and fats in order to create a master concept map using the concept maps for learning website. Later, the students also rate the relatedness of concepts and browse their resulting concept maps along with their associated feedback. As indicated earlier, this feedback might be different forms of explanations such as text, videos, websites, Word documents or pdf files. Then, Ms. Jefferson browses each student's concept map so that she becomes aware of any common missing and different links across the class. Ms. Jefferson uses these commonalities as the focus of a subsequent lesson. Afterwards, she has her students again do the concept mapping task. Ms. Jefferson then asks students to discuss online any remaining missing and different links in their concept maps and gives them an assignment whose questions mainly focus on common missing links in the students' concept maps.

Tables 1 through 3 display the elements of effective assessment for learning as described by Greenstein (2010) and highlight how each element is achieved in the case study using the concept maps for learning website.

Elements	Actions in case study
Track individual achievement	Records all concept maps as well as students' scores
Provide appropriately challenging and motivational instructional activities	Students find concepts related to proteins, carbohydrates, and fats; Students perform concept mapping task; Students reflect on discrepancies between their concept maps and the master map
Design intentional and objective student self-assessment	Students' concept map with feedback allows students to objectively assess themselves
Offer all students opportunities for improvement	Provides individual learning via concept maps with feedback

Table 1: Student focused elements in the concept maps website.

4   Conclusion and Future Work

It is concluded that the concept maps for learning website does conform to the principles of effective formative assessment: it is student focused, instructionally informative, and outcome based. Nonetheless, further development of the website could potentially enhance its utility as a formative assessment tool. For example, the website presently provides feedback in terms of missing and extraneous links in a student's map (as compared to a referent map); whether the student provides appropriate *reasons* for concept relationships could be considered, as well. With this regard, we could adapt the scoring framework stated by Rozali, Hassan and Zamin (2011). This framework is used to compare students' maps and a master map considering whether the reasons provided by students are appropriate. Also, in the present website, feedback is provided exclusively by experts. Integration of a discussion board in to the system could allow for peer feedback and a collaborative learning setting.

Finally, it may be noted that students' perceptions of the effectiveness of the website are currently being obtained in a variety of classroom settings.

Elements	Actions in case study
Allows for the purposeful selection of strategies	Initially, an individual remediation strategy is employed by having students reflect on discrepancies between their own individual concept map and the master map and viewing the associated reasons for those discrepant links; Later, group instruction is used to focus on common missing and different concept relations; as well, a collaborative online task asks the whole group to discuss common missing conceptual relations
Embeds assessment in instruction	Students perform the concept mapping task two times during the unit
Guides instructional decisions	After the first concept mapping task, Ms. Jefferson plans a lesson around common missing and different conceptual relationships; After the second concept mapping task, Ms. Jefferson decides to create discussion groups and develop an assignment focusing on remaining common missing conceptual relationships

Table 2: Instructionally informative elements in the concept maps website.

Elements	Actions in case study
Makes goals and standards transparent to students	Ms. Jefferson states goals and standards at beginning of the unit
Provides clear assessment criteria	Students are shown the master map after completing the concept mapping task
Closes the gap between what student knows and desired outcomes	Both Ms. Jefferson and her students review their concept maps with feedback to adjust their further learning decisions
Provides feedback that is comprehensible, actionable and relevant	Feedback is actionable thanks to different forms of explanations and pedagogical activities.
Provides valuable diagnostic information by generating informative data	The concept maps for learning website allows teachers to view each student's overall score as well as their specific missing and different links

Table 3: Outcome based elements in the concept maps website.

5   References

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