USING MOODLE AND E-ASSESSMENT METHODS DURING A COLLABORATIVE INQUIRY LEARNING SCENARIO

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ABSTRACT

In this paper, we present a learning scenario for promoting students' collaborative inquiry thinking skills in Physics by exploiting the affordances of the learning management system ―Moodle‖, which is one of the most popular open source systems (Moodle Statistics, 2014). The proposed scenario is based on the Schmidkunz & Lindemann model of Inquiry Based Learning (IBL), which seems to be one of the most effective for promoting the development of critical thinking, in-depth information processing by students, co-acquisiting of knowledge and skills through collaboration, communication and social networking. This scenario has been applied to authentic secondary school environment to teach basic concepts about Thermal phenomena. A unique feature of this scenario is the exploitation of an innovative tool for assessing students' collaborative inquiry thinking skills, the Learning Analytics Enriched Rubric - LAe-R (Petropoulou et al., 2012; Dimopoulos et al., 2013). The added value of this scenario comes from a) using various resource types and learning activities from a worldwide renowned and free educational tool such as Moodle, and b) providing teachers a distinct and structured method to perform a holistic evaluation of learning outcomes and student engagement though out the phases of the proposed scenario.

INTRODUCTION

During the last decades, teachers tend to apply modern learning techniques, e.g. inquiry based learning, as well as Information and Communications Technology (ICT) in order to enhance the educational process and insure the learning outcomes (Minner et al. 2010; Rochard et al. 2007). As Wu & Huang (2007) state, the adaptation of new learning technologies has the potential to promote student engagement, help students understand various scientific theories and facts, and help them nourish their spatial intelligence. Several studies have shown that ICT in learning have many positive effects in a classroom such as increasing computer literacy, advancing problem solving techniques, providing motivation to students, and promoting critical thinking and creativity (Drayton et al., 2010, Shapley et al., 2010 and Suhr et al., 2010).

By combining inquiry based learning with ICT-based education, more stimulating and effective educational scenarios for several science subjects can be designed thus

enhancing students' understanding of complex concepts, in a more efficient and effective way than the traditional learning practices (Van Joolingen et al., 2007; Linn et al., 2006).

In this paper we aim to a) present the design and implementation of an innovative ICT-based inquiry learning scenario that can be enacted in a Moodle environment, and b) assess and evaluate with in a usable and holistic way students' engagement and performance, using a modern e-assessment method called enriched rubrics. Enriched rubrics are a variation of the well accepted rubrics assessment method that uses extra performance criteria that stem from students' online learning behavior such as participation to a forum.

The structure of this paper is as follows. In the next session we present the added value of Moodle LMS as a tool for enacting innovative learning scenarios. Next, we portray our proposed inquiry based learning scenario that contains modern assessment techniques. The paper closes with concluding remarks and plans for future work.

USING THE MOODLE EDUCATIONAL PLATFORM

According to its documentation ―Moodle is a learning platform designed to provide educators, administrators and learners with a single robust, secure and integrated system to create personalized learning environments (Moodle Definition, 2014). Moodle is being used by millions of teachers and students worldwide, as a tool for creating and embedding learning resources and providing educational activities such as forums, quizzes, workshops, assignments etc. It is an open source web platform that can be used freely and modified even at its core by experienced technicians in order to be tailored to specific educational needs. It can also be updated by numerous plugins and modules, already created by experienced programmers, in order to provide more innovative and specific functions.

Some of Moodle's special features, which are proposed to be used when a practitioner wants to offer engaging and effective online learning experiences, are: a) the enactment mechanisms of well-structured learning scenarios, b) the extensive logging data about students interactions that can be collected, c) the advanced grading-assessment methods like rubrics and enriched rubrics, and d) the integrated tools for learning activities such as Concept Maps.

By using such features, Moodle can help teachers and students to interact and co-construct knowledge during the online learning session and apply inquiry-based learning philosophy to science related courses. Students can search for information and carry out investigations while analyzing their findings; they can develop and share their own hypotheses; they can propose their own alternatives and debate upon theses with fellow students; they can participate in synchronous and asynchronous conversations in order to have a more immediate and efficient interaction with each other; and they can view previous conversations so as to benefit from such information wealth.

As far as teachers are concerned, Moodle can provide the necessary tools in order that can structure an online session in chunks (with or without rules) as well as monitor students' involvement and online learning behavior. Moodle offers a reporting tool that can give teachers valuable information regarding students' participation, e.g. access of resources, sequence of performed activities, etc. Also, it offers a set of grading-assessment tools for creating, administering and grading students' tasks & assignments using a wealth of grading scales.

A LEARNING SCENARIO FOR TEACHING PHYSICAL PHENOMENA

Educational Problem

Heat and temperature are two different physical amounts that can't be observed directly, thus students usually form their own meaning over these terms, depending on their life experiences and intuition (Leura et al., 2005). Furthermore, students' language and culture form a significant part regarding the meaning and separation of these two physical terms (Lubben et al., 1999). In many cases, students form a dissonance about heat and temperature which is utterly wrong according to science, resulting in a misunderstanding about thermal phenomena. According to literature, some of the most frequent thesis that students state about heat and temperature are the following:

- Students think that heat and temperature have identical meaning (Harrison, 1996).
- According to Engel Clough & Driver (1985), students think that "cold" is a form of material/substance dissimilar to "hot", and in many cases heat is a substance (like the air) that has physical form and can flow thought solid objects like liquids.
- Students' idea of heat transfer is distinguished between the transference of hot and cold as different kind of materials. Heat is been transferred from hot objects, whereas cold air is transmitted from cool substances (Choi et al., 2001).
- Lastly, it is noted that not only students, but also scientists experience difficulty when they are trying to describe scientific facts, regarding heat and temperature, even in everyday situations (Başer, 2006).
- Taking in account the above facts, it is essential to establish new and more effective ways to teach these physical phenomena and so we propose the following learning scenario.

Educational Objectives

Students acquire knowledge regarding:

1. the recognition and regain of basic scientific concepts namely energy, forms of energy, energy conversion, material states, changes on material state,
2. the understanding of new terms like heat, temperature, thermal scales, thermal equilibrium, heat transfer, thermal behavior, and
3. the connection between heat transfers in everyday situations.

Students cultivate skills and abilities like:

1. observation, research, analysis, comparison, recall, evaluation and conclusion,
2. communication and collaboration as individuals or part of a team, and
3. implementation, usage and utilization of acquired knowledge.

Students form attitudes about:

1. the positive impact of inquiring methods and the search for knowledge,
2. the meaning of stating scientific arguments,

3. the value of partnership and collaboration with others,
4. the satisfaction upon dealing with authentic daily situations directly, decisively and effectively.

Instructional Method: Inquiry Learning Method

By studying the educational problem and taking into account the educational objectives, as well as the students characteristics, we concluded that the proper instructional method should be based on the Schmidkunz & Lindemann model of Inquiry Learning (IBL) (Schmidkunz & Lindemann, 1992). Using this educational approach, we can take advantage of students' natural tendency upon active discoveries, thus coaching them on how they can explore and discover new fields of knowledge effectively. This specific approach consists of five discrete steps:

1. stating the problem,
2. researching and collecting data for verification,
3. conducting experiments,
4. organizing derivatives and forming scientific explanations and
5. analyzing results.

These steps were implemented in a three session (3x45 min) lesson course.

Step 1. Stating the problem

Heat recognition and misunderstandings (Duration: 5 min)
Students view a presentation with various examples regarding heat and its main effects on everyday life, as well as the main misconceptions arousing from studying this phenomenon.

Recollecting prior knowledge (Duration: 15 min)
Students watch certain simulations concerning energy and energy sources, which help them better understand the phenomenon.

Step 2. Researching and collecting data for verification

Examples of thermal phenomena (Duration: 10 min)
Students watch an educational video with various daily examples about thermal phenomena, which will help them understand how heat can be transferred in different ways.

Brainstorming (Duration: 10 min)
Students participate in a group dialog created as a forum topic in Moodle, stating their own opinion as an answer to the main question: "in how many ways does the heat transfer".

Quiz: the meaning of heat conductance (Duration: 5 min)
Students take a quiz to answer how many ways are there to transfer heat and which daily examples support these ways. This is a grading activity counting 10% of the final grade. This activity is supported by Moodle's Quiz module and grading of students is carried out automatically within the platform.

Step 3. Conducting experiments

Experimenting on ways of heat transfer (Duration: 10 min)
Students participate in an online simulation experiment, regarding the different ways of heat transference, by following the teacher's instructions.

Stating facts (Duration: 10 min)
Students state scientific facts based on their previous experimentation using the indicated forum instance created in Moodle in order to support online communication and sharing. This activity will be graded using Moodle's advanced grading plugin LAe-R. This plugin is used to create enriched rubrics that contain interaction analysis indicators as criteria, assessing students according to their participation during their evolvement in forum conversations. This grade will be counting for 15% of the final grade and it will be computed automatically by the plugin.

Step 4: Organizing derivatives and forming scientific explanations

Forming workgroups and composing scientific arguments (Duration: 10 min)
Students are divided into groups where each group forms its own statement according to instructions given by the teacher. A Workgroup activity module is used in Moodle to facilitate this operation.

Peer evaluation (Duration: 10 min)
Students evaluate each other's statements and provide logical and scientific explanation about their assessment. The teacher, using the workgroup's features in Moodle and counting 20% of the final grade, will manually grade this activity. A simple rubric, created by the teacher, can be used for the needs of assessment. It will contain specific criteria regarding the group discussion items and the feedback comments given by other peers. Criteria will be related to content, structure, continuity, consistency, written expression, as well as mutual respect and helpful behavior.

Classification of thermal phenomena according to ways of transfer (Duration 5 min)
Students form a concept map using Moodle's Concept Map plugin in order to present: a) concepts regarding thermal phenomena, b) ways to transfer heat, c) connecting thermal effects with daily events. This assignment will be manually graded by the teacher using a simple rubric. It will count 20% of the final grade. Rubric criteria will be content structure, content connectivity, relationship description, used examples and map layout.

Step 5. Analyzing results

Matching quiz (Duration: 5 min)
Students participate in an assignment quiz to match scientific phenomena with actual everyday circumstances using Moodle's Quiz module. This is a grading activity counting 15% of the final grade and grading of students is carried out automatically within the platform.

Proposals for reducing the cost of heating (Duration: 30 min)
Students create a small presentation regarding heat transference and proposing a way to reduce the cost of heat using a daily example. This is an assignment that will be manually graded by the teacher using a simple rubric, according to the file each student submits and counting 20% of the final grade. Rubric criteria will be created according to content, structure, continuity, consistency, written expression, number of slides and embedded multimedia and layout.

Evaluation of instructional method (Duration: 10 min)
In the last part of the lesson's final step, students complete a questionnaire regarding cognitive and meta-cognitive statements for each step of this learning scenario. For example: do they feel satisfied upon their inquiries and their findings, or do they feel confident to try this method another time for acquiring knowledge on another learning subject, etc.

Final Grading
Student's final grade was produced as a summative result of previous assignments. Specifically students' final grade was estimated according to the following type:

Final grade = [Quiz: the meaning of heat conductance]

- +[Stating facts]
- +[Peer evaluation]
- +[Classification of thermal phenomena according to ways of transfer]
- +[Matching quiz]
- +[Proposals for reducing the cost of heating] / 100

CONCLUSIONS

In this paper we presented the analytic design of an innovative science-related learning scenario that can be enacted into the Moodle platform thus taking advantage of its features for offering engaging and effective learning experiences. The scenario follows the principle of IBSE and proposes the use of modern e-assessment techniques. The ultimate learning goal is to help junior high students understand scientific concepts around heat and temperature, as well as to promote the acquisition of students' inquiry thinking. This scenario has been applied into an authentic school environment. Also, it was been shown to teachers during teacher training workshops on IBSE. According to students and teachers feedback,: a) they appreciated the use of Moodle for performing the various activities, b) the learning process seems engaging, c) the assessment process was transparent and the evaluation comments are holistic since several factors f performance can be measured.

Our future plans consist of designing, developing and implementing more educational scenarios around scientific concepts, as well as adapting new and enhanced assessment methods that should provide better understanding of what and how students learn during an ICT-based inquiry learning scenario.

ACKNOWLEDGEMENTS

This work has been partially supported by the SAILS project that has received funding from the EU Seventh Framework Program (http://www.sails-project.eu/).

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