PBL3.0

Integrating Learning Analytics and Semantics in Problem-Based Learning

Zotou, Maria; Tambouris, Efthimios; Triantafyllou, Evangelia; Timcenko, Olga; Kofoed, Lise; Stracke, Christian; Riviou, Katerina; García Barriocanal, Elena ; Utz, Wilfrid; Martos, Peter ; Tarabanis, Konstantinos

Publication date:
2016

Document Version
Accepted author manuscript, peer reviewed version

PBL3.0: Integrating Learning Analytics and Semantics in Problem-Based Learning

Maria Zotou[1], Efthimios Tambouris[1], Evangelia Triantafyllou[2], Olga Timcenko[2], Lise Busk Kofoed[2], Christian M. Stracke[3], Katerina Riviou[3], Elena García Barriocanal[4], Wilfrid Utz[5], Peter Martos[5] and Konstantinos Tarabanis[1]

[1]University of Macedonia, Thessaloniki, Greece
{mzotou,tambouris,kat}@uom.gr
[2]Aalborg University, Copenhagen, Denmark
{evt,ot,lk}@create.aau.dk
[3]Open University of the Netherlands, Heerlen, The Netherlands
{Christian.Stracke,Katerina.Riviou}@ou.nl
[4]University of Alcalá, Alcalá de Henares, Madrid, Spain
elena.garciab@uah.es
[5]BOC Asset Management GmbH, Vienna, Austria
{Wilfrid.Utz,Peter.Martos}@boc-eu.com

Abstract. This paper presents the PBL3.0 project that aims at enhancing Problem Based Learning (PBL) with Learning Analytics (LA) and Learning Semantics (LS) in order to produce a new educational paradigm and pilot it to produce relevant policy recommendations. To this end, the project will reach the following objectives and corresponding specific goals: 1) Construct a new educational approach that combines a well-established learning strategy like PBL with novel technologies in learning like LA in PBL respecting legal and ethical considerations (PBL_LA), 2) Design a semantic model for PBL_LA, which will enable the annotation of learning resources in order to easily integrate them to the PBL approach and enable their discoverability when setting personalized learning pathways, 3) Adapt a set of open source software tools for supporting PBL_LA and the semantic model based on existing Learning Management Systems, analytics tools, and an intuitive semantic annotation tool, 4) Create relevant, semantically annotated educational material and perform trials at various sites in order to draw evidence-based conclusions, 5) Produce relevant policy recommendations for PBL_LA that could raise the quality in education and training, 6) Create an organic ecosystem of among others organizations, researchers, educators, students with an interest in PBL_LA. Finally, the project will develop a Community of Practice, where institutions and individuals from across Europe will be able to exchange knowledge and expertise on LA, learning semantics, innovative learning tools and approaches. This aims to support transnational cooperation and mutual learning on forward-looking issues between key stakeholders to provide solutions to current challenges in education and training.

Keywords: learning analytics · learning semantics · problem-based learning

adfa, p. 1, 2011.

1 Introduction

The education and training field has progressed over the years, by introducing novel learning strategies that aim to shift the focus from the educator to the learners as well as novel technologies to support learning activities [1]. However, policies in the field continue to identify limitations and issues that are required to be addressed and solved [2]. Moreover, the current ever-changing world causes economies, trends, technologies and professional domains to constantly shift and transform. To this end, all sectors require competent employees with lifelong learning abilities and skills to quickly adapt and contribute to economic growth and boost societal benefits [3].

This paper presents the PBL3.0 project that aims to address these challenges and propose new innovative pedagogical and technological approaches that will tackle existing issues in education and training and raise their quality. This project aims to establish a robust cooperation mechanism where institutions across Europe will be equipped to successfully incorporate Learning Analytics (LA) and semantics in their educational settings. To this end, the project consortium will work towards the development of new innovative models, good practices and recommendations regarding the usage of LA in well-structured learning environments, i.e. environments where courses are designed and executed following a structured learning strategy that fosters transversal skills development such as Problem-Based Learning (PBL).

2 Background

2.1 Problem-Based Learning (PBL)

PBL is a student-centered pedagogy in which students learn through the experience of problem solving [4]. The goals of PBL are to help the students develop flexible knowledge, effective problem solving skills, self-directed learning, effective collaboration skills and intrinsic motivation [5]. PBL represents also a paradigm shift from traditional classroom/lecture teaching. The role of the instructor in PBL (known as the tutor) is to facilitate learning by supporting, guiding, and monitoring the learning process. Finally, PBL supports group work. Working in groups, students identify what they already know, what they need to know, and how and where to access new information that may lead to resolution of the problem. This procedure enhances content knowledge while simultaneously fosters the development of communication, problem-solving, critical thinking, collaboration, and self-directed learning skills.

PBL was first introduced in the medical school program at McMaster University in Hamilton, Ontario, Canada in the late 1960s [4]. Since then, various universities and other educational institutes have adopted PBL as a model of teaching and learning. From such local adaptations, various PBL models have arisen. In Aalborg University, Denmark, all university programs have been based on PBL, also referred to as “PBL - The Aalborg model” [6, 7]. When establishing the AAU in 1974, a redeveloped approach to the traditional PBL had already emerged, and the ideals in this involved providing students with an active, participative role, and high degree of engagement

in the creation of knowledge, both in lectures and as part of group-based project work. The PBL - Aalborg Model has become both nationally and internationally recognized and a trademark for Aalborg University.

2.2 Learning Analytics (LA)

The increased usage of learning technologies such as learning management systems, Web 2.0 tools, and social media has led to the generation of a large variety of different and multimodal educational data [8]. Thus, an important question is how we can gather and make sense of all these data in order to improve learners' performance, teachers' role and course's design. Up to 2010, there was still limited exploitation of such data from educational institutions and companies, leading to increased numbers of dropouts and delayed actions taken to enhance performance [9]. The main purpose of this new field is to try and make sense of learning related data and provide insights on how to enhance the learning experience for both learners and teachers [8].

LA is strongly related to the learning technologies that have become an integrated part of the learning experience through the technology enhanced learning paradigm. Such technologies generate large amounts of educational data, and range from cognitive tools to more sophisticated and complex environments like Learning Management Systems (LMSs), Virtual Learning Environments (VLEs) and the recent Massive Open Online Courses (MOOC) spaces.

The LA domain can thus reinforce education and training through providing feedback based on generated data and allowing an in-depth understanding of the learning experience. This can be done by accumulating as much educational data as possible and enabling learners and educators to comprehend the information provided and make decisions in regards to the learning process, the learning processes, learners' knowledge and skills as well as their weaknesses and misconceptions, and the assessment's efficiency. All these insights can then underpin successful personalized and adaptive learning that improve all aspects of education and training.

2.3 Existing approaches on using LA in PBL-environments

In the literature, there are a few case studies that have attempted to integrate LA in PBL environments. Tempelaar et al. [10] carried out a research study for learning and teaching of mathematics and statistics in a blended learning environment. The methodology used includes a face-to-face part of the learning process which followed the PBL strategy and an online part which is optional. Within PBL, students were required to form small groups, where each group had a specific content expert and mentor. The data collected during the learning process included performance scores, frequency of using the practice tests, time spent on practice tests, number of attempts at solving a problem, variables that demonstrate prior knowledge, student profile, groups formed, engagement levels and learning styles. This case study concluded that the usage of the online environments as a complimentary tool to PBL proved to help students, as they helped in the support of self-direction, reflection and decision making. Students of PBL are usually new at this learning model, where they hold the majority

of the responsibility to gain knowledge, and it seemed that visual feedbacks on how the self-directed learning is proceeding has made them more confident in this control shift.

Göhnert et al. [11] have developed a web-based Analytics workbench that allows multiple types of analytics results as separate modules, such as community detection, networks of interactions amongst learners and course elements, log statistics, workflows, identification of central actors, diverse visualizations with graphs, and activity statistics. This workbench has not been developed specifically for education and training, however the authors believe that it can easily be employed in such settings, and performed three different case studies to determine the validity of their assumption. One of the case studies involved a project, which provided trainings for doctors practicing in family medicine using the PBL strategy. The integration of the platform used in this project with the Analytics workbench required the gathering of data from the platform so that it can be processed and analyzed within the workbench. The LA results available after this integration included graphs or data tables with results similar to the modules supported by the workbench. No specific information was provided in the study regarding the effectiveness of the solution and actual LA outputs from the doctors' PBL practices.

This project utilizes the PBL strategy, since PBL shifts the focus from understanding common knowledge to developing new knowledge through "learning by doing" activities, and accommodates active participation of students with varying learning styles. However, there is a need for this very promising model to be renovated and exploit novel opportunities and technologies that will unleash new benefits and capabilities [12]. On the other hand, these novel developments, such as LA, can be confusing and overwhelming for stakeholders. Thus, the project aims to integrate PBL with LA in order to capitulate on their respective strengths and address their drawbacks. Finally, it is essential that education and training will connect with the web of data, and participate in providing meaning to data, enabling personalized learning and resources discoverability as well as enriching knowledge and processes utilized by observing the worldwide developments. To this end, the project will design a semantic annotation model that will enable the learning resources' annotation, allowing their future discoverability and connection with other resources.

3 Aim

The project will include a number of cooperation activities such as brainstorming sessions, workshops, focus groups, interviews etc. within the consortium and with external parties for the production of multi-sectoral and multi-dimensional systematic results. During this process the whole LA lifecycle will be taken into account: i) data gathering, ii) information processing, and iii) knowledge application.

These activities will lead to a domain- independent LA intervention educational model (PBL_LA), which will study each PBL step based on the 1) identification of educational data that is generated in all steps of PBL (data gathering), 2) analysis of all processes and techniques that transforms educational data to meaningful, multi-

modal information (information processing), 3) identification of all intervention mechanisms that could be put into practice based on all LA feedback during course design and course execution.

However, the interventions that should be carried out during education and training based on LA recommendations require a common understanding of the appropriate resources to be delivered. To this end, the consortium will also develop a Semantically Annotated Learning Object (SALO) model, which will indicate all the necessary elements (e.g. learning objectives, learning topic, skills, learning outcomes, type of materials etc) that should be included in the description of a learning object. The project will continue to provide a semantic annotation tool based on this model in order to enable learning resources annotation by all learning content providers such as MOOC providers, OER providers, educational institutions, national organizations etc. This will foster content discoverability and linkage of learning resources with the Web of Data. Also, this way LA tools can more easily and automatically suggest learning objects to teachers or students based on specific criteria.

Furthermore, the project will develop a platform called LACoP (Learning Analytics Community of Practice) that will host two spaces. The first is the community building space, where institutions and individuals from across Europe will be able to exchange knowledge and expertise on LA, Learning Ssemantics (LS), innovative learning tools and approaches etc. The platform will also will also be a sustaining repository of all results, brainstorming sessions, digital learning resources and tools that will aim to support a higher quality in education and training. The second will be the e-learning space based on existing LMS (e.g. Moodle), which will host all educational and training activities, and it will be populated with all PBL, LA and LS tools, learning materials and a model-based continuous assessment tool.

Finally, the project will employ the PBL_LA model by designing educational and training sessions according to the model's features in order to test its validity and executing the corresponding courses in their respective sectors. The learning objects annotated with the SALO model will also be used and further tested in these trials if and how they support adaptability and personalization based on the LA feedback. The trials will be hosted and executed in the e-learning space that will be developed with the LACoP platform.

4 Conclusion

This paper presents a project, where the PBL_LA paradigm will be developed that combines PBL with LA and LS. This new paradigm will bring about PBL 3.0., which will merge PBL with Web 3.0., i.e. the connective intelligence, where we can connect data, concepts and even people. The project will reach the following objectives and corresponding specific goals: 1) Construct a new educational approach that combines PBL with LA (PBL_LA), 2) Design a semantic model for PBL_LA, 3) Adapt a set of open source software tools for supporting PBL_LA and the semantic model, 4) Create relevant, semantically annotated educational material and perform trials at various sites in order to draw evidence-based conclusions, 5) Produce relevant policy recom-

mendations for PBL_LA that could raise the quality in education and training, 6) Create an organic ecosystem of stakeholders with an interest in PBL_LA. Moreover, the project will develop a Community of Practice, where institutions and individuals from across Europe will be able to exchange knowledge and expertise on LA, LS, innovative learning tools and approaches. This aims to support transnational cooperation and mutual learning on forward-looking issues between key stakeholders to provide solutions to current challenges in education and training.

5 Acknowledgments

This project is co-funded by the Erasmus+ programme of the European Union under the project number 562236-EPP-1-2015-1-EL-EPPKA3-PI-FORWARD. The European Commission support for the production of this publication does not constitute an endorsement of the contents which reflects the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

References

1. Norman D. A., Spohrer J.C.: Learner-centered education. Commun ACM 39, 24-27 (1996).
2. European Commission: Youth on the move initiative. an agenda for new skills and jobs: A european contribution towards full employment. (2010).
3. EU: Joint progress report of the council and the commission on the implementation of the education and training 2010 work programme. "Key competences for a changing world". 2010/C 117/01 (2010).
4. Neville A. J.: Problem-based learning and medical education forty years on. 18, 1-9 (2009).
5. Hmelo-Silver C. E.: Problem-based learning: What and how do students learn? 16, 235-266 (2004).
6. Barge S.: Principles of Problem and Project Learning, The Aalborg PBL Model. Aalborg University, Aalborg (2010).
7. Kjærsdam F., Enemark S.: The Aalborg experiment project innovation in university education. Aalborg Universitetsforlag (1994).
8. Ferguson R.: Learning analytics: Drivers, developments and challenges. 4, 304-317 (2012).
9. Siemens G., Long P.: Penetrating the fog: Analytics in learning and education. 46, 30 (2011).
10. Tempelaar D. T., Heck A., Cuypers H., van der Kooij H., van de Vrie E.: Formative assessment and learning analytics. , 205-209 (2013).
11. Göhnert T., Ziebarth S., Malzahn N., Hoppe H.U.: Enriching (learning) community platforms with learning analytics components. , 177-184 (2014).
12. Dolmans D. H., De Grave W., Wolfhagen I.H., Van Der Vleuten, Cees PM: Problem-based learning: Future challenges for educational practice and research. Med.Educ. 39, 732-741 (2005).