Ways of Seeing Student Learning

With Machine Learning and Learner Models

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ABSTRACT

The emerging field of learning analytics is showing promise as a light to shine into the dark corners of individual student experience. By making the richness of the learning process more visible, learners and teachers can access deeper insights into their shared experience. Data and models can provide a mirror for self-reflection and metacognition [1]. As Gašević [2] reminds us, Learning Analytics are about learning. However, too little attention has been paid to the student's role in data-rich learning environments [3].

This research will use probabilistic machine learning techniques in conjunction with other learning model approaches to produce interactive learning models [4] that can be integrated in existing learning analytics systems. One such system will be shared with students in a module of a BSc in Computing degree course and a mixed-methods study of their experience conducted – with students having full control of their data.

KEYWORDS

Learning Analytics, Open Learner Modelling, Machine Learning, Metacognition

1 INTRODUCTION

As Biesta [5] notes, central to education's purpose is 'the coming into presence of unique individual beings' and to facilitate this, education spaces must 'open up for uniqueness to come into the world'. This is the ontological starting point of this research along with Paulo Freire's [6] emphasis on the student as an agent of praxis in their learning environment.

A key part of this individual development is the role of metacognition. As students encounter learning challenges, they can greatly increase their agency and personal development by learning about their own learning process and engaging in metacognitive activities [1].

2 GOAL OF THE RESEARCH

Develop and apply machine learning and open learner models to support student metacognition in a pre-existing connected learning analytics systems. These models and machine learning enhancements will be used to make learning more visible to students and facilitate metacognitive reflection on their learning.

This goal will be achieved through the following objectives:

1. Identify appropriate candidate modelling techniques like Open Learning Modelling (OLM) [7], and similar, to allow students to capture and visualise their metacognitive activities
2. Classify student learning activity data to build an enhanced model of their learning – particularly in relation to metacognition
3. Identify, develop and implement appropriate machine learning techniques to use in conjunction with other learning models to allow students to see the nature of their metacognitive activity and to track it over time
4. Map and visualize these patterns and relations to make them more visible to students
5. Enhance and optimise existing machine learning approaches for future work in student learner modelling

3 ETHICAL FRAMEWORK

These objectives will be grounded in a clear ethical framework for the management and governance of the data involved to ensure the protection of student privacy informed by Prinsloo et al [8] and Draschler et al [9].

4 HOW IS THIS SOLUTION DIFFERENT, NEW OR BETTER THAN EXISTING APPROACHES?

- Grounded in the Student perspective
- Students as owners of their learning data
- Links learning analytics to learning design
- Emphasis on Connected & Networked learning [10]
- Machine Learning with an emphasis on modelling and visibility as well as prediction
- Data literacy capacity building for students

5 CURRENT KNOWLEDGE OF THE PROBLEM

There are many student modelling approaches [11] but not all are accessible to the student themselves and not all lend themselves to effective reasoning approaches. Bayesian Networks are simple constructs in some ways but have been proven to be powerful in student modelling [4]. Bayesian Networks were first described by Judea Pearl [12] as 'directed acyclic graphs' which can be used to model causal dependencies between variables. The paper was initially presented at a cognitive science conference which may hint at the original motivation behind Bayesian networks.

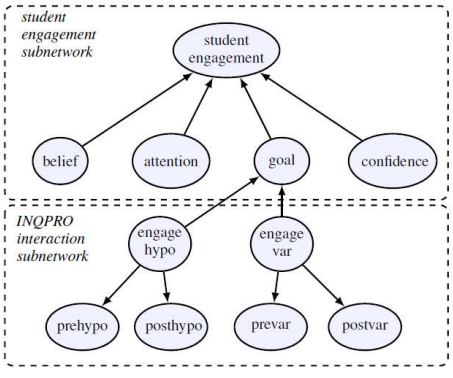

Figure 1 Bayesian Network Model of Student Engagement [13]

ACKNOWLEDGMENTS

The authors acknowledge the support of Ireland's Higher Education Authority through the IT Investment Fund and ComputerDISC in NUI Galway.

REFERENCES

1] K. R. Koedinger, V. Aleven, I. Roll, and R. Baker, 'In vivo experiments on whether supporting metacognition in intelligent tutoring systems yields robust learning', *Handb. Metacognition Educ.*, pp. 897–964, 2009.

[2] D. Gašević, S. Dawson, and G. Siemens, 'Let's not forget: Learning analytics are about learning', *TechTrends*, vol. 59, no. 1, pp. 64–71, Jan. 2015.

[3] K. Kitto *et al.*, 'The connected learning analytics toolkit', 2016, pp. 548–549.

[4] E. Millán, G. Jiménez, M.-V. Belmonte, and J.-L. Pérez-de-la-Cruz, 'Learning Bayesian Networks for Student Modeling', in *Artificial Intelligence in Education*, vol. 9112, C. Conati, N. Heffernan, A. Mitrovic, and M. F. Verdejo, Eds. Cham: Springer International Publishing, 2015, pp. 718–721.

[5] G. J. J. Biesta, *Good Education in an Age of Measurement: Ethics, Politics, Democracy*. Routledge, 2015.

[6] P. Freire, 'Pedagogy of the Oppressed. 1970', *N. Y. Contin.*, p. 125, 1993.

[7] S. Bull and J. Kay, 'Open Learner Models', in *Advances in Intelligent Tutoring Systems*, vol. 308, R. Nkambou, J. Bourdeau, and R. Mizoguchi, Eds. Berlin, Heidelberg: Springer Berlin Heidelberg, 2010, pp. 301–322.

[8] S. Slade and P. Prinsloo, 'Learning Analytics: Ethical Issues and Dilemmas', *Am. Behav. Sci.*, vol. 57, no. 10, pp. 1510–1529, Oct. 2013.

[9] H. Drachsler *et al.*, 'Ethical and privacy issues in the application of learning analytics', 2015, pp. 390–391.

[10] C. Cronin, 'Open, networked and connected learning: Bridging the formal/informal learning divide in higher education', *Proc. 10th Int. Conf. Networked Learn. 2016*, May 2016.

[11] K. Chrysafiadi and M. Virvou, 'Student modeling approaches: A literature review for the last decade', *Expert Syst. Appl.*, vol. 40, no. 11, pp. 4715–4729, Sep. 2013.

[12] J. Pearl, *Bayesian networks: A model of self-activated memory for evidential reasoning*. University of California (Los Angeles). Computer Science Department, 1985.

[13] C.-Y. Ting, W.-N. Cheah, and C. C. Ho, 'Student Engagement Modeling Using Bayesian Networks', 2013, pp. 2939–2944.