Learning process analytics for a self-study class in a Semantic Mediawiki

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ABSTRACT
We describe a framework and an implementation of learning process analytics for both learners and teachers to enhance a self-study class on psychological and educational theory. The environment is implemented in a Semantic MediaWiki using Semantic Forms and Semantic Result Formats. The design is in early development, but it is deployed and operational.

Categories and Subject Descriptors
K.3.1 Computer Uses in Education: Collaborative learning
H.5.4 Hypertext/Hypermedia: Theory

General Terms
Measurement, Documentation, Design, Human Factors.

Keywords
Learning analytics, learning cockpit, learning dashboard, online learning, Semantic MediaWiki, Semantic Forms, Semantic Result Formats, self-study course.

1. INTRODUCTION
This paper describes a design and implementation of learning process analytics to enhance an online self-study course. The learning environment (including the study materials and the learning management system functionality) is implemented within an existing Semantic MediaWiki [4] installation (http://edutechwiki.unige.ch/fr/BASES).

According to Knight, Buckingham Shum & Littleton [13], the type of analytics chosen reflects the pedagogical orientation chosen. We define learning *process* analytics as the measurement and collection of learner actions and learner productions, organized to provide feedback to learners, groups of learners and teachers during a teaching/learning situation. This information can be presented in various forms, e.g. a browsable analytics web site or a dashboard and should engage participants in reflection with respect to their different goals, roles, tasks, productions, and so forth.

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2. CONTEXT AND REQUIREMENTS
In 2013, we introduced a new course to provide master students in educational technology with theoretical background in psychology and education. Due to the lack of resources, we decided that it should be a self-study class capitalizing on the wiki. To design the overall workflow for the class and to scaffold self-regulation, both Merrill's [11] first principles of instruction and Ley & Young's [14] POME (Prepare Organize Monitor Evaluate) models inspired us. In essence, since reading doesn't automatically lead to learning, students must be engaged in active reading, interacting, reflecting, and producing.

We defined the following operational design goals: Learners should be part of a collective reading and learning experience, be aware of other's productions, and help each other. Learners must create productions. These also should demonstrate their understanding of chosen topics. The wiki environment should include navigational aids and help students coordinate their activities. Student productions should become teaching materials for future classes.

In order to meet these educational principles and practical goals, we implemented data collection and analytics tools that will be presented in the next section.

The course requirements are very simple:

- Each participant must create three concept maps that address three central questions on a single subject. The maps then must be presented with screencasts. Both are called "productions".
- Maximum of two students are allowed to work on the same global subject represented by a single wiki "subject" page.
- Provisional productions are to be inserted in discussion pages attached to subject pages. Final productions are subpages and therefore become part of the subject pages.
- Using the aforementioned discussion pages, each participant must provide comments and help for at least six other productions.
- Both productions (75%) and peer commenting (25%) will be evaluated at the end of the course.
- No tutoring is provided, except for occasional reminders or help with organizational and technical problems due to bad design or bugs.

The main study material is an expandable wiki textbook. Each subject area uses one wiki page. Contents are available to the public at large and could be used organize a future MOOC-like course. Student-made screencasts could replace the typical videos found in xMOOCs. The purpose of this contribution is to present and discuss (a) a learning design that meets design goals and course requirements for a effective self-study class, and (b) to reflect on a technical implementation that was done with “end-user programming” tools and skills.

3. THE SYSTEM

MediaWiki (the technology developed for Wikipedia) plus the Semantic MediaWiki extensions have interesting affordances to support “whole scholarship” as defined by Boyer [3], in particular for the integration of diverse academic activities like exploration, research and teaching. A well-configured and maintained wiki can combine “learning management” with “collaborative information and knowledge management”, and do so at a reasonable cost [12]. We use wikis (http://edutechwiki.unige.ch/) for many educational purposes, e.g. as content management tool for writing tutorials including study books, as lesson planning and management system for technical classes, as writing-to-learn environment, as literature review tool, and as technology resources tool.

For Suthers & Verbert [15] cited by Knight et al. [13], learning analytics “occupies the ‘middle space’ between the learning sciences/educational research, and the use of computational techniques to capture and analyze data. Consequently, there is a “triadic relationship between epistemology, pedagogy and assessment provid[ing] critical considerations for bounding this middle space” (p.2). Our design can be situated between a pragmatic, sociocultural approach (concerned with assessing and improving the learning process), an instructionalist approach (concerned with assessing some kind of “knowledge transfer”), a constructivist/constructionist approach (focusing on progress and productions) and a connectivist approach (concerned with exploring the connectedness of the learner’s knowledge). (p. 9-10).

To design learning process analytics support aligned with the above mentioned mixed approach, the system currently provides the following functionalities: enhanced navigation, information collection forms, page/subject dashboards, learner dashboards and a global learner/teacher dashboard. Each of these is continuously improved as ideas pop up and needs arise.

3.1 Navigation

A global course page provides direct links to various navigation and information tools. Navigation between pages is enhanced with widgets (see Figure 1) and tables summarizing page contents.

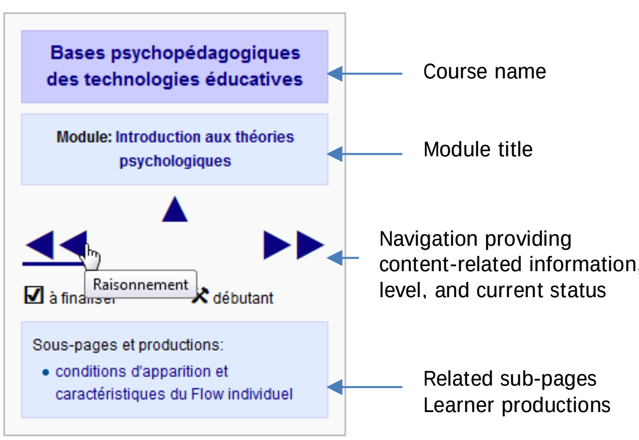

Figure 1: Navigation widget

The navigation widget can be edited with a simple form as shown in Figure 2. The authors of a page must provide defined related pages (previous, next, up, module and course), status (from draft to final), and any extra information such as difficulty level.

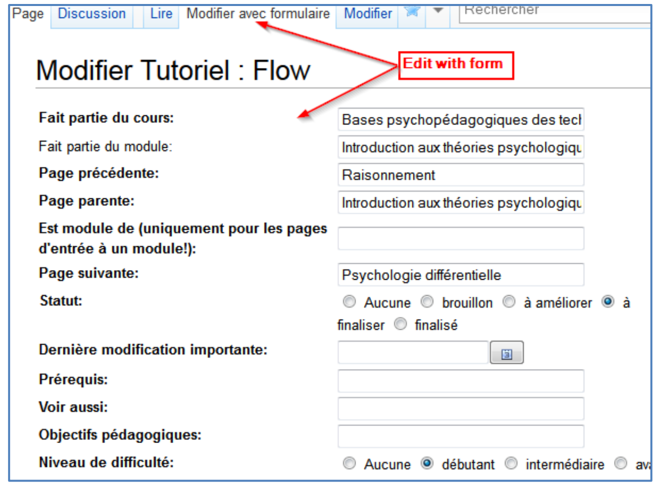

Figure 2: Navigation widget edit

A graph allowing verification of the topology of the navigation structure is automatically generated by the wiki.

3.2 Page Cockpit

Each subject page includes a cockpit (see Figure 3) that summarizes information collected from learners. Participation analytics include the following: who contributed a concept map and screencast and who will be the discussant. Reading analytics display statistics of the learners’ reading progress and their evaluation of the page contents/subject area.

Learners provide and update data through (the same) single forms that are attached to subject pages, i.e. by clicking on the “participation button” shown at the bottom of Figure 3. Learners enter three types of information in the form that appears in Figure 4: Engagement to participate as producers or peer commenters, completion rate of these productions, completion of reading and understanding, and their rating of the subject/wiki page.

Figure 3: Wiki page cockpit (partial view)

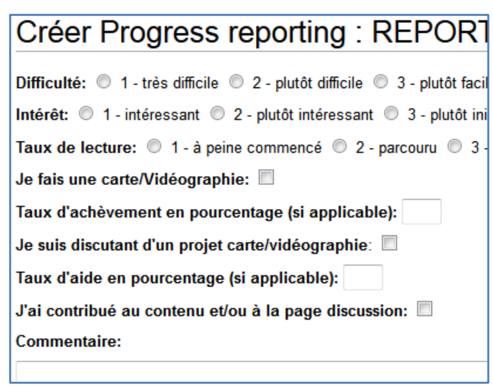

Figure 4: Page/subject reporting form

3.3 User page cockpit

Information entered by individual learners is made available on each student's home page in order to help them manage their own learning. Learners see data about productions and peer commenting, including achievement badges and details. Furthermore, a chart summarizes and a table details their reading-related data (partly shown in Figure 5).

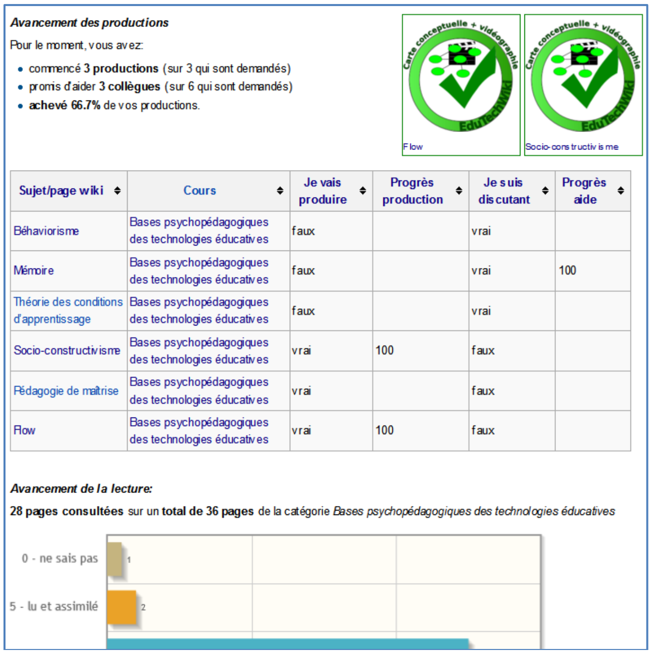

Figure 5: User page dashboard

3.4 Course dashboards

Similar information is then aggregated at the course level. Course dashboards allow participants to get (a) an overall picture and (b) to look at specific data as shown in Figure 6 and Figure 7. For these overall pictures we experiment with various types of charts (e.g. bubbles, bars, pies, word clouds, treemaps).

For example, the bubble chart in Figure 6 provides a graphical summary of each participant's number of wiki pages annotated with the form. It gives the picture typical of a small class, i.e. two very active students and some that lag behind…

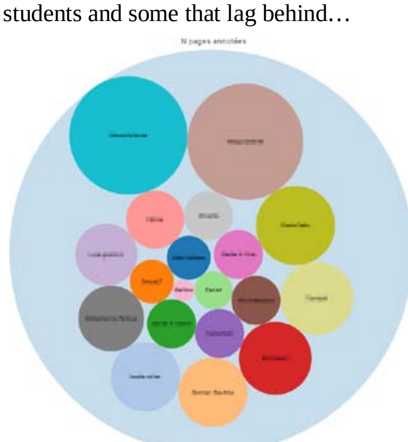

Figure 6: Bubble chart, N pages annotated per user

Figure 7 provides an overview of participants' engagement as peer commenters with respect to the subjects/wiki pages. Some subjects appear to be more popular than others.

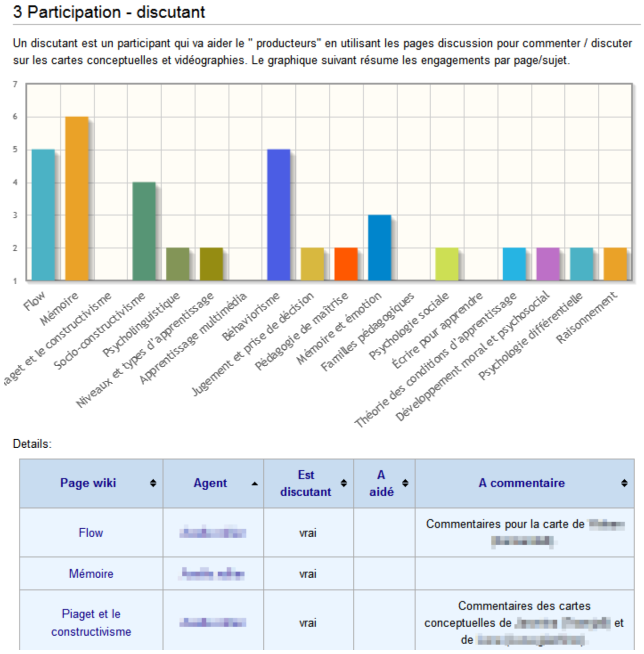

Figure 7: Overview of discussants' work

4. IMPLEMENTATION

The system is implemented with Semantic Media (SMW) [4] and various extensions built on top of it, in particular Semantic Forms (SF) and Semantic Result Forms (SRF).

On the technical end, we implemented an annotation system using SMW properties. Although Semantic Forms was not designed for this, we managed to implement a data collection and analytics tool. Figuring out how to store data was difficult. We finally decided to use a custom REPORTING namespace and a subpage hierarchy, i.e. to create one subpage for each student's annotation of a page, resulting in the following type of structure:
REPORTING:Progress_reporting/Learner Name/Subject

Since the implementation is subject to continuous change, except for a short informal paper [5], we have not yet produced any documentation. However, since our wiki is open to the public, anyone familiar with SF can grab the various SF templates, forms, and the semantic property definitions.

5. RESULTS AND DISCUSSION

In order to prepare the next design cycle, we conducted semi-structured interviews with four students, we explored wiki data, and we looked at course evaluation statistics. Overall, the course was rather well received and the concept maps and screencasts produced were of good quality. However, students expressed many criticisms and suggestions for improvement that will inform the next design: (a) Instructions and expectations need to be made more explicit. (b) The interface(s) must be improved to allow all students to "see" what is crucial. (c) The reporting form must be redesigned to reflect current needs (e.g. "commenter needed") and willingness to engage in commenting. (d) A single central cockpit should display all information needed for planning and coordinating activities. (f) We judged discussion pages used for peer discussion to be "messy". Most students found peer commenting crucial and highly useful, however, some argued that its quality could be improved by providing some "structure". (g) Three interviewed students found badges very useful and stimulating, one did not. (e) Reading analytics was used little.

5.1 Related work

We designed our system using a rapid prototyping approach. Little theory was used: first principles of instruction [11], a self-regulation instructional design model [14], a CSCL cockpit concept [9] and learning analytics [8,13,15]. Learning *process* analytics has a long tradition in educational technology research, e.g. Soller et al.'s collaboration management cycle framework [9]. Most are made for research and not found in production.

Our analytics tools can be related to cognitive tools that rely on the participation of learners, as defined by LaJoie & Derry [1] and Jonassen & Reeves [2]: Cognitive tools are unintelligent and rely on the learner to provide the intelligence, not the computer. They provide scaffolds for planning, decision-making, reflection, discussion, and collaborative problem-solving.

Learning process analytics data could be retrieved from the system, e.g. with advanced text mining technology built on top of system like StatMediaWiki [7]. However, it is simpler to ask the user. To get *dispositional* analytics as defined by Ferguson and Buckingham Shum, we *must* ask the user. Their Enquiry Blogger [8] provided us with some initial inspiration.

Further inspiration was provided by the widgets produced for the ROLE project, e.g. the Student Activity Monitor [10]. However, their system relies on external widgets and services, whereas our implementation relies fully on standard SMW functionality. Our solution may turn out to be technically more sustainable.

5.2 Discussion

Could Semantic MediaWiki (SMW) end-user programming technology play a more important role in education and is it "affordable"? SMW documentation is fairly abundant, but it was somewhat difficult to *get going*. In order to understand Semantic Forms (SF), one must understand Semantic Web principles, Wiki templates and parser extensions, and SMW principles. The only good book for wiki administrators [6] requires good technical reading skills. There are gaps in the documentation and SRF documentation barely exists. Debugging tools are underdeveloped so far. Nevertheless, it took us about two person-months to become familiar with the technology and less than two person-weeks to implement this system.

We also use the SMW/SF/SRF technology for research documentation in citizen science and text mining, demonstrating that it could be used to implement inquiry-learning scenarios where students engage in collective data collection and analysis. SMW technologies bridge the worlds of unstructured hypertext and structured data. Its potential for education seems very promising, but more "design experiments" are needed to confirm this.

Our first impression of this pilot class, created with limited planning and effort, is positive. Most students engaged in the class and did make use of the system. As this stage we didn't carry out any in-depth research and, as planned, we will redesign the course and the interface for the 2015 edition. We plan to carry out more formal studies on learner and learning behavior once a fully satisfactory solution is found and implemented.

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7. REFERENCES

[1] Derry, S.J., & LaJoie, S.P. 1993. A middle camp for (un)intelligent instructional computing: An introduction. In *Computers as cognitive tools*. S.P. LaJoie & S.J. Derry, Ed., Lawrence Erlbaum Associates, Hillsdale, NJ.

[2] Jonassen, D. H., & Reeves, T. C. 1996. Learning with technology: Using computers as cognitive tools. In *Handbook of research for educational communications and technology*. D. H. Jonassen, Ed., (pp. 693-719). Macmillan, New York.

[3] Boyer, E. 1997. Scholarship reconsidered: Priorities of the professoriate, Jossey-Bass, San Francisco.

[4] Krötzsch, M.; Vrandecic, D., Völkel, M.,Haller,H. & Studer, R.. 2007. Semantic Wikipedia, *J Web Semant* 5, 251-261.

[5] Schneider, D.K. & Da Costa, J. 2013. Adding power to educational and research wikis with Semantic MediaWiki, Paper presented at *SWMCon*. http://semantic-mediawiki.org/wiki/SMWCon_Fall_2013

[6] Koren, Yaron 2012. Working with MediaWiki, WikiWorks Press, http://workingwithmediawiki.com/

[7] Rodríguez-Posada, E. J., Dodero, J.M., Palomo-Duarte, M., Medina-Bulo, I. 2011. Learning-Oriented Assessment of Wiki Contributions. 3rd Int. Conf. on Computer Supported Education. Noordwijkerhout, The Netherlands, http://statmediawiki.forja.rediris.es/papers/StatMediaWiki-CSEDU2011.pdf

[8] Ferguson, R., Buckingham Shum, S. and Deakin Crick, R. 2011. EnquiryBlogger – Using widgets to support awareness and reflection in a PLE setting, In Proc. PLE 2011, Reinhardt, W. & Ullmann, T.D., Eds. http://oro.open.ac.uk/30598

[9] Soller, A.,Martinez, A., Jermann,P & Muehlenbrock, M. 2005. From Mirroring to Guiding: A Review of State of the Art Technology for Supporting Collaborative Learning, *Int. J. Artif. Intell. Ed*. 15, 4 261-290.

[10] Govaerts, S., K. Verbert, J. Klerkx, E. Duval. 2010. Visualizing Activities for Self-reflection and Awareness, In *Proc. 9th Intl Conf. on Web-based Learning*, Lecture Notes on Computer Science, Springer, New York https://lirias.kuleuven.be/handle/123456789/283362.

[11] Merrill, M. D. 2002. First principles of instruction, *ETRD*, 50 (3), 43-59.

[12] Schneider, D.K., Benetos, K. & Ruchat, M. 2011, MediaWikis for research, teaching and learning. In T. Bastiaens & M. Ebner, Eds., Proceedings EdMedia 2011. AACE, Chesapeake, VA:, 2084-2093

[13] [Knight, Simon; Buckingham Shum, Simon and Littleton, Karen (2014). Epistemology, assessment, pedagogy: where learning meets analytics in the middle space, *Journal of Learning Analytics* (In press). http://oro.open.ac.uk/39226/3/JLA%202014.pdf

[14] Ley, K., & Young, D. B. (2001). Instructional principles for self regulation. *ETRD*, 49 (2), 93-103.

[15] Suthers, D. D., & Verbert, K. (2013). Learning analytics as a "middle space." *In Proc. 3rd Intl. Conf. on Learning Analytics and Knowledge* (pp. 1–4). ACM, New York, NY, USA.DOI=10.1145/2460296.24602