Requirements for learning scenario and learning process analytics

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Abstract

This contribution attempts to define what kind of learning analytics both learners and teachers should have in various forms of project-oriented learning designs in order to enhance the learning and teaching process within learning scenarios.

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Abstract: This contribution attempts to define what kind of learning analytics both learners and teachers should have in various forms of project-oriented learning designs in order to enhance the learning and teaching process within learning scenarios.

Keywords: learning analytics, constructivism, CSCL, project-based learning, problem-based learning, inquiry learning, writing-to-learn, and knowledge community learning.

Introduction

In this discussion paper, we define learning process analytics as a collection of methods that allow teachers and learners to understand what is going on in a learning scenario, i.e. what participants work(ed) on, how they interact(ed), what they produced(ed), what tools they use(ed), in which physical and virtual location, etc. Learning analytics is most often aimed at generating predictive models of general student behavior. So-called academic analytics even aims to improve the system. We are trying to find a solution to a somewhat different problem. In this paper we will focus on improving project-oriented learner-centered designs, i.e. a family of educational designs that include any or some of knowledge-building, writing-to-learn, project-based learning, inquiry learning, problem-based learning and so forth.

We will first provide a short literature review of learning process analytics and related frameworks that can help improve the quality of educational scenarios. We will then describe a few project-oriented educational scenarios that are implemented in various programs at the University of Geneva. These examples illustrate the kind of learning scenarios we have in mind and help define the different types of analytics both learners and teachers need. Finally, we present a provisional list of analytics desiderata divided into “wanted tomorrow” and “nice to have in the future”.

A short overview of learning scenario and learning process analytics

From a technical point of view, “learning analytics is the measurement, collection, analysis and reporting of data about learners and their contexts, for purposes of understanding and optimizing learning and the environments in which it occurs” (1st International conference on learning analytics, 2011). We define learning scenario and 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.

This type of analytics has a long tradition in educational technology research, in particular in the subfields of artificial intelligence and education (including intelligent tutoring systems) and in computer-supported collaborative learning (CSCL). We shall not discuss the former, since we are not interested in using computers in the role of a virtual teacher/expert. In a project-oriented setting, the learner is to provide the intelligence, not the computer. Computers are best used only as tools that assist the learner’s cognition. “Cognitive tools [...] are unintelligent tools,
relying on the learner to provide the intelligence, not the computer. This means that planning, decision-making, and self-regulation are the responsibility of the learner, not the technology. Cognitive tools can serve as powerful catalysts for facilitating these higher order skills if they are used in ways that promote reflection, discussion, and collaborative problem-solving [...]” (Derry & Lajoie, 1993, p. 5).

In the field of CSCL, Soller, Martinez, Jermann and Muehlenbrock (2005) developed a collaboration management cycle framework that distinguishes between mirroring systems, which display basic actions to collaborators, metacognitive tools, which represent the state of interaction via a set of key indicators, and coaching systems, which offer advice based on an interpretation of those indicators. “The framework, or collaboration management cycle, is represented by a feedback loop, in which the metacognitive or behavioral change resulting from each cycle is evaluated in the cycle that follows. Such feedback loops can be organized in hierarchies to describe behavior at different levels of granularity (e.g. operations, actions, and activities). The collaboration management cycle is defined by the four following phases” (Soller et al., 2004:6).

- Phase 1: The data collection phase involves observing and recording the interaction of users. Data are logged and stored for later processing.
- Phase 2: Higher-level variables, termed indicators are computed to represent the current state of interaction. For example, an agreement indicator might be derived by comparing the problem solving actions of two or more students, or a symmetry indicator might result from a comparison of participation indicators.
- Phase 3: The current state of interaction can then be compared to a desired model of interaction, i.e. a set of indicator values that describe productive and unproductive interaction states. “For instance, we might want learners to be verbose (i.e. to attain a high value on a verbosity indicator), to interact frequently (i.e. maintain a high value on a reciprocity indicator), and participate equally (i.e. to minimize the value on an asymmetry indicator).” (idem, p. 7).
- Phase 4: Finally, remedial actions might be proposed by the system if there are discrepancies.

Soller et al. (2005:) add a phase 5 that is outside of the cycle: “After exiting Phase 4, but before re-entering Phase 1 of the following collaboration management cycle, we pass through the evaluation phase. Here, we reconsider the question, “What is the final objective?” and assess how well we have met our goals”. In other words, the behaviors in the "system" are analyzed as a whole.

Another school of thought in CSCL concerns knowledge-building communities. “Sustaining knowledge-building communities online requires the creation of electronic environments that support both formal and informal learning, and capture significant tasks and activities that are central to the day-to-day work of the participants. These environments must provide supports for real world activities and learning, while providing the potential for something more. That something more is knowledge building, or the production and continual improvement of ideas of value to a community” (Scardamalia & Bereiter, 2003). This knowledge-building environment model relies on so-called Computer Supported Intentional Learning Environments. Its commercial version, Knowledge Forum, is an “electronic group workspace designed to support the process of knowledge building, [i.e.] any number of individuals and groups can share information, launch collaborative investigations, and build networks of new ideas…together,” (Knowledge Forum, 2012). The technology can be described as a concept map, hypertext and forum system hybrid that can display information from multiple vantage points and entry points. In other words, there are no special analytics, but its networked architecture and various display options allow users to understand “connections” between contents, between contents and users, and between users themselves.

While CSCL research produces many interesting approaches and systems, these are rarely used in practice since they require advanced knowledge of collaborative learning and a mastery of the technology used. In addition, orchestrating CSCL scenarios is very time consuming. Most courses that aim at deep learning, e.g. applicable knowledge and/or higher order knowledge are usually taught in small classes and many teachers seem to use software that is distinct from ones used in mainstream conceptions of e-learning. Typical environments are wikis, learning e-portfolios, content management systems, blogs, webtops, social networking sites and/or any combination of these. In addition, scenarios can include the use of various special-purpose social software, such as bookmarking services, reference managers and feed aggregators. While such software is well suited for supporting a wide range of learning activities, it can become difficult for both learners and teachers to follow and understand “what is going on”.

Few systems seem to exist that enhance this kind of “streetware” that is popular in education. Ferguson, Buckingham Shum, and Crick (2011) developed Enquiry Blog Builder; an interesting set of Wordpress plugins that will enhance inquiry-learning scenarios. The MoodView plugin can produce a line graph plotting the mood of the student as their enquiry progresses. Students can consult the evolution of their mood over time or insert a new one by selecting an item from a drop down list (from 'going great' to 'it's a disaster'). Changing a mood creates a new blog.
entry where the student may articulate his/her reason for the mood change. Both the EnquirySpiral and the EnquirySpider are widgets that provide a graphical display of the number of posts made in various blog categories. The spiral, a key metaphor in inquiry learning, concerns the first nine and the spider the seven following ones. This implies that the sixteen categories should be well chosen in advance. The nine “Spiral categories” concern the inquiry process and the seven “spider” categories are based on the Effective Lifelong Learning Inventory diagram. The toolkit then includes a blog generator that will generate a blog for each student and one for the teacher(s). The teacher blog will then include a dashboard showing the progress of students assigned to the connected teacher. Other systems have emerged, e.g. the Hapara teacher Dashboard provides a “view” over the class Google Apps environment. It mainly automates many configuration tasks, but also provides a “birds view” and may in the future include more advanced analytics.

De Liddo et al. (2011) implement a structured deliberation/argument mapping design in the Cohere system. It “renders annotations on the web, or a discussion, as a network of rhetorical moves: users must reflect on, and make explicit, the nature of their contribution to a discussion”. Since the tool allows participants (1) to tag a post with a rhetorical role and (2) to link posts to these roles or to participants, the following learning analytics can be gained per learner and/or per group: learners’ attention, rhetorical attitude, learning topics distribution, and social interactions. These indicators are then used to create higher-level constructs such as learners’ rhetorical moves, distribution, and interactions.

The popularity of Wikipedia, initiated a whole field of “Wikipedia science” that attracted many researchers from the data mining and the data visualization community. However, tools used in their research are mostly not suitable for teachers, since they require fairly high-level technical skills. There are a few easier to use examples that work with specific Wiki technologies. E.g. for MediaWikis (the Wikipedia engine), StatMediaWiki (Rodríguez-Posada et al., 2011) can generate static XHTML pages including tables and graphics, showing content evolution timelines, activity charts for users and pages, rankings, tag clouds, etc. We tested this system on our own MediaWikis described in Schneider et al. (2011) and found it very useful, in spite of the features lacking, identified in part by the authors.

One solution for coping with the lack of analytics and management tools is to rely on self-reporting. For example, at Curtin University, to encourage students to reflect on and assess their own achievement of learning in the e-portfolio environment, the iPPortfolio system incorporates a self-rating tool based on Curtin’s “graduate attributes”. The tool enables “the owner to collate evidence and reflections and assign themselves an overall star-rating based on Dreyfus and Dreyfus’ Five-Stage Model of Adult Skill Acquisition (Dreyfus, 2004). The dynamic and aggregated results are available to the user: […] the student can see a radar graph showing their self-rating in comparison with the aggregated ratings of their invited assessors (these could include peers, mentors, industry contacts, and so on)” (Oliver & Wheelan: 2010). This strategy is used by several other projects, e.g. de Pedro Puente (2007) requested students to tag wiki contributions from a list of contribution types, e.g. “New hypotheses”, “New information” or “help partner”. From these indicators he then computed process indices that were combined with the grading of the final product.

Another, more portable strategy was developed in the framework of the EU ROLE project. Govaerts et al., (2010) describe a Student Activity Monitor (SAM). Its main purpose is to increase self-reflection and awareness among students and it can also provide learning resource recommendations. It allows teachers to examine student activities through different visualizations. Although SAM was developed in a project that focused on developing a kit for constructing personal learning environments it can be used in other contexts where the learning process is largely driven by rather autonomous learning activities. SAM is implemented as a Flex software application and it will aggregate data from environments that include the CAM widget developed in the same project. In principle, widgets can be inserted in most environments. However, so far, we did not try to test this with our own environments.

An older powerful approach is to rely on project management principles. E.g. Helic et al. (2005) describe a web-based training system that includes a virtual project management room. The system includes what they called support for data analysis, i.e. tools that allow teachers to help learners follow the right path and learners to better understand, present, and apply the results. Web-based agile project management tools such as Pivotal Tracker also find their way into education. Agile design methodologies like SCRUM (Schwaber & Beedle, 2002) also may turn out to be closer to project-oriented learning (Pope-Ruark, in press) than traditional project methodology. Since project tools by definition include minimal analytics, they can be used off the shelf as orchestration and monitoring tools, although in both cases some adaptation and repurposing would be needed.

Finally, the technically least intrusive portable analytics systems can be implemented through user-side JavaScript. A good example is SNAPP (Dawson, 2009). Implemented as a JavaScript booklet, it can analyze some types of structured forum pages through the web browser and provide a networking diagram. SNAPP is a nice tool to
have when no other tools are available and it is a good tool for analyzing “deep” forum debates. Since it is defeated by forums that spread over several web pages, teachers have to adapt to SNAPP and organize forums (including Q/A forums) as single nested topics.

To conclude this discussion of a few example systems, we summarize a few strategies and principles:

- Systems that structure learning activities and contents in one way or another usually include some kind of analytics. In addition, structured environments provide, per definition, more structured information to the participants.
- Asking users is an easy strategy that can provide good information with respect to learners' own perceptions of their learning, their contributions, and their interactions.
- Student productions are key indicators for learning.
- Project-management tools, i.e. tools that require learners to self-report in a structured way do include both structured data and at least some overall analytics.
- Modern web technology allows for the insertion of widgets into various online environments. Widgets can “talk” to other services and therefore can be used to create aggregating dashboards, e.g. for the teacher.
- Analytics are meant to be used by both learners and teachers.
- Analytics can provide various levels of assistance and insight: from simple mirroring tools, to metacognitive tools, to guiding systems (Soller et al., 2005).

The bottom line that emerges from this short discussion of a few systems is that “locally” used analytics are already available in more sophisticated systems built for education, in particular in CSCL. Some isolated devices (like plugins or widgets) are available to enhance simpler writing and collaboration environments like wikis, CMSs and blogs, as well as collection services (news aggregators, webtops, link and artifact sharing, social networking). This type of street technology is much more popular in project-oriented education than systems that grew out of educational technology research, however, various “portalware” do lack the analytics components that we would like to have.

General-purpose end-user analytics tools do exist of course and work with most web-based applications, e.g. Google Analytics, but these are fairly useless for enhancing project-oriented learning and other constructivist approaches since they do not present and organize data in way that helps to improve the teaching/learning process in real time. In addition, it would be technically feasible to use a combination of sophisticated web scraping and text mining tools plus data organization/visualization tools, but these require technical skills that end users do not have. However, we believe that if clear demands could be formulated, some interesting solutions could be implemented quickly. Williams, Sawyer, and Hutchinson (1999) define data mining as “the computer-assisted process of sifting through and analyzing vast amounts of data in order to extract meaning and discover new knowledge.” Therefore, the current question is what knowledge we would like to discover and not what kind of software end users could use. In other words, educators that engage in project-oriented design should clarify what kind of metrics we should be able to collect, and how the data then should be organized and presented. In order to initiate this discussion we will first present a few example scenarios that we are familiar with and then discuss again our needs in more general terms.

Example scenarios

In order to exemplify some of our needs we briefly present three learning scenarios that have been designed or co-designed by the authors. A forth case concerns a whole training program and it illustrates how learning process analytics joins “main-stream” analytics.

1) Problem-based learning activity (MAS in interpreter training)

**Learning objectives**: Learners should understand the mechanisms of modeling and be able to apply them to the development of pedagogical tools.

**Description**: The activity required learners to select a common difficulty in simultaneous or consecutive interpreting, identify the cognitive processes most likely responsible for the cognitive constraints, and remodel the process to address the constraints. Groups of three to four students work together on one scenario collaboratively. Each group selects a known difficulty in simultaneous or consecutive interpreting, identifies the cognitive processes most likely responsible for the cognitive constraint, and finally remodels the process in order to offer solutions to these constraints.

Time necessary: 20 hours

Evaluation: Formative feedback from instructor plus a grade for the collaborative report.

Expected final productions: Produce a model of the sub-processes in question, sketch the model and write up the report (min. 800, max. 1000 words) that also includes pedagogical recommendations (but not detailed exercises) with regard to circumventing cognitive constraints.

Data that could be collected: Data are available through the database of the portalware (Zikula with custom-built extension modules). An external API is not available.

Existing analytics: Almost none

Needs: What is of interest to teachers is not only the final outcome of the activity but also and maybe even more, the process: how did learners manage to achieve this outcome? Which concrete steps did they take? Teachers cannot read everything learners produce on the portal. And since some of the work is done outside the portal, the tools teachers mostly rely upon now are the forum to check the evolution of the work done and the journal for the process. However, this is a tedious task and involves looking at isolated bits of data will “hide the forest”. Concerning process, it is not the process itself that they can track but the reporting of the process. Problems linked to this approach are twofold: teachers hardly ever have access to the process itself and the entire process is seldom entirely reported. This suggests that in addition to data mining, some easy to use self-reporting tools would be needed.

2) Mini-project based learning (Blended course on Internet technology, MA in EduTech)

Four courses on Internet technology use a similar design. A central page outlines the program, course level outcomes and general rules. Topics are taught through problem exercises, typically nine mini-projects for a 6-ECTS course. All information needed is centralized in an exercise/topic page.

Learning objectives: Be able to apply various Internet technologies to a problem, e.g. create a multimedia animation that illustrates a principle, configure an e-learning management system, produce an e-book, create an XML schema for a writing class.

Description: Students must identify a project that respects a set of general requirements, implement it, write a short report and participate in the wiki (adding relevant contents and participating in discussions). Student support is available through the wiki discussion page. In addition, students must contribute to the wiki, e.g. make changes in study materials prepared by the teacher. As in most European research universities, we don’t use a formal textbook and teaching materials are prepared by the teacher in the wiki. In addition, we use various open educational and technical resources and students are encouraged to find their own. Student productions other than wiki contributions are not managed through the wiki for both security and information management reasons. Students can upload products (including the report) to a student web server and must edit an XML-based portfolio file that indexes all contributions.

Environment: MediaWiki with several plugins (described in Schneider et al., 2011), traditional web server, Moodle 2.0 (just for the grading rubric).

Time necessary: About 2-3 days per mini-project. 3 mini-projects are assigned in each five-week cycle.

Evaluation: Products, report and wiki participation (using a combined 10 item grading rubric).

Expected final productions: Produce a prototype of and Internet product (such as a Flash animation, a LAMS activity, an e-book, an XML Schema), contribute to improve wiki materials and a reflective report.

Data that could be collected: A lot of information could be collected through the external MediaWiki API. The (underused) XML project files are machine-readable.

Existing analytics: We use simple MediaWiki functionality like page history and user contribution, in addition to the collaboration diagram extension we installed. The external StatMediaWiki tool runs as a batch job accessing the wiki database and provides a good amount of data with respect to user contributions and evolution of articles. A PHP script can summarize data from the XML project files.

Needs: Currently, the teacher can monitor student progress by inspecting their XML work page. However, since it only includes links to productions, work in progress is not captured. In complement, the teacher could inspect the web server’s file system and make guesses from forum (non)participation. The Wiki can display individual student contributions or can list or visualize edits made to pages. At grading time, we also use the StaMediaWiki Analytics tool to evaluate wiki participation. To improve both students’ self-monitoring and teacher monitoring we would like to have a simple combination of a portfolio system and a task-based project.
management tool. With respect to Wiki participation, we would like to have a dashboard showing number and amount of edits. The StatMediaWiki tool should also be improved to include collaboration diagrams, support for group-wide analysis, plus more interesting word lists that summarize contributions.

3) Project-based learning (course in educational sociology and history, BA in education)

Learning objectives: Students should acquire both in-depth understanding of a topic in special education and general skills, such as working within a “collective intelligence” environment, conducting interviews, article writing and so forth.

Description: This project-based design has four stages. (1) Preparation: The teacher defines a global course topic. If the class is small (4-5 students) all work on the same project, else groups are formed. (2) Planning: Team members search for resources, start reading and write the initial project proposal, which includes goals, questions and some planning elements. (3) Each team contributes to a single project/research plan page and to a “paper” page. They also have to contribute to a common bibliography and to a glossary of terms. (4) Finalization: The final project is a single long wiki article page that should meet academic standards. The teacher announces important activities such as literature reviews, initial fieldwork, methods, further fieldwork, etc. in class and on the front page of the wiki. Student contributions are discussed both in class and through wiki discussion pages.

Environment: A MediaWiki dedicated to this class (over several years) and no additional tools.

Time necessary: About 10 days spread over a semester plus work in class (2 sessions / month)

Evaluation: The final paper and wiki contributions are evaluated and negotiated by the participants with the teacher having the final authority in case of conflict.

Expected final productions: The whole class or groups will produce a common paper that includes teacher contributions plus general wiki productions like summaries of articles or dictionary definitions.

Existing analytics: Same as for case 2

Needs: The standard (insufficient) MediaWiki tools like page history, recent contributions plus a collaboration diagram extension are used. In future editions, we plan to use the StatMediaWiki tool.

4) Certificate in e-learning

Learning objectives: Apply the theories, processes and tools of ICT-based teaching and learning to the development of blended and distance learning.

Description: Participants in a blended-learning continuing education certificate take a common introductory course on theories, processes, and tools of ICT-based teaching and learning and then take two or three of four advanced modules according to the aspects of their professional project that needs to be developed. Each module consists of three thematic sessions and a feedback session. Each session comprises of one face-to-face day of presentations and workshops followed by two to three weeks of activities to be completed at a distance and an end of module report. To accommodate for the variety of professional backgrounds of the target audience, participants may complete the certificate in one, two, or sometimes three years. The certificate's coordinator and personal tutors insure continuity.

Environment: Moodle is used to structure each module offered each year and offer an environment for the deposing of resources by the various instructors, for administrative purposes, and to keep track of and grade assignments and reports using a customized rubric. The forum in Moodle is used for communications and questions during the distance portions. Participants are encouraged to use Mahara as a personal learning environment to group their productions, resources and reflections throughout the course and are expected to present "views" to showcase their productions. Links to these vies are submitted in Moodle assignments for grading.

Time necessary: 100 work and study hours per module, 50 for end of studies report.

Evaluation: Formative feedback on activities by particular instructors, feedback and grades on reports and project development from assigned tutors.

Expected productions: participation in collaborative work and completion of assigned activities whose products can be on a wide variety of supports and formats submitted as documents and/or links. At the end of each module participants must apply what they have learned to the development of their chosen project and present a summary report. This project, developed over the course of the entire certificate, is accompanied by an assigned tutor and is presented in a final report that includes a functioning prototype and reflective analysis.
Existing analytics: Currently the only analytics are those offered by Moodle's course specific activity reports and gradebooks. Productions are only visible to "teachers" through assignments submitted in Moodle and if submitted as links to views in Mahara, they become blocked to further changes making formative and progressive evaluations impossible.

Needs: Each module has multiple instructors in addition to the participants that vary from module to module according to their needs and time constraints, and their assigned tutors. Analytics need to present an overall view across all Moodle courses for each participant by the coordination and individual tutors as well as students who do not always complete work within convenient deadlines, so as to monitor status and individual progress. A view of student productions and participations (forums, blogs, and shared resources) across modules and platforms is also needed to adequately accompany the development of their projects. Analytics should also be available to participants so that they can see the productions, process and progress of their fellow participants (as long as they wish to share), as this view of different problems, choices and approaches used within the various projects and their contexts is one of the major benefits of working within a community of adult learners.

Desiderata

The examples briefly summarized here, show how we design some learning scenarios and how we use fairly simple learning environments: a CMS, a complex Wiki plus some extra tools, an e-portfolio and an LMS. Students are of course free to make use of additional environments, e.g. PLEs, or face-to-face meetings for collaborative tasks. All these environments include various tools, various text genres and various ways of interacting. Text is unstructured (except for category tags) and will remain so for a while. This is also true for content entities, although most content sits in SQL databases, there is no common high-level standard for accessing forum messages, CMS documents, wiki pages, chat messages and so forth. A future semantic web (web 3.0) may offer interesting possibilities, since semantic text is inherently structured and could be annotated, retrieved and processed in a somewhat standard way.

The main processes expressed at an instructional design level and that we would like to observe and have the learners observe include productions, interactions, reflection, and regulation.

The tools, which allow collecting and organizing this type of observation, need to be reliable and work for many years. Most of the systems that come out of research in applied educational computer science tend to decay, i.e. stop working after system upgrades. This leads us to an institutional issue. At least in Europe, hundreds of millions are invested in sometimes very interesting three-year EU projects. Once these projects expire, the software dies. Our initial exploration of available software, in particular of wiki analytics (EduTechWiki), led us to many half-working prototypes, broken links, no download links, and so forth. Possible incentives for improving this situation may be giving academic credits for maintaining systems. Another interesting suggestion formulated in the SoLAR framework, is to use a service-oriented architectures that could interact with various applications. In other words, we could aim at some form of standardization. Finally, we believe that success of educational informatics projects depend very much on communication between creative scholarship of teaching, research in the learning sciences and applied computer science. Too often, it does not exist.

Teachers and learners need analytics for project oriented teaching and learning in four domains: production, interaction, reflection, and management and regulation. The list below, divided into wanted tomorrow (i.e. really urgent support) and wanted in the future, i.e. a vision for ICT-supported project based development is an attempt to call for sustainable capacity building.

1) Productions

Ideally, an analytics system should provide data from each type of environment used. Using an LMS is not an option, since (for good reasons) students cannot upload executable files. An LMS is also not a productive collective writing environment nor does it allow student productions to be shared with the world.

Wanted tomorrow: (1) A kind of lightweight productions/portfolio system that also includes a simple task management system and a rubrics-based grading tool. Productions can be produced and deposited in any kind of environment as long as all participants have at least read access. Both learners and teachers should have access to a dashboard showing task progress, productions, and grades. A stand-alone tool probably would add maximum flexibility, but it also could be designed as portal module or as a web service that could interact with other systems. E.g. Synteta and Schneider (2002) describe a simple portal extension that required students to edit an XML-based project file and from which dashboard data was extracted, but it is no longer working. (2) A tool like StatMediaWiki
that provides visualizations for content evolution. The tool should be enhanced with a better tag cloud generator and take into account categories and user groups and show collaboration graphs.

**Wanted in the future:** (1) A e-Framework-like service-oriented architecture that would allow students to manage their personal learning environment and include some kind of course-specific “segment” allowing other students and teachers to interact. (2) Web API-based content and collaboration analytics for writing and discussion environments such as wikis, CMS and forums. Such functionality would allow creating centralized dashboards, networking and visualizations of content structure/links. “In a Web 3.0 world the relationships and dynamics among ideas are at least as important as those among users. As a way of understanding such relationships we can develop an analogue of social network analysis—idea network analysis. This is especially important for knowledge building environments where the concern is social interactions that enable idea improvement” (Scardamalia et al., 2002).

2) **Interactions**

In all our scenarios, students will engage in some form of collaboration. In some cases (not described above) students engage in more complex scenarios where they have to play various roles (e.g. “discussant”). We would also like students to be aware of how they contribute to texts and hypertexts. Typically, we find that when students engage in loosely defined scenarios, they tend to interact as little as possible with each other’s text segments. Rewriting others’ productions is an interesting pedagogical activity that all participants should be able to monitor.

**Wanted tomorrow:** Collaboration diagrams for wikis that work across individual pages, categories of pages and groups of participants. Collaboration diagrams for forums, e.g. tools that behave like SNAPP but work across topics.

**Wanted in the future:** Collaboration diagrams that work across systems. This may require the use of some standardized digital identity like OpenId and will raise privacy issues. An alternative is to rely on self-reporting. However, in that case self-reporting should be easy and contextual, e.g. in a wiki there should be a button that allows the user to tell what he just did and maybe why and this data should then be sent to an external collection device.

3) **Reflections**

In most of our scenarios, students at some point should engage in reflection. Reflections can be part of other writing activities and may be difficult to detect. This is why in many pedagogical workflow systems, e.g. in the LAMS learning activity platform (Dalziel, 2004), students can be forced to write notebook entries after each activity. Another method is to require that learners tag certain productions (e.g. forum entries or blog posts) as “reflective”. Some environments include progress or mood widgets (e.g. Enquiry Builder) that can collect and centralize learner-provided metrics. One could also imagine using an experience sampling approach, i.e. querying students at given intervals or after completion of an operation.

**Wanted tomorrow:** Portable widgets like EnquiryBuilder with a server-side component (optional) that could be run by teachers concerned or their organization.

**Wanted in the future:** Design of reflection tools and analytics should be included in the discussion about e-portfolio systems and personal learning environments. Many learning institutions, particularly in the applied sciences, now define institutional competence catalogues that could be linked to students’ reflective activities, to which the learner should be able to add his own goals.

4) **Management and regulation**

Management and regulation refers to both teacher and learner interventions that aim to organize the learning process. First, it would be interesting to know (within reason) who is doing what and where learners are in the process. This is an easy task in educational workflow systems such as LAMS or CELS, but it is neither in open designs that we described here nor in main-stream e-learning platforms such as Moodle. Second, learners and teachers should be able to monitor Q/A “help-desk”-like activities and productions. Third, when learners are given group work, group participants should have the means to distribute and monitor tasks.

**Wanted tomorrow:** A simple monitoring dashboard for the lightweight productions/portfolio/planning system described in point 1. It may be possible to repurpose an existing agile development tool.

**Wanted in the future:** (1) A LAMS-like monitoring tool that works across environments. (2) Q/A help-desk like forums that provide a state of problems addressed and solved. Such tools do exist of course, but they are not integrated within production environments like wikis, blogs, or CMS and this means that questions/answers are too decontextualized. The advantage of a discussion/forum page in wiki for example, is that participants can easily hyperlink to other contents. Existing tools may also not provide the views a teacher needs. E.g. getting an overview of open problems is fine, but one should also be able to see who is active, who helps others, etc.
In conclusion, we believe that merging ideas from various technical domains such as web analytics, general purpose data mining, semantic web, project management and educational technology research could provide tremendous opportunities for all sorts of project-oriented designs such as project-based learning, problem-based learning, inquiry learning, writing-to-learn, or knowledge community learning. A lot of interesting tools for learning process metrics could be implemented at fairly low cost. Prototypes for several tools actually already do exist but need to be further developed. We hope to contribute a little bit towards raising awareness of various issues and opportunities.

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