Requirements for flexible learner monitoring

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Abstract: This paper analyses the requirements for the sensor and the semantic layer with regard to the scenario in which the prototype is applied. In particular, the requirements address one problem with open online communities: community members can switch communication services and channels while they participate and contribute to the community. This raises special challenges to learner monitoring. The paper discusses the functional requirements for learner monitoring with regard to these challenges.

Keywords: personal data, learner profiling, activity monitoring

Introduction

When performing a task, actors need various types of information in order to monitor the progress of the task. The basis for this information is provided by what we call *indicators*. Indicators provide a simplified representation of the state of a complex system that can be understood without much training. Furthermore, they help to focus on relevant information when it is needed, while the actors don't have to bother about this information most of the time.

Actors depend on indicators in order to organise, orientate and navigate through complex environments by utilising contextual information (Butler & Winne, 1995; Weber, 2003). Contextual information on the learning process has been proven as important to support the learning process. It stimulates the learners' engagement in and commitment to collaborating processes (Beenen et al., 2004; Ling et al., 2005; Rashid et al., 2006); it helps to raise awareness of and stimulates reflection about acquired competences (Kreijns, 2004; Kreijns & Kirschner, 2002); and it supports thoughtful behaviour in navigation and on learning paths (Van Nimwegen, Van Oostendorp, Burgos, & Koper, 2006).

It has been argued that indicators are part of the interaction process between learners and learning environments (Glahn, Specht, & Koper, 2007). As such, indicators depend on information about previous learning activities and their contexts. The information processing from monitoring learners to responding back to them can be modelled in four layers: a sensor layer, a semantic layer, a control layer, and a presentation layer. This layered architecture has been implemented as a preliminary prototype that uses indicators for supporting learner engagement in open online communities.

This paper analyses the requirements for the sensor and the semantic layer with regard to the scenario in which the prototype is applied. In particular, the requirements address one problem with open online communities: community members can switch communication services and channels while they participate and contribute to the community. This raises special challenges to learner monitoring. The paper discusses the functional requirements for learner monitoring with regard to these challenges.

Experimental Scenario

The prototype integrates indicators into a community system. This system combines the community member's web-logs, del.icio.us[1] link lists and tag clouds. The indicator provides information on the interest and the activity to the learners. It contains two core components: An interest tag cloud and an overall activity chart. To maintain these indicators the system tracks selection activities, tagging activities, and contributions. The system adapts the presented information according to a learner's activity and interest level: It provides richer information the more a learner contributes to the community. Therefore, new participants will have different information indicated than those who contribute regularly to the community.

The community system acknowledges that its participants might already use a web-log or del.icio.us instead of offering similar services. However, it is not a requirement for participation to have both. When learners register for being "members", they can provide a URL to a feed address of their web-log and their nick-name on del.icio.us. This *personal data* is later used for creating a *learner profile*. Therefore, the community system provides only a portal to recent contributions, while the actual content is external to the system.

Each action within the system is considered as a learning activity and learners score "learning points" with each action they perform in order to indicate their learning progress. However, some actions require more effort than others. For example, accessing content provided by other users is easier to perform than contributing content through a web-log. Because of these differences, the actions have different scores.

The indicator system of the prototype is based on immediate and delayed interaction monitoring. Immediate monitoring is implemented only for selections (so called click-through), through which the system gathers information about requests of web-log entries or links from the link list. Data about contributions is accumulated from RSS2[2] or ATOM[3] feeds independent from a learner's actions on the user interface. Information on the collected links and associated comments is gathered through del.icio.us' RPC interface[4]. The tagging activities are extracted from the data on tag clouds that is provided from both the link lists and the learner's web-logs. A learner tags an external link or a web-log entry if a tag is added to the contribution.

The semantic layer of the prototype provides two aggregators: an activity aggregator and an interest aggregator. The semantic layer analyses the sensor data according to a definition given by the aggregators. Different to the sensor layer, the semantic layer is not

[1] http://del.icio.us
[2] http://blogs.law.harvard.edu/tech/rss
[3] http://tools.ietf.org/html/rfc4287
[4] http://del.icio.us/help/json/

limited to organising incoming sensor data, but it uses the aggregators to *transform* the sensor data into meaningful information.

The control layer defines how the indicators adapt to the learner's behaviour. The prototype implements two elemental adaptation strategies. The first strategy aims at motivating learners to participate to the community's activities. The objective of the second strategy is to raise awareness on the personal interest profile and stimulate reflection on the learning process and the acquired competences. The prototype adapts the strategies according to a learner's participation to the community.

The purpose of the indicator layer is to integrate the values selected by the control layer into the user interface of the community system. The indicator layer provides different styles of displaying and selects an appropriate style for the incoming information (**Fig. 1** shows an example). Two graphical and one widget indicator are provided by the prototype. One graphical indicator is used during the first level of the control strategy. This indicator shows the amount of actions for the last seven days. A second control strategy uses a different graphical indicator. It displays the activity in comparison to the average community member. The maximum value of the scale used by this indicator is the most active community member. Finally, the indicator layer provides a tag cloud widget for displaying the interests of a learner. In principle this widget is a list of hyperlinks. The tag cloud indicates higher interest values for each topic through the font size of the related tags.

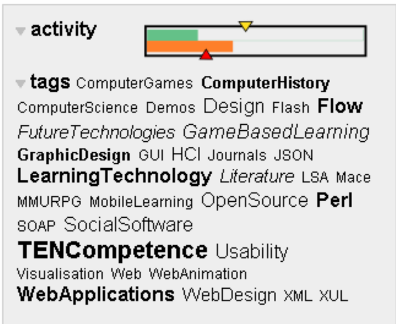

Fig. 1. Indicator of the third level strategy

Meta-model

The purpose of the experiment is to analyse effects of activity indicators that adapt to the learner's progress. The hypothesis for the experiment is that adaptive activity indicators increase engagement in open communities in which learning goals and learning topics are not explicitly available.

Indicators are part of the interaction between a learner and a system, which is either a social system, such as a group of learners who are supported by a trainer, or a technical system like software for computer supported training. A single interaction is defined by two parts: an action performed by a learner and a response to this action from the system. With regard to learning, a learning process is described as a chain of interactions. These interactions have received some attention in research by focusing on the learner's cognitive processes (Butler & Winne, 1995; Garries, Ahlers, & Driskel, 2002). However, indicators are part of the interface of an external system. Following concepts of context aware systems (Dey, 2000; Dey, Abowd, & Salber, 1999; Zimmermann, Specht, & Lorenz, 2005) interaction appears as a symmetrical process between an actor and a system that is interconnected by the system's interface (see **Fig. 2**).

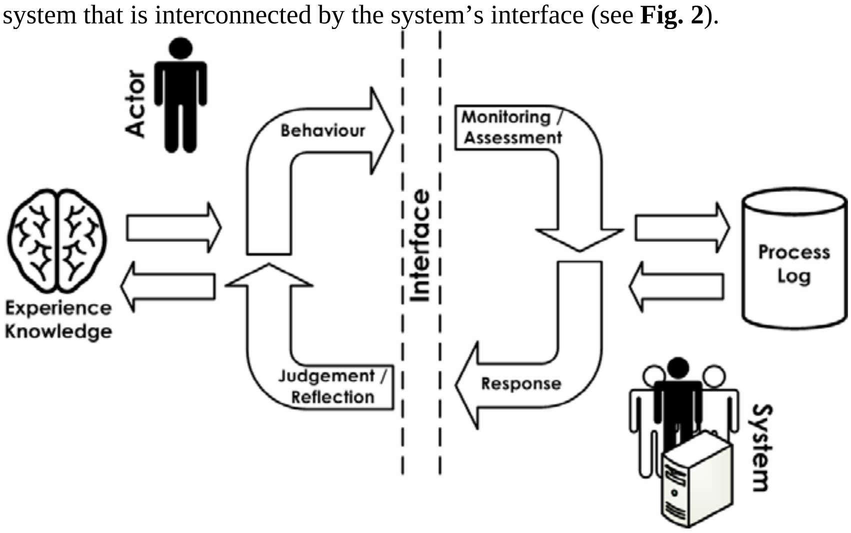

Fig. 2. Learning interaction cycle

With regard to this model, two types of context have to be distinguished: action context and constructed context. Action context is defined by all factors that are present when an action is performed. Examples for such factors are the time of the action, the geographical location where it is performed, the number of concurrent tasks, or even the pulse frequency of the actor. These factors are directly observable through monitoring, but are not necessarily related to the action. Additionally, the constructed context defines higher level factors that affect a learner's action. Examples are the social role of the learner, the experience of a learner in the community, and the learner's performance. These factors are not directly accessible by observing the learner's action itself, but require semantic enrichment and assessment of a range of information.

Functional requirements for learner monitoring

The prototype in applied by an open community in which the participants use different communication channels for their contributions. This raises a problem of learner monitoring: learners may perform learning actions that are not directly or immediately observable by the learning environment.

The prototype uses six sensors to monitor the actions of the community's participants:

- *Tagging sensor*, which traces the tags that a learner applied either to a link in del.icio.us or to an entry in a web-log.
- *Tag selection sensor* traces those tags that were selected from a tag cloud or a tag list of an entry in a web-log.

- *Tag tracing sensor*, this sensor traces the tags that are assigned to web-log entries or del.icio.us links when a learner visits this entry.
- *Entry selection sensor* that reports the hyperlinks a learner has accessed.
- *Entry contribution sensor*, which traces the contributions of a learner to the community.
- *Access time sensor*, this sensor traces the time of an interaction.

The sensor layer has to be aware of delayed observations. Only the *tag tracing sensor*, the *tag selection sensor* and the *entry selection sensor* are directly observable by the community system, because they can be part of the user interface. For the other sensors, synchronous learner monitoring of contributions is not possible for performance and policy reasons. Therefore, the sensor layer has to assure that events can be entered to the system asynchronously.

The learners can specify in their personal data, the nick names they use for the del.icio.us social bookmarking service. The *tagging sensor* has to check for this data entry in order to select the appropriate information from the service. If a learner has not specified a nick name, the sensor must ignore this service for the given user.

Furthermore, learners can specify one feed URL to their web-logs. This URL is used by the *entry contribution sensor* to identify new contributions. The feed URL has to point to an RSS2 or to an ATOM feed-record. The entry contribution sensor has to access this URL frequently in order to identify a user's contributions to the community. These feeds also provide information to the *access time sensor* about the time when this contribution has been made. The *tagging sensor* has to analyse the tags that are used for the contributions sa they are available in the feed-record.

In the learner's profile the different sensors have to be distinguished, because the observed actions have different semantic meaning regarding the learner's performance and interests.

On the semantic layer the prototype implements two types of contexts: *learner activity* and *learner interest*. Both contexts are related either to the learner or to the community. Therefore, the semantic layer has to provide an interface that allows selecting each context either from the learners' or the community's perspective.

The learner's activity is given by the actions performed within a certain time frame. This can be seen either from an absolute or a relative perspective. The absolute activity refers to the number of actions a learner has performed, whereas relative activity puts the learning actions in relation to an external value. For the prototype the activity context has to provide the absolute activity, the types of actions that are involved, and the activity in relation to the best performing community member.

According to Claypool, Le, Wased, & Brown (2001) the interest context has two different forms: explicit interest and implicit interest. For the prototype, the interest of a learner is defined by the tags used. Explicit interest is given if learners use specific tags for their contributions. Implicit interest is defined by a learner's selection of tags or accessing content that has certain tags assigned. The semantic layer has to provide the learner's interest regarding a certain tag as two values that reflect the explicit and implicit interest of the learner.

Conclusions and further research

This paper discussed the functional requirements for learner monitoring in a prototype of a learning environment for open communities. These requirements define how learner editable data has to be used to select learner contributions that have been made through different communication channels or services in order to build up a learner profile. This profile is used to provide adaptive indicators that support the learners' engagement to a community. The requirements presented in this paper specify the preconditions that have to be met by the learner profile in order to enable adaptation to the learners' experiences by utilising contextual information. Further research will assess and extend these requirements towards a flexible system of context aware learner monitoring.

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