

Tracking and Visualizing Time Management for Self-Regulated Learners

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Abstract—Self-Regulated Learning (SRL) has become one of the most suitable approaches to learning and teaching for the development of competent and autonomous lifelong learners. A main issue is to support learners setting up their own learning goals, managing their own resources, including spaces and time, and monitoring and reflecting about their performance. Time management plays a main role in this approach. During the last years many web tools and mobile apps have been developed to support students managing their agendas, recording the time they devote to different activities and visualizing it in attractive graphics. In general these systems provide a view of the activities performed by the student in a particular system and the time devoted to each activity. In this paper we propose a contribution on this subject focused on two issues: self-regulation and interoperability. We are working towards the recording of online and offline student activities not just taking into account the functionalities or resources used, but also the goals, strategies, tasks or rewards considered from a SRL point of view. From the interoperability point of view, our goal is to support the tracking from different systems using a specific SRL xAPI profile.

Keywords—Self-Regulated Learning; Time Management; Learning Strategy; Application Profile; Learning Analytics.

I. INTRODUCTION

Time management is an important element in Self-Regulated Learning (SRL) [1]. It is strongly related to the learners' control of behavior and it spreads through all SRL phases. In this paper we focus on the monitoring part of time management. More particularly on what do we need to record to track time management, how to record it and how to visualize time related data to facilitate monitoring from a SRL approach. In this context, it is important to specify some concepts [2]:

- **Monitoring.** It refers to tracking learner's activities and outcomes. Learners can monitor themselves (self-monitoring) or can be monitored by others, such as their peers or teachers. Monitoring can be focused on activities (the process) or outcomes (the result). It also can take place in real-time or post-hoc.
- **Awareness.** It refers to the learner's understanding of what is happening. It can be considered as a subsequent step from monitoring. This involves a metacognitive process of being aware of one's own state of understanding and progress (self-awareness).

- **Reflection.** It is built on awareness. It involves examining the information obtained, questioning it, and drawing critical conclusions.

A main tool to support monitoring, awareness and reflection is visualization. "Visualization converts the abstract and complex to the concrete and simple" [3]. Graphs and charts based on analyzed data and even raw data, when well-presented and well-designed, are powerful tools to communicate and help us being aware of and understanding situations, tendencies and possible problems, making it easier to make the right decisions. These techniques have been used in business for years (to manage sales or team resources, for instance) and now it is a very active field of research in learning, especially in SRL [3] [4]. However, just monitoring login and logout times, activity in each part of a system (e.g., forum, content, profile, dashboard) and time devoted to a piece of content or resource is not enough from a SRL point of view. As we are going to show, it is important to measure time along the whole learning process, from planning to evaluation, including offline activities when possible.

Up to date many systems and apps have been proposed to support learning monitoring, but there is a long road to achieve the aforementioned ideas. Current systems generate their own proprietary traces, process them and eventually report the information through graphs or alerts. In general, they cover parts of the learning process related to cognitive activities. Nevertheless, learners usually use several tools to plan, organize, perform and evaluate their learning. Our proposal is to gather student activity data from multiple sources (tools) and process it to provide learners and teachers with relevant information, including not just cognitive activities, but also metacognitive: goal setting, planning, monitoring and reflection. This way we can cover the whole SRL experience.

The rest of the paper is arranged as follows. Next we present some related work in section II. Section III shows the activity data relevant from the SRL approach, how to capture SRL activity in section IV and how to present it in section V. Conclusions and future work are discussed in section VI.

II. RELATED WORK: MONITORING AND REPORTING SYSTEMS

During the last years many systems and apps have been developed to record and show the time devoted by students to perform their learning activities [3] [4]. There are differences in

terms of who is the target user of the information (learners, teachers or both), which conditions what is shown and how it is shown, and in terms of how this information is treated (some systems present raw data and some use data mining algorithms to predict or estimate future results or performances). This is a brief compilation of these systems:

- Some systems are just focused on supporting teachers' monitoring: LOCO-Analyst [5] and Moodle dashboard [6] support teachers providing feedback about learners' performance; Student Success System [7] aims at identifying students at risk; and SNAPP [8] shows participants' relationships based on forum discussions.
- Other systems provide visualizations both for teachers and for learners: GLASS [9] provides graphs to compare learners' performance with the rest of the class; Student Activity Monitor (SAM) [10] uses time spent and resource use metrics trying to enable students' self-reflection and awareness; and StepUp! [11], which displays learners' social interaction, time spent, artifacts produced and resource use to promote reflection and awareness.
- Finally, some systems are just focused on learners: LearnTracker [12] provides social learning analytics and focuses on monitoring patterns and behavior, specially time spent (see Fig. 1) and progress through activities within a course; and Course Signal [13], which informs of current scores and alerts learners and teachers if any learner is below a threshold.

All these systems have different dashboards built with different types of graphs and charts to display the information: bar graphs, timelines, pie charts, line charts, table matrices, tag clouds and sociograms. These graphs are easy to understand, but the key is what information is shown, and how the available raw datait is combined and/or processed. We showed some examples of raw data combinations for SRL in [14].

III. WHAT DATA IS RELEVANT FOR SRL MONITORING?

As we discussed in [15] and [16], learners can self-regulate their learning based on self-regulation and learning strategies. Some of these strategies are supported by existing systems, partially in most cases, but many of them are not supported [17] [18]. Here we are going to omit this limitation in order to start with a white canvas, so we will not consider just the data we can use now from existing systems, but the data we actually need to properly monitor time management from a SRL point of view.

We need traces that represent the implementation of SRL strategies related to time management, and traces about the time used in other activities like the implementation of other SRL strategies or the learning itself. Of course it is important to track time data about cognitive tasks, but also about metacognitive ones, like for instance, planning strategies: setting a goal, creating a task, editing a goal or task, scheduling a task, measuring the time spent on a task, setting a deadline for a task and selecting a strategy for a task. In this regard, planning and performing is usually considered by learning tracking software (although planning is just supported partially), but self-

monitoring and self-evaluation are always omitted. These metacognitive tasks are very relevant from a SRL point of view. Examples of these are: time devoted to monitoring (time spent, resource use, content creation, content reading, etc.), to reflection or evaluation actions, to rate or comment a strategy, etc. Self-monitoring and self-evaluation processes are part of the SRL core. Information about which monitoring graphs were viewed by the learner, what information visualized, what reflections and conclusions produced, can provide valuable information about if learners are developing SRL meta-cognitive strategies or not.

A main problem of monitoring solutions is that many student's activities cannot be recorded because they occur off-line. This problem is maybe more important in case of meta-cognitive activities, because they usually involve inner thinking activities. We are trying to provide systems that support learners during these metacognitive tasks so we can collect data automatically. For instance, a task manager can have time management features to record the time spent on planning. Nevertheless, we assume that some activities will be performed offline. The time recording of offline activities needs to be registered by the user, or measured with a timer.

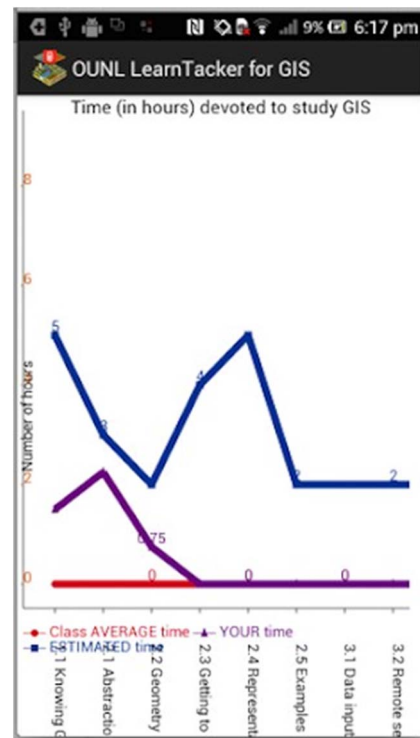


Fig. 1: Time devoted to study as displayed in LearnTracker (your time vs. class average time vs. teacher's estimation) [12].

IV. CAPTURING ACTIVITY DATA

An important issue when talking about tracing learning activities, especially SRL, is that the learners use different tools for different activities during learning. From task managers to LMSs or online collaborative content creation tools, the range of tools that learners use is wide and diverse. In order to ensure interoperability and maximize the amount of available information, it seems essential to use a standard to record and

retrieve data from all the tools. At present, the most extended standard to capture activity data is Experience API.

A. Experience API

Experience API, also known as Tin Can API or xAPI [19], is a learning technology standard managed by ADL designed to enable the recording of almost any type of activity performed within a software application. Every action is recorded as a xAPI statement in the form of “*I did this*” (actor + verb + object). These statements that represent the action performed by the user are coded by the software tool following the API specification and sent to a Learning Record Store (LRS), to be stored. This activity data can be retrieved from the LRS by any authorized software at any moment. Tin Can API statements are easy to code and include human-readable equivalents for each of the main parts of the statement (actor, verb, object, result and context). One of the key features of xAPI is that it is device independent and it supports different technologies, so it allows interoperability.

Important factors to consider when adopting xAPI are:

- It has a limited but expandable vocabulary, driven by the community. There is a repository of verbs, activity types, attachment usages and extensions that are recommended called The Registry [20]. If the use of a different or new verb, activity type, etc. is needed, you can request its addition.
- The same action can be recorded in different ways, for instance, using different verbs (*John watched ‘my video’*. vs. *John played ‘my video’*.) or using different fields to store the same information. This flexibility makes it adaptable to new situations so it does not become obsolete easily, but it also forces the use of profiles for specific uses in order to ensure interoperability.
- The xAPI profiles enable the definition of specific vocabulary and statements for specific use cases or communities of practice. This includes the definition of extensions, which are fields that are not part of the core of the specification but can be defined to adapt the specification to a particular use.
- It is possible to get a chronological sequence of activities, even from different tools, because the time when the action was performed is also recorded.
- It is possible to retrieve information about the same person from different software tools just by knowing the identifier for that user in each tool (generally the email address).

B. xAPI-SRL Application Profile

xAPI-SRL is an application profile for xAPI that “defines how to record SRL actions derived from the implementation of SRL strategies” [21]. The development of this profile was based on a deep analysis of the main SRL strategies [15] and was done with two important goals in mind: 1) defining the most relevant SRL-related actions that can be implemented in a software application that supports SRL strategies to produce suitable traces [16]; and 2) enabling the sharing of SRL-related activity

data between applications. This is really important to enable the development of monitoring systems focused on SRL, both automatic and user driven (for learners and educators).

The profile has 9 recipes: Task and goal management, planning, resources and learning content management, step sequencing, view control, time and flow control, motivation, curation, annotation, learning strategy management, self-monitoring and self-evaluation, and causal attribution. These recipes are combined in different sets to represent the following software functionalities (types of tools): task and goal management and planning, resources and information management, time management, strategy management, content delivery and self-monitoring and self-evaluation. The xAPI-SRL profile is already published and available in the Tin Can API Registry [22].

V. SRL TIME MANAGEMENT REPORTING TOOL FOR LEARNERS

Once we defined what data we need and how we record it, there are two related main challenges: processing the data from multiple sources and designing visualizations for learners and teachers that are easy to understand and foster reflection. As a result, learners can improve their SRL competences (in this case, the ones related to time management) and teachers can detect possible problems early.

Our goal is to show information about the time devoted to SRL strategies in a way the students can monitor their activities, be aware of their evolution and reflect about their performance. One typical mistake when displaying aggregated data from multiple sources is to arrange it according to simple but wrong criteria, like for instance where the data was captured, as shown on the upper side of Fig. 2. This graph shows the time spent at each application or functionality. For instance, all the activities performed in a task manager are planning activities, so that graph may represent accurately the time that the user devoted to plan his/her learning. Nevertheless, this is not correct in most cases. For example, the action of reflecting on a task (e.g. writing a comment), although it is performed within the planning tool, it is a self-evaluation activity. Data should be aggregated according to meaningful criteria.

The graph at the bottom of Fig. 2 shows the result of aggregating and processing the data from multiple sources attending to SRL criteria, in this case, the type of activity and to what SRL strategy it is related (each bar represents a part of the self-regulated learning process). The arrows show where the data comes from for each bar. The *time spent per activity type* graph is an example of this work. This aggregation of data would be impossible without the xAPI-SRL profile.

Fig. 3 shows a graph that displays the time spent per task, comparing it to the time estimation made by the learner (or the teacher for class tasks), the time spent on planning the task and the time spent in monitoring and evaluating the performance. It also displays which task is complete, which one is not, and it shows the average times for the rest of the class if the tasks are shared. There is a lot of information in one graph that can support learners (and teachers) to detect possible problems or things to improve. For instance, if the time used to plan one task is greater than normal, this may indicate that the learner had problems to understand the task, or that the task is really

complicated and needs more attention. It also allows the user to add comments or reflections on each task and, of course, the user can see the time, comments and reflections of other users (if marked as public). The time that the user spends viewing the graph or adding a reflection is added to the monitoring and evaluation time. If a task has subtasks, the time displayed is the aggregation of the time of the subtasks.

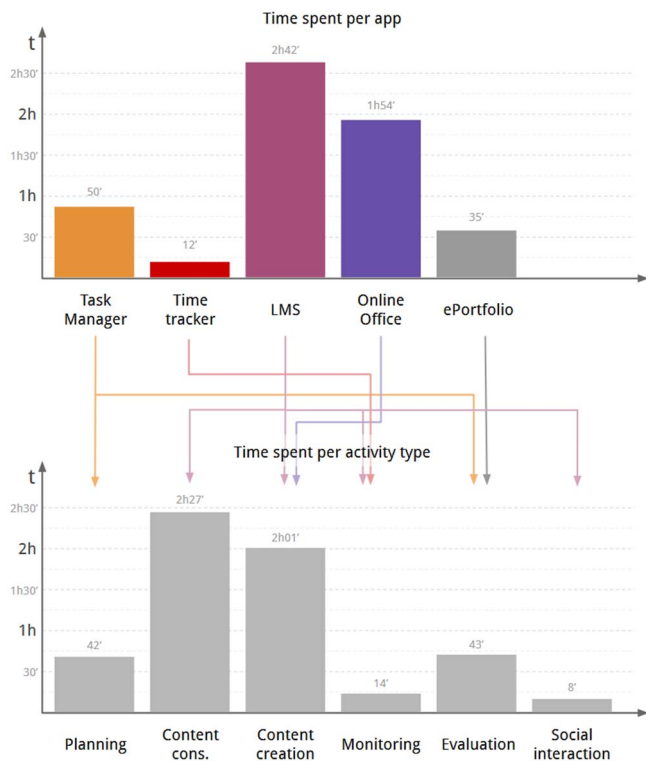


Fig. 2: Origin of the data used for each bar in the time usage graph: application (top) vs. type of activity (bottom).

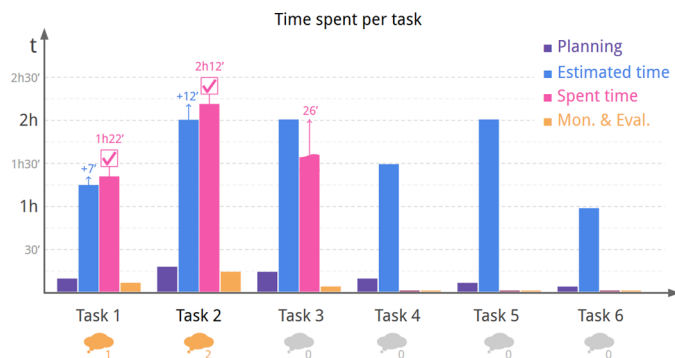


Fig. 3: Time spent per task in the whole SRL process.

Fig. 4 shows the time spent and the final grade per unit of an online course. It also shows the average time for the class for each unit. In this example, the time the learner devoted to unit 4 is lower than the average of the class, and the grade is lower compared to the rest in the course. By clicking on the bar, the learner can see the time difference and a detailed view of the time spent on each piece of content for that unit.

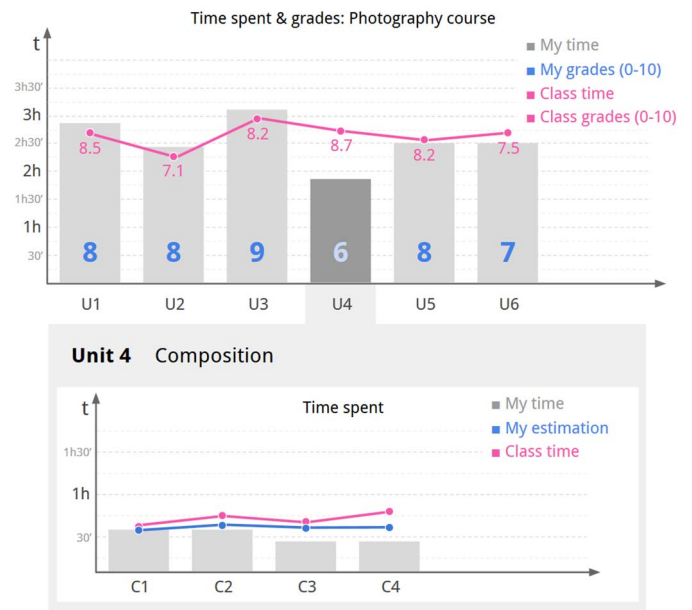


Fig. 4: Time vs. grades for an online course.

VI. CONCLUSIONS AND FUTURE WORK

This proposal offers a comprehensive solution to support the aggregation of data from multiple sources in time management reporting systems, and uses SRL criteria to select and display such data focusing on time management. Current systems offer great functionalities and graphs for time management, but there is still a lot of room for improvement, especially because they are focused on just a part of the learning process: activities performed on software learning tools. Our proposal aims to the visualization of the whole learning process from a SRL point of view, taking into account online and offline activities, cognitive and metacognitive processes, including planning, monitoring and reflection activities.

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