The Side Effect of Learning Analytics: An Empirical Study on e-Learning Technologies and User Privacy

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Abstract. Student monitoring, the most common practice in Learning Analytics (LA), has become easier and more efficient thanks to the use of tracking approach that consists of collecting data of users and of their interactions throughout learning platforms. While LA gives considerable assistance to the tutors in the tasks of monitoring online learning, it also creates major drawbacks for the learners. For instance, tracking approach in LA raises many privacy questions. As for the learners, knowing that their personal data are being used, even for educational purposes, they could radically change their perception on e-learning technologies. Not to mention that these concerns would have a strong impact, sometimes very negatively, on not only their behaviors but also their learning outcomes. To better understand the side effect of LA, more particularly the privacy issues in e-learning, the research effort presented in this paper covers two main aspects. First, it outlines various tracking approaches in e-learning. Second, it analyzes how the learners perceive the use of their personal data and the related privacy issues. To do so, an experiment has been carried out with the participation of students from three different universities in France and one university in Germany. The major contribution of this paper is the awareness-raising of privacy concerns in exploiting tracking data in e-learning, which are often overlooked by researchers and learning content providers.

Keywords: Data analysis · Data indicator · Ethics in e-learning · Learning analytics · Privacy issues in e-learning · Tracking data

1 Introduction

In 2011, when we first presented a study on security and privacy issues in e-learning [1], we pointed out the lack of data protection measures from the learning content providers. We also discussed how users relied on trust when accessing to their online learning platforms, and how technical solutions still had their limitation in terms of privacy protection. Since then, we continue to expand our research scope by focusing more on users and their perception on the use of their personal data in various educational settings. More precisely, our research team studies how privacy concerns would affect user behavior during the learning process. The study presented in this paper combines

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existing research findings with the empirical data acquired throughout an experiment that we have conducted with the participation of students from three universities in France and one university in Germany.

Our research approach is to take a closer look at Learning Analytics and the technologies that support it. More precisely, the user-tracking technologies that provide great assistance in terms of student monitoring while creating at the same time negative impact on the learning experiences. By focusing on the learners' perception of tracking technologies used in the majority of e-learning platforms, the study presented in the paper is the first attempt to understand what cause privacy concerns and how learners perceive them.

It is worth mentioning that the purpose of this paper is to share scientific findings based on field studies and empirical data. Our research team has no intention to make any claim regarding how to definitely solve privacy matters that one might encounter accordingly to a variety of factors, including institution's regulations, learning contexts and cultural points of view. This paper is not meant to address new research challenges either, but to assist the participants in the learning process, including researchers and learning content providers in acquiring a better understanding of privacy matters when it comes to making use of tracking data in e-learning. Our goal is to raise awareness of the issues in question, which are often neglected in the research efforts that involve user tracking and personal data analysis.

This paper is structured as follows. The second section provides an overview of our research work that emphasizes on user-tracking approach and data visualization. An example of using tracking data from a previous study is presented in the same section. A general discussion on user tracking approach is made in the third section. It is based on a number of related works, which help us gain a broader perspective on what causes privacy concerns. The fourth section is dedicated to our experiment. Data analysis and commenting on results are made in the same section. In the last section, we draw a conclusion and highlight future work.

2 Research Context

2.1 User Tracking Approach in Learning Analytics

E-learning has been evolving rapidly, from purely Web-based to mobile and ubiquitous learning experiences, thus providing even more personalized solutions that better suit each individual need. For that reason, institutions, teachers and learners seemingly embrace e-learning [2] and consider it among the most innovative learning mediums [3]. In fact, within the past ten years, we witness a strong ongoing growth of research interests in e-learning [4, 5] and the emergence of technologies that better support user interactivity [6] and content sharing [7].

In order to make e-learning more practical and more efficient in terms of student monitoring, other research efforts like [8, 9] focus more on user tracking approach that consists of collecting data of users and of their activities within learning platforms. As discussed in our previous work [10], using a tracking mechanism to observe the learning process has been proven to be a reliable support to both instructors and learners,

particularly in e-learning contexts [11]. To state an example, by monitoring an e-learning session, the instructors are able to follow the activities being undertaken by the learners and to observe their behaviors on learning resource consumption [12]. As for the students, having records of their own activities allows them to keep track of their individual progress, their interactions among other students as well as their achievements throughout the learning session [13].

Acknowledging the contributing factor of "user tracking approach" to high quality teaching and learning guidance in e-learning as pointed out by [14], researchers and learning content providers choose to integrate systematically a tracking system in their educational settings. To back up this claim, the most recent studies of [15, 16] review a variety of learning platforms that make use of students' tracking data for different purposes, among which are student assessment and evaluation. Further evidence on how user tracking approach is broadly used to help enhance e-learning can be found in the research works of [17–21].

Implementing user tracking systems in e-learning has been done in numerous ways as identified by [9, 22–24]. With the progress being made in regard to the tracking mechanism, the technique of collecting data has become more sophisticated and powerful while being effortless to be deployed in an existing e-learning environment. In the meantime, such progress has increased privacy questions, which lead to a situation where security and privacy protection are becoming crucial for the users. Hence, it is relevant to our research interests to determine users' concerns and to investigate their needs in terms of privacy provision.

2.2 Previous Works

Our research team works on learning environments and studies numerous research questions related to "Modeling the Observation of Usage Tracks and their Analysis". Our goal is to better observe and analyze users' activities by exploiting the user declaration model and user-tracking data [11, 25].

A part of our research work involves user tracking on e-learning platforms where Computer Mediated-Communication tools (i.e., forums, chat, newsgroups, wiki, etc.) are widely used to foster learning activities and to compensate the lack of face-to-face interactions among the participants [26]. We proposed an explicit tracking approach to assist the conceptual design and implementation of a tracking system for a variety of Web-based communication tools [27]. The proposed approach was built upon a tracking mechanism that simultaneously collects fine-grained data from both client and server sides. On top of that, the tracking process can be made on different levels of Human-Computer Interactions, which allows us to characterize the nature of the acquired data (i.e., user's action, user-machine interaction or system event) and to conduct the analysis accordingly. The technical aspects of the tracking approach in question can be found in [28].

Tracking data analysis is very often associated to data-mining, but one of our proposals is also to consider the analysis as a prescriptive approach [29]. We proposed a formal description of data indicators and more generally observational data according to the description of observational needs given by the participants in the learning process.

This kind of tracking data analysis focused on the following questions: (i) what is interesting to observe, (ii) why it is important, what is the observational goal (assessment, regulation, adaptation, re-engineering, reflexivity), and (iii) what is the most efficient way of data presentation for improving the comprehension of indicators? The Usage Tracking Language (UTL) [11] aims to be neutral regarding learning technologies in order to describe the analysis process and the corresponding data. It is based on generic models and a processor to corporate tracking data and compute indicators.

For the sake of comprehension, "data indicator" refers to a piece of information, extracted from a set of tracking data. Generally computed in graphical representations, a data indicator features the process of the considered "cognitive system" learning activity, the characteristics or the quality of the interaction being performed on a learning environment [30]. Data indicators provide means of abstracting and visualizing the information that they feature. Obtaining data indicators is a complex process. It involves many phases, among which the transformation of data indicators in graphical representations.

2.3 Data Indicators in Learning Analytics

Another part of our research effort focuses on tracking data exploitation where research challenges were studied in [10]. Our goal is to make use of the collected tracking data in order to help the participants explore their past and ongoing activities on a learning platform. With the technical support in terms of data analysis and visualization, the participants could not only examine their activities, but also make an assessment of their effectiveness, achievements, etc. We identified 4 observation goals for our tracking tools: reengineering, adaptation, assessment and reflexivity. All participants in the learning process can classify their observational needs at least in one of these goals.

The need of data analysis and visualization tools can be briefly explained as follows. With the current support of e-learning that prioritizes content sharing and user communication [6, 7], the participants are compelled to neglect some fundamental facets of online learning, such as self-monitoring and self-evaluation. Additionally, despite the learning possibilities provided by an e-learning platform, the participants are unable to fully control their activities in the way they used to do in a traditional classroom. Not to mention the fully online interaction between the participants that makes the supervision tasks very laborious for the instructors. Last but not least, while the learners usually encounter difficulties in getting feedbacks on their own activities, the instructors, on the other hand, are often constrained by the lack of technical assistance to conduct a proper analysis on the learners' tracking data.

Having studied these issues, we addressed the importance of technical supports in tracking data analysis and visualization in order to enhance e-learning experiences for both the instructors and the learners. Therefore, we have designed and developed TrAVis (Tracking Data Analysis and Visualization tools) for the instructors who are in need of supervising learners' activities [25], and also for the learners who seek to self-monitor during their learning sessions [31]. We have also designed and implemented UTL to support tracking data analysis. For instance, UTL enables the tutors to specify their observational needs in a learning session and to compute data indicators used to better monitor and evaluate the latter.

To illustrate how tracking data analysis could contribute to e-learning enhancement in terms of student monitoring, we give below an example of a "data indicator" representing a group activities on a learning platform supported by Moodle. The following data indicators are modeled and computed by UTL. They illustrate activities of 2 groups of students while navigating lecture modules according to a given learning scenario. If taken a closer look, such data indicators allow a comparison of different aspects of group activities. For instance, we can easily point out that in group A, the students had enough time to use all modules. On the other hand, the group B had more difficulties to navigate between modules. While there might not be enough information to make further conclusion, it is still very useful for the teacher to have data indicators that help them to better analyze and understand the activities of each group of students.

Another example of data indicators is shown in Fig. 2. Generated by TrAVis, the data indicators provide a visualization of two groups of students on three forums that have the same structure, dedicated to group collaboration. Each radar graph, filled in with a distinct color, provides a quick perception of the forum and its access frequency, number of active participants, threads, messages, and files, etc. Hence, the teacher can

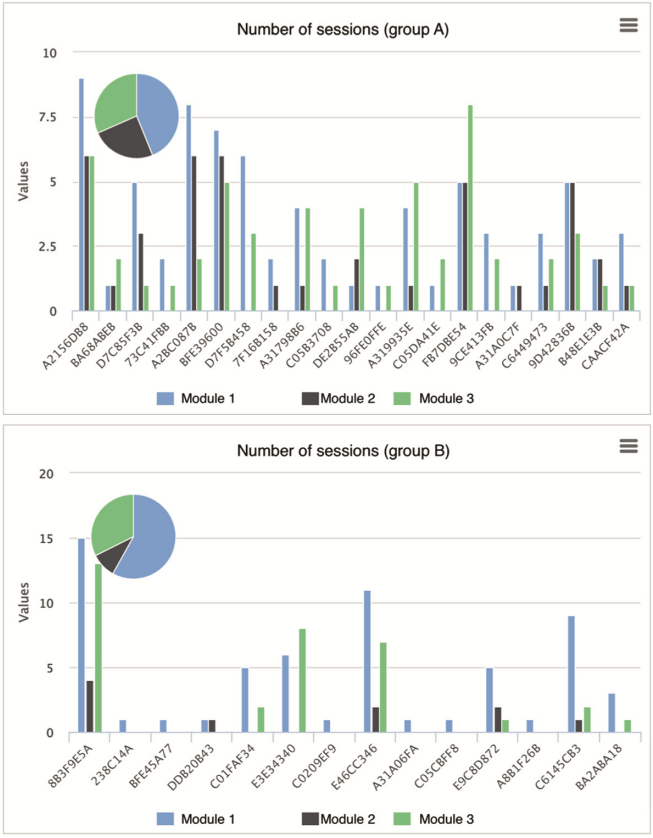

Fig. 1. Example of data indicator with UTL.

make use of these indicators to analyze the interactions among the students. On top of that, the given quantitative information allows the teachers to evaluate the collaboration level of each group. For instance, Fig. 2 shows that group A has more intense interactions than group B in almost the three forums. Such indications can be used to (i) compare the participation rates of both groups during the collaborative task or (ii) to evaluate the productivity rates of one group in relation to another, according to the number of created threads and shared files. More data indicators and their analysis can be found in [10].

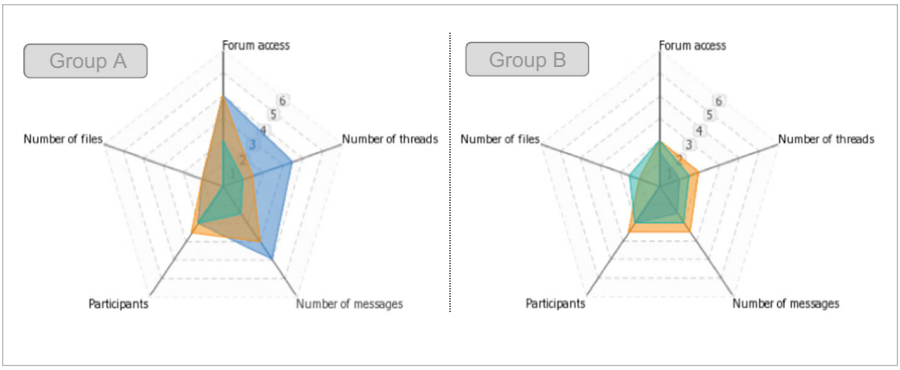

Fig. 2. An example of data indicators that analyze the participation level of two groups of students.

To sum up, data indicators computed from e-learning tracking data provide means of awareness, assessment and evaluation of a learning situation. However, obtaining data indicators involves a complex procedure that starts with a tracking technique. Indeed, the latter is crucial to the whole data gathering process and always has an impact on the production of quality and substantial data indicators. Consequently, most tracking techniques that are robust and efficient in collecting users' data are at the same time very intrusive [9, 23]. To gain a broader perspective on how tracking approaches could cause privacy issues, the study we present in the following section covers a number of research works with examples of how tracking data are used.

3 Related Works

3.1 The Correlation Between Learning Analytics and Privacy Concerns

Using data indicator in the analysis process enables one to synthesize, infer and interpret the information that it features. In e-learning, while it gives considerable assistance to the tutors in the tasks of monitoring online learning, it also creates major drawbacks for the learners. For an example, some learners who are cautious about privacy matters would become apprehensive of being traced and of having no control over how their personal data are being exploited. Yet, they have to accept the undesirable inconveniences of having their data scrutinized so that they could receive in return the assistance when needed. To better understand this phenomenon, a literature study has been

conducted on a number of research works where data indicators computed from e-learning tracking data are being exploited by the tutors to gain awareness, to make an assessment and to evaluate learners' activities.

Starting with Argunaut [32], which is an awareness tool, built to keep track of online interaction. It provides data indicators of collaborative learning activities, thus allowing the instructors to examine the behavioral aspects of each individual student during a collaborative task. It should be noted that the awareness indicators of users' collaboration were first found in the research effort of [33], which demonstrate how data indicators on the interaction links could give awareness of the discussion depth and of the student's learning attitude. Later, we have studied iHelp [34], another awareness tool that shares the same characteristics of Argunaut. iHelp assists the instructor in supervising the communication process among the learners.

Besides gaining awareness, making an assessment of learners' activities is also compulsory. For that matter, [35, 36] suggested an analysis of various aspects of an individual or a group activities. For example, the instructor can make an appreciation of the participation level of an individual or a group of learners based on the number of messages exchanged among the group. On the other hand, [37] proposes a platform that offers means to analyze the temporal and spatial dimensions of learners' interactions on a communication tool. As for the data indicators, they are computed in a form of activity map, enabling the instructor to observe and assess communication characteristics such as the degree of participation of a learner, compared to the whole group.

Regarding the evaluation tools that provide data indicators on students' activities and their outcomes, CourseVis [38] provides the instructor with means of evaluating the social aspect of each student in a learning session. Not too far from CourseVis in terms of data analysis and visualization, DIAS (Discussion Interaction Analysis System) of [39] is another evaluation system that helps the instructors investigate learners' interactions on a communication tool. Data indicators computed by DIAS mainly serve for the evaluation of the social dimension of each learner. In the same context, GISMO, a Graphical Interactive Student Monitoring tool, developed by [8], proposed another way to visualize behavioral and social data of learners' activities. Its objective is to help instructors evaluate the involvement of the learners during the course activities on a learning platform (e.g. Moodle). For a more complex learning environment like MOOC, Coffrin et al., [40] made use of data indicators to classify student types and to analyze students' engagement and performance throughout their learning process. Last but not least, Glass (Gradient's Learning Analytics System), a Web-based visualization platform [41] that offers the possibilities to keep track of students' activities on different tools used in a learning setting. Data indicators provided by Glass are meant to assist the instructors in evaluating the students on how active they are and how they perform in a given learning context.

Thus far, our primary observation regarding the existing tools is that most of them aim to better support the instructors in exploiting learners' tracking data. To do so, they explore every possible piece of information related to the learner's activity in order to accordingly generate significant data indicators on the latter. The intrusive characteristics of each tool allow, on the one hand, a pertinent analysis on learners' activities, but causes major privacy concerns on the other hand [42]. While some recent research efforts

like [43, 44] took into account the need of users in controlling how their personal data are being used, only a few are accessible by the learners. This is due to their restricted user rights from a technical standpoint, as well as their roles in the learning process. As a result, the learners always comply with the regulations of the e-learning platform and put their trust on the latter [45]. Consequently, the privacy concerns remain to be addressed as the learners are not always in the position to determine what data to share and whom to share with. This is not to mention that in some circumstances, the learners were not informed of the use of their tracking data either for instructional or research purposes.

Another observation is relevant to the strong focus of the previous works, placed on the efficiency of the tracking approach and the data indicators. The privacy concerns seem to be overlooked. Nonetheless, these concerns have a direct impact on the learner behavior as studied by [46]. Sharing the same concerns as [47], our research team has been studying the learner's perception on privacy issues, which usually cause some changes to the behavioral aspects of each individual activity in e-learning. For instance, the confidentiality and anonymity play an important role in learner engagement and performance as an individual or a group. Without necessary protection measures, learners are becoming too afraid to be exposed to what meant to help them learn in the first place as found in the studies of [42, 43].

3.2 Identifying the Privacy Concerns

According to [48], privacy concerns are mainly caused by the use of technologies. As a matter of fact, with the growth of new platforms, new learning opportunities can be created along with new problems. The participants usually require technical knowledge of how technologies work in order to understand the privacy levels and threats. Nevertheless, the lack of information and technical supports in that matter causes the most privacy concerns.

Learning service and content providers also bear the responsibility of intensifying the privacy issues. The participants frequently ask the question how their personal data are stored and protected by the learning content providers. As found in the study of [49], the participants are primarily concerned with trust assessment of learning environments they are using, and with the protection of their sensitive data.

The study of [47] pointed out that privacy issues are also related to the participant consent, data ownership, confidentiality and anonymity. The participants expressed their concerns regarding how information collected throughout the learning process would be kept secure and private. The confidentiality is part of the privacy protection that refers to participants' right to control the access of their tracking data as well as other information about them. Regarding the anonymity, most participants are unaware of their right to request the removal of any characteristics (i.e., name, address, affiliated institutions, geographical areas, etc.) that would allow them to be identified.

Our findings reveal that most participants regret not being part of the decision-making on what information to be collected, what to be used, and for what purpose. Despite the compromise they have to make when consuming resources on an e-learning

platform, the participants expect to have choices to accept to be traced, to deny the use of their data or to limit access to some users.

Privacy issues also concern the security threats of technologies we are using. Indeed, the participants are exposed to a risk of data and identity theft. Such issues make participants doubt the confidentiality and data protection measures proposed by their affiliated institutions or learning content providers. Research evidence can be found in the study of [50].

Our study also took an interest in mobile e-learning where security and privacy threats remain challenging despite technological progress made on ubiquitous learning. This is due to the fact that granting access to mobile devices on learning contents opens doors to security threats that have not been taken into account by the learning service providers. The diversity of mobile devices and their security protection measures are varied in accordance with the operating system, the application used and user own measures to protect their privacy. Research data from the study of Young [51] cover the privacy preservation for mobile e-learning. Yong pointed out the security threats regarding ubiquitous learning and the privacy preservation techniques for the learners.

To summarize, security and privacy levels differ in various learning environments and depend on types of learning activities being conducted by the participants. For instance, a collaborative learning situation where interactions between participants are inevitable and their exchanges of both personal and collaborative data are intense, a strong protection of participants' privacy could only be done on a particular environment that is specifically built for such situation as found in [52] on establishing a privacy-aware collaborative learning environment.

In practice, it is not always straightforward or simple to promise absolute privacy, confidentiality and anonymity when using open e-learning environment. However, identifying the privacy levels clearly and their relative protection measures allow us to set rules and policies in terms of user tracking.

4 Case Study

4.1 Setup and Participants

On top of the study we made on existing research works, we have conducted a semi-controlled experiment where TrAVis was used to analyze and visualize tracking data collected on a Moodle learning platform. Our main goal is to acquire an overview of student perception on privacy issues when their personal data are being used in an authentic learning situation. Our clear intention is to consult the students who are naturally concerned about their data in an actual practice setting instead of interviewing some random students. As a matter of fact, every student who participates in our experiment uses online learning platform on a regular basis. A total of 178 students from three universities in France and one university in Germany participated in our study.

Most participants have sufficient knowledge in Computer Sciences and e-learning technologies. Each one of them is clearly explained the purpose of the study and how their tracking data are being treated. Having acknowledged the necessity of protecting the participants' personal data, we choose to discuss in this paper the findings from a

general perspective. Experimental data will be presented without distinguishing the groups of participants, their respective university, and academic background. Furthermore, any sensitive information susceptible to identify the participants or the level of their implication in the study will be intentionally left out.

4.2 Procedure

The participants were assigned the task of using Moodle to organize their group activities. They were also encouraged to use a discussion forum, already integrated into Moodle, to perform their communication activities. Depend on their affiliated university, the participants had between one and two weeks to complete the assigned task. They were then asked to use TrAVis to analyze their personal data gathered during the period of the experiment. We also provided to the participants technical assistance in choosing tracking data to analyze and in visualizing data indicators on their past activities.

At the end of the experiment session, the participants were solicited to answer a questionnaire with over twenty questions, which emphasizes on three main aspects: (i) their perception of privacy issues in e-learning, (ii) their general knowledge on tracking approaches and tracking data analysis, and (iii) their request for privacy protection measures.

4.3 Experimental Data

The most significant data from the questionnaire that reflect how students perceive the privacy and security issues in e-learning are illustrated in Fig. 3. What gets our attention the most is the belief of the participants that an anti-virus or an anti-spyware would help them overcome the privacy issues in e-learning. Indeed, 34% of the participants claimed to have a good protection system that prevents their personal data from being collected. Such misunderstanding is a big part due to the lack of technical knowledge on how a

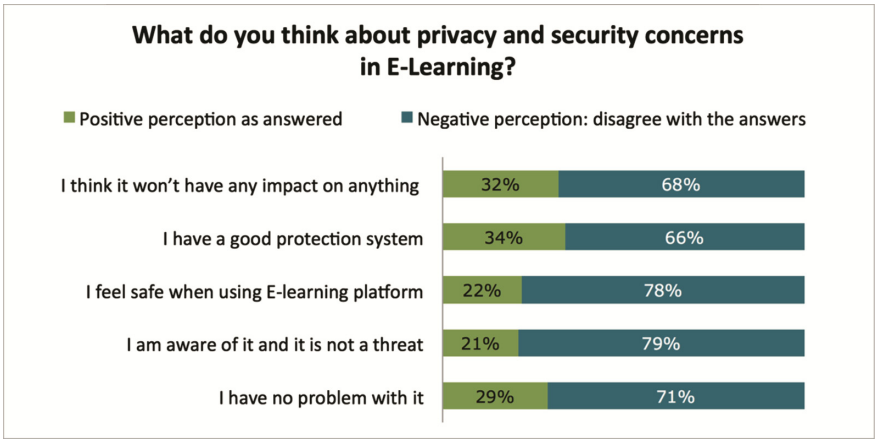

Fig. 3. Student perception on privacy and security concerns in e-learning.

tracking mechanism works. It is also because the privacy issues are very confusing for the participants. For instance, the most frequently asked question during our experiment was whether or not they were tracked when using a browser in incognito or private mode to access their online learning environment. In fact, most participants do not have a clear perception on the tracking process and its correlation to the privacy concerns.

Although the majority of the participants seem to figure out the most common security aspects in e-learning technologies, they still have difficulty identifying the related threats. As confirmed the data from the fourth and fifth rows in Fig. 3, only 21% claimed to have knowledge of the tracking process and considered it without harm to their private data. Respectively, 29% admitted that they have neither privacy nor security preoccupation in e-learning. On the contrary, over 78% disagreed with the previous claims and felt unsafe when using e-learning regardless the tracking process being deployed or not.

Figure 3 also reveals interesting data that support our hypothesis regarding the impact of user-tracking approach on user behavior in e-learning. 68% of the participants expressed their fears towards a learning environment with an integrated tracking system. The participants recognized that the latter had sometimes affected how they perform certain types of activities. For example, they suggest limiting private activity or reducing public intervention like on a discussion forum, so that they would leave the least of their traces possible on an open e-learning environment.

The second analysis we made on the data from the questionnaire focuses on the participants' general knowledge on tracking approach and tracking data analysis. As illustrated in Fig. 4, we find the most familiar tracking approaches used on Web-based learning environments. With the exception of the browsing history, which 69% of the participants are aware of, the rest of the tracking approaches are either new or unclear to the participants. 18 to 44% declared that they have only heard of the tracking system,

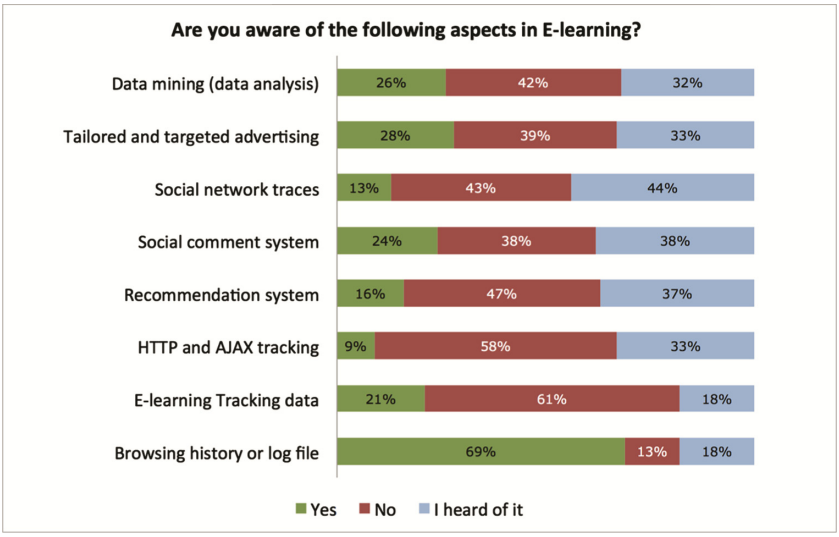

Fig. 4. Student awareness of user-tracking approach and tracking data analysis in e-learning.

but they had no idea of what it is and how it works. What is more intriguing is that 61% of the participants are not common to a tracking system in e-learning and are unaware of its existence.

Judging from the experiences of the participants in online learning and social environments, we expected to witness a higher positive response rate to the questions on tailored advertising, social network traces and social comment system (cf. row 2, 3 and 4 in Fig. 4). Nonetheless, only 13% understand what social traces are and 28% are aware of the targeted advertisements. The social comment system is sometimes used in an online learning environment (e.g., blog, wiki), only 24% realized that their personal information from their social network account (e.g., Facebook, Google +) are being used in their e-learning environment. While 30% are familiar with such tracking possibility, another 30% have no clue of it.

If we take a closer look at some more complex notions like HTTP and AJAX tracking, only 9% of the participants acknowledged its usage on a large scale in Web-based e-learning platforms. In the meantime, over 58% ignored that their activities could be monitored on both client and server sides thanks to HTTP and AJAX tracking system. As for the data analysis, the participants seem to be more familiar with data mining as confirmed 26% of them while another 32% mentioned that they only have heard of it. Still, 42% did not have knowledge of various analyses being made on their tracking data by the researchers, the instructors or the learning content providers.

The third objective of our experiment is to explore different privacy protection measures as seen by the participants, to help them get beyond privacy concerns. Table 1 shows the most demanding features regarding personal data protection, consent agreement, anonymous use of learning services, ethics legislation and awareness raising. On a scale of 0 to 5, the participants expressed the least and the most important privacy protection measures.

Table 1. Most requested features in terms of privacy and personal data protection.

Importance level	0	1	2	3	4	5
Awareness raising	0%	2%	15%	15%	33%	35%
Avoidance of personal data	2%	5%	10%	16%	18%	49%
Data protection	6%	11%	15%	22%	18%	28%
Anonymous access	10%	7%	18%	13%	33%	19%
Data access management	2%	12%	5%	33%	30%	18%
Right to be forgotten	9%	9%	11%	23%	27%	21%
Guarantees from content provider	0%	6%	33%	29%	18%	14%
Consent agreement	0%	3%	12%	33%	14%	38%
Ethics legislation	19%	29%	14%	13%	13%	12%

Interesting information can be retrieved from Table 1. Examples include “avoidance of personal data” and “consent agreement”, which are both strongly relevant to privacy concerns in e-learning. In fact, consent is one of the keystones of privacy research practices in e-learning. Somehow, we were surprised to learn that most of the participants had never been reached out by anyone to sign a consent form. Yet, they have been

regularly using Moodle, and their tracking data have been exploited in both educational and research settings.

The data from Table 1 also show that the participants consider "user data protection" and "anonymity" among the most important privacy provisions. As for "personal data protection", the participants requested to be informed of the tracking process. According to the participants, being aware of the latter is the key to reducing privacy concerns.

If take a closer look at how the participants perceive tracking approach in e-learning, while 49% of them claim that user tracking as a big threat, only 12% believe that ethics legislation could help them control the visibility and the use of their sensitive data. Interestingly, we have found similar results in our previous study [1] that user tracking is not welcome even when users receive personalized content and assistance in return.

To wrap up, this study enables us to gain a broader perspective of the most crucial aspects regarding privacy concerns in e-learning. While we still need to conduct more analysis on the experimental data we have acquired, the early findings point to the most critical measures to undertake to keep users informed of the privacy issues and to help them avoid confronting one. The study we made thus far also inspires us to explore a proper solution for our research work, which implicates user tracking and data analysis.

5 Conclusion

The research effort we presented in this paper analyzes existing findings and experimental data obtained from a case study on privacy issues in e-learning. While attempting to demonstrate, with research evidence, the benefits of a user tracking approach to e-learning enhancements, we also point out the necessity of gaining an insight on the privacy concerns that most participants encounter in their daily learning activities.

We also address the lack of guidance for the participants to acquire a better understanding on privacy levels and threats. Data from our study reveal that the participants have a very negative perception on e-learning technologies when it comes to privacy and data protection. We recognize that avoidance of personal data is the most requested privacy provision, enabling students to anonymously access to e-learning platforms. However, we should also point out that a learning application aims at assisting students and so they cannot act in full anonymity. For that reason, participants in our study were always informed of the tracking process and given the right to control access to their data. On top of that, we always have a clear policy regarding the use of student tracking data in research and instructional purposes. For instance, the consent agreement is compulsory for the students and only authorized and anonymous data are used in our publications. We have no intention to make any claims regarding how to definitely solve privacy issues that one might encounter. Nonetheless, we hope to raise awareness of researchers, pedagogical teams and other e-learning practitioners in terms of user tracking and data analysis.

What we have also learned from the current study is that the research trends in Learning Analytics tend to focus more on technologies. To us, it is worth questioning our research strategy that places technologies ahead of the users, their actual needs and their concerns with privacy. LA has been indeed positively welcomed by the e-learning

community and practitioners, but has also been indirectly forcing users to constantly readjust themselves to newly created environments and technologies. Are we actually adapting to technologies? If so, why is it not the other way around?

Privacy concerns remain one of the main research challenges in LA. Therefore, our future work will focus on a more in-depth analysis of the current experimental data to explore other aspects like ethics in e-learning. We are also attempting to quantify and qualify the impact of the privacy issues on the behavioral, social and cognitive aspects of online learning. To do so, research colleagues from France, Germany and Greece are collaborating on an experiment to study the evolvement of privacy questions and their associated threats by taking into account both ethical and cultural points of view.

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