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Learning analytics in small-scale teacher-led innovations: Ethical and data privacy issues

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ABSTRACT: As a further step to maturity, the field of learning analytics (LA) is working on the definition of frameworks that structure the legal and ethical issues that scholars and practitioners have to take into account when planning and applying LA solutions to their learning contexts. However, current efforts in this direction are especially focused on institutional higher education approaches. This paper reflects on the need of extending these ethical frameworks to cover other approaches to LA; more concretely, small-scale classroom oriented approaches that aim at supporting teachers in their practice. This reflection is based on three studies where we applied our teacher-led learning analytics approach in higher education and primary school contexts. We describe the ethical issues that emerged in these learning scenarios, and discuss them according to three dimensions: the overall learning analytics approach, the particular solution to learning analytics adopted, and the educational contexts where the analytics are applied. We see this effort as a first step in the wider objective of providing a more comprehensive and adapted ethical framework to learning analytics that is able to address the needs of different learning analytics approaches and educational contexts.

KEYWORDS: Learning Analytics, Ethics, Privacy, Higher Education, Primary Education

1 INTRODUCTION

The increasing trend towards the massive data collection in educational settings has raised new ethical concerns in the learning analytics (LA) research community. On the one hand, there is a need for identifying the students across platforms and retrieving as much data as possible to obtain informed analysis about the learning processes. On the other hand, other aspects influence the adoption and acceptability of learning analytics approaches, such as data ownership and openness, potential abuse and the need of new key competences to interpret and act on learning analytics

results (Greller & Drachsler, 2012). These and other aspects are part of the ethical concerns that the field of learning analytics has to face to grow as a mature discipline.

Several authors have reflected on the ethical issues that affect the field (Slade & Prinsloo, 2013; Sclater, 2014) and have made proposals to face them, like the set of design guidelines proposed by Pardo & Siemens (2014). However, most of these analyses and proposals apply to higher education institutional contexts. There is scarce reflection on the implication of using learning analytics in smaller-scale contexts where teachers use the data to manage their classrooms both at university and school educational levels, but especially in the latter. However, as pointed out by Griffiths (2012), the kind of ethical considerations that have to be taken into account are different depending on the approach taken to Learning analytics. Therefore, there is a need to reflect on what ethical aspects are relevant in the applications of learning analytics to small-scale teaching practices, and especially in school contexts.

During the last years, we have worked in the support to teachers' orchestration (Dillenbourg, 2013) of CSCL activities in blended learning scenarios. With the aim of providing teachers with meaningful and easy to appropriate data, we have proposed a scripting and a monitoring process, both of them aware of each other, so that the analysis and the results provided by the learning analytics system are influenced by the information provided (by the teacher) at design time (Rodríguez-Triana, Martínez-Monés, Asensio-Pérez, & Dimitriadis, 2012; Rodríguez-Triana, Martínez-Monés, Asensio-Pérez, & Dimitriadis, 2013). Both processes are supported by a technological infrastructure – a data integration architecture- able to integrate different kinds of data sources, including LMS, tools and user-generated data (Rodríguez-Triana, Martínez-Monés, & Asensio-Pérez, 2011). This integration aims to apply learning analytics to the existing technological ecosystems the users (teachers and students) are familiar with.

These proposals were designed and validated following a Design-Based Research (DBR) process applied to seven cases in higher education (Rodríguez-Triana, Martínez-Monés, Asensio-Pérez, & Dimitriadis, 2015). To test the capability of our solutions to adapt to a different educational level, we applied them to a primary school case. We found that while we could easily manage the technical aspects of data retrieving, analysis and visualization, emergent issues related to data ownership and control, students' identity, and other legal and ethical concerns were more difficult to handle.

We present in this paper a reflection on how the ethical frameworks that are being proposed in the learning analytics literature apply to our teacher-centered classroom-based approach and to the two aforementioned educational contexts. The two studies presented in the paper illustrate with concrete examples which ethical issues are relevant in learning analytics applied to small-scale teacher-led innovation in higher education and at school levels. The findings of the studies provide initial evidence of the need of adapting the existing ethical frameworks to the different approaches to learning analytics and to the educational contexts to which it may be applied.

The rest of the paper is structured as follows: the next section provides an overview of the ethical issues identified in the learning analytics literature; Section 3 describes the main aspects of our approach to LA; Sections 4 and 5 explain how we applied our learning analytics approach in university and primary school contexts as well as the main ethical issues that we encountered; Section 6 discusses and compares the findings obtained from the different contexts; and finally, the paper ends with the main conclusions drawn from this work.

2 ETHICAL ISSUES IN LEARNING ANALYTICS - A FRAMEWORK OF REFERENCE

As the field of learning analytics is abandoning its infancy, ethical issues related to its application to real practice are receiving more attention. In parallel with the increasing impact of the proposals coming from the field, there is a need of reflecting on the consequences that these proposals have on the persons involved (Slade & Prinsloo, 2013), and on how learning analytics has to be shaped to respond to those demands (Pardo & Siemens, 2014).

We aim at providing new insights on how ethical issues depend on the approach to LA, and on the particular contexts to which these approaches are applied. In order to structure the analysis, there is a need to organize the issues and establish a common framework that allows discussing about them (Ferguson, 2012). However, to the best of our knowledge, there is a lack of frameworks addressing the ethical issues related to the application of small-scale teacher-led learning analytics in schools. There exist studies that draw attention on the potential benefits of learning analytics for learning in primary schools (see e.g. Ebner & Shön, 2013), or on how to support LA-enabled teachers' interventions (Wise, 2014), but they do not usually address the ethical or privacy concerns that may affect them.

The existing frameworks take an institutional approach. Kay, Korn & Oppenheimer (2012) identify a set of legal and ethical issues, with a focus in on higher education institutions. Sclater, (2014) provides a comprehensive list of concepts and issues related to ethics accompanied by an extensive literature review. Based on this review, and after a process of structured discussion and validation involving experts and stakeholders (Sclater, 2015), a Code of Practice for learning analytics was released to support educational institutions in the effective use of learning analytics (Sclater & Bailey, 2015). In the rest of this section we describe the categories defined in the Code of Practice, pointing out how the mentioned issues apply to the teacher-led small-scale learning analytics approach addressed in this paper.

Responsibility: There is a need for defining who is responsible for the legal, ethical and effective use of LA. Concretely, specific responsibility should be allocated for data collection, anonymization, analysis, retention and stewardship, as well as interventions. At the classroom level teachers will be in many cases the responsibles of these aspects. One question derived from this is whether the involved teachers have the capacity and are provided with the tools needed to face this responsibility.

Transparency: This aspect refers to how and whether students should be informed about the data collection, the results, and the analysis methods. Any potential adverse consequences of withdrawal from a learning analytics process should be also explained to them. At the institutional level it makes sense to ask whether teachers should be aware of this information, while in small-scale approaches, this question does not normally apply, as the teachers will be the ones that control the analysis.

Therefore, the main concern in this case is whether and how the envisioned data collection and analysis are to be presented to the students.

Consent: This topic refers to how and in which circumstances the students should be asked for consent to collect and use their data, e.g., aspects related to informed consent, whether students hold the right to opt out, and what the consequences of doing it are for the individual and for the group. Consent can be formulated to enable students to decide on the data being collected about them, or to preserve their anonymity. This topic also includes issues related to the *informed* nature of the consent, asking whether a consent can be considered as informed when the participants do not understand the analytics, or when these analytics may evolve in the future in unknown ways. The need to describe the analysis so that the participants understand it may be very relevant at the school level, where the participants (teachers, children, and their parents) may have difficulties to interpret them. At the classroom level, opting out may not be possible if the analysis is part of the learning activities. In case it is possible, one issue to address is how to provide teachers with logistic support to exclude these learners from the analysis.

Privacy: Access to student data and analytics must be restricted to those with a legitimate need to view them. There are important issues related to the capacity of learning analytics algorithms to re-identification of individuals based on the aggregation of these data sources. If there is a need of using "sensitive data" (e.g. ethnicity, religion, sexual preference) additional safeguards and possibly additional consent should be collected before granting request from external bodies to share data. Privacy may be less important at the classroom level, when data is only used and shared within the members of the class. However, it is necessary to ensure that privacy is not being violated, especially when working with minors, where it is a very sensitive issue.

Validity: This concept refers to the accuracy of the analysis. Relevant questions relate to which data sources are necessary for ensuring this accuracy, how to verify the algorithms used to draw conclusions, and how to avoid extracting conclusions from spurious correlations. In contexts where learning analytics is applied to historical data, it is also necessary to consider that students evolve and the conclusions based on that data must take that evolution into account. Finally, this aspect refers to a more technical issue related to the authentication of data sources coming from public sites or, in general, from third parties, i.e., how to ensure that students are correctly identified when using data coming from these external data sources. In classroom-based experiences, where blended learning is common, there are many threats to validity, as participants may interact in many forms, including face to face outside the classroom.

Access: This topic relates to whether and in which ways students can access the analytics performed on their data. This aspect considers the need of allowing students to correct inaccurate data about themselves. At the small scale teachers can even ask the learners or take extra data sources to make this corrections.

Enabling positive intervention: This topic relates to what should be done by the institution with the information obtained, and what the consequences of not doing anything are, e.g., not informing a student that s/he has a risk to fail a subject. This aspect also comprises issues related to pedagogical interventions, such as who should be responsible of presenting the results and how, the possible

danger of favoring one group over another, how to adapt the intervention to the different needs of the students, etc. The approach discussed in this paper assumes that learning analytics is applied to support teachers' interventions in the class. As with any other pedagogical intervention, it is necessary to reflect on the impact that these interventions (or lack thereof) have on the learners.

Minimizing impact: This topic comprises some of the main adverse impacts already identified in the application of Learning analytics and how to face them. We should be aware that an analysis can never give a complete picture of an individual's learning and may sometimes ignore personal circumstances. Thus, we have to ensure that trends, norms, categorization or any labeling of students does not create bias, reinforce discriminatory attitudes or increase social exclusion. At the small scale, this aspect is closely related to the effect that the intervention will have on the students.

Stewardship of data: This aspect is related to the administration of the data by the institution, including the observance of the legal issues applicable in each case. Data for Learning analytics must comply with existing institutional data policies, and these policies have to ensure that the rights of all the involved persons are observed. Additionally, data should be kept to the minimum necessary to deliver the purposes of the analytics and retained only for appropriate and clearly defined periods. Teachers need help to be able to accomplish these tasks.

This classification proposed by the Code of Practice was useful to structure the discussion about ethical concerns found in the cases described in Sections 4 and 5. Moreover, this discussion helped us identify aspects where the framework should be adapted to the approach to learning analytics addressed in this paper. The next section outlines the main characteristics of this approach.

3 OUR APPROACH TO LEARNING ANALYTICS

Griffiths (2012) identifies two types of analytic interventions with potential impact in teaching practices: a) methods oriented to achieve enhanced regulation of the teaching and learning environment; and b) methods and tools intended to help lecturers carry out their tasks more effectively. Our approach to learning analytics is aligned with the second approach. It is devoted to support teachers' reflection, as opposed to prediction, in terms of Greller & Drachsler (2012). This section outlines the main components of our approach, highlighting those aspects of the proposed solutions that have an impact on the ethical issues discussed in this paper.

Our learning analytics approach aims at providing monitoring information to be used for regulation, formative assessment, or self-reflection about the learning design and the learning process. We propose to provide teachers with feedback about the accomplishment of pedagogical decisions made at design-time. The educational settings where the approach can be applied cover face-to-face and distance activities carried out at different social levels (individual, group and whole class). In other words, blended Computer-Supported Collaborative Learning (CSCL). In addition, in terms of technological support, the proposal is devoted to Distributed Learning Environments (DLEs) made up by an institutional Virtual Learning Environment (VLE), Web 2.0 tools, and GLUE! – an architecture devoted to integrate third-party tools in VLEs. As described in the rest of this section, our proposals aimed to face specific challenges met in these contexts that also have ethical implications. These challenges included the need to support teachers in holding the *responsibility* of the data analysis and interpretation; how to help them in the *stewardship* of data in these complex technological systems; as well as how to enhance data *validity* in blended learning supported by DLEs.

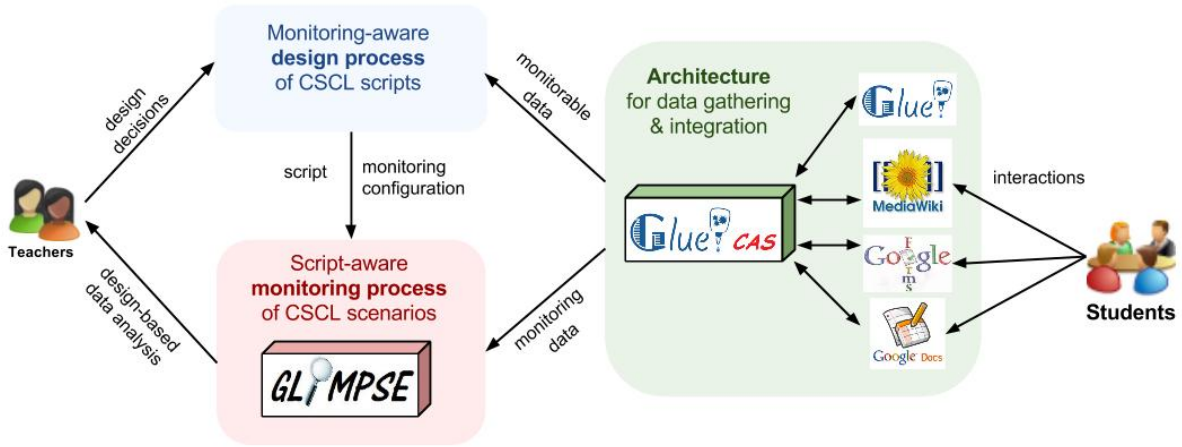

Figure 1. Overview of the main components involved in our learning analytics approach.

The solution consists of three components (See Figure 1): two processes and an architecture for data gathering and integration in DLEs to help teachers integrate learning analytics in their practice. The first component is a *monitoring-aware design process* of the learning scenario that takes into account the teacher's information needs (Rodríguez-Triana et al., 2013). This enriched design process helps teachers identify and make explicit which moments or aspects of their envisioned learning activities should be monitored. These aspects are based on the identification of a set of *constraints*: special conditions that must be met to comply with the pedagogical intentions expressed in the design, e.g., whether participation of all the students of a group is required in a phase of the activity, or whether a particular product must be delivered at a specific deadline, etc. The process entails a second phase where teachers are prompted to enrich the design to satisfy these monitoring needs (e.g., choosing the most appropriate tools for both pedagogical and monitoring concerns, or identifying complementary data sources). The second component of the solution is a *monitoring process* guided by the decisions made at design-time (Rodríguez-Triana et al., 2012). In this monitoring process, the data gathering is focused on those sources chosen by the teacher and the data analysis pursues to verify whether the current state (the gathered evidence) matches with the desired state (the learning design). These two processes (the design and the monitoring process) are two sides of an overall approach that aims at helping teachers take control of the data analysis and interpretation. By means of the design process they become active participants in the definition of the analysis. The contextualized visualization of the results enabled by the script-aware monitoring process aims at supporting teachers in their interpretation of the analyses.

The third component of our proposal is *GLUE!-CAS*, *an architecture* that addresses the need of data gathering and integration in DLEs made up by VLEs (typically Moodle or Mediawiki) and web 2.0 tools (e.g., Google applications) (Rodríguez-Triana et al., 2011). GLUE!-CAS defines how to collect and integrate data coming from these data sources, overcoming the problems of gathering data from external tools when using a VLE. However, in blended scenarios, these automatic data sources are not enough to get a full picture of the interactions taking place. Frequently, part of the learning process occurs out of the technological context. Besides, the Information and Communication Technologies (ICTs) register a limited set of evidence, usually based on user interactions with the

platforms, and sometimes it is not possible to authenticate the student identity properly (Slade & Prinsloo, 2013). Since restricting the analysis to the data registered by the ICT tools may offer just a partial view of the user activity (Avouris, Fiotakis, Kahrimanis, Margaritis, & Komis, 2007), GLUE!-CAS enables the integration of ad-hoc information provided by the participants of the learning context. This practice enriches the evidence gathered and allows teachers to triangulate the data coming from the different data sources. From the ethical point of view, this approach entitles teachers and students to rectify the data automatically collected from the ICT tools (Sclater, 2014) and to better understand the reasons behind the results obtained (Greller & Drachsler, 2012). Overall, this integration of heterogenous data sources aims at increasing the validity of the analysis. In terms of privacy, this involvement of the stakeholders has also benefits, letting them decide about what information they want to share (Slade & Prinsloo, 2013). Finally, the technical solution helps teachers to face the difficulties derived from data stewardship in DLEs.

To support teachers in the analysis, we implemented GLIMPSE (Rodríguez-Triana et al., 2013) a tool that, interacting with GLUE!-CAS, automatizes data gathering, integration and analysis, offering the teacher a comparison between the current and the desired state of the learning scenario. The outcome of this tool is a monitoring report where the information is visualized by means of tables that connect the participants, the data sources, the indicators and the warnings that emerged from the analysis (See Figure 2 below for an example).

4 FIRST SCENARIO: HIGHER EDUCATION

The proposal presented in the previous section was iteratively applied to 7 learning scenarios in higher education (Rodríguez-Triana et al., 2015). In this paper we focus on the last two of these scenarios, which were devoted to evaluate the proposal in its final version. This section offers an overview of the learning contexts and how the proposal was implemented throughout the learning scenario lifecycle. We will not describe the results related to the application of the learning analytics approach as such, which have been reported elsewhere (See Rodríguez-Triana et al., 2015). We will focus on illustrating those aspects of the cases that had an influence on the ethical issues described in Section 2.

4.1 Learning Context

The approach described in Section 3 was applied to two learning scenarios in higher education with a common profile: 3-4 weeks, implementing learning designs inspired by CSCL principles, and supported by DLES, interleaving face-to-face and distance activities as well as blended interactions among students. The studies involved two teachers coming from different backgrounds, different levels of expertise in CSCL scenarios, and different knowledge about the proposal. To reference these studies, we will use *HE1* and *HE2* as labels for the first and second scenario in higher education.

The first study (HE1) was carried out in a course of a Degree in Early Childhood Education, involving a non-expert teacher on CSCL scenarios with less than 6 years of teaching experience. 150 students participated out of 165 students enrolled in the course. The learning scenario lasted 4 weeks and consisted of various distance and face-to-face activities combining individual and collaborative work. The whole learning design was supported by Moodle and Google applications, summing up a total of

316 resources. The main challenge of this scenario was to cope with the high number of students and resources.

The second study (HE2) took place in a course of educational research belonging to a Master's Degree for Pre-service Secondary Education Teachers. The teacher in charge of this course is an expert on CSCL and she had previous knowledge on the approach. During 3 weeks, 15 students were involved in this study. They worked on the definition of a proposal of an educational research project, combining individual, group and class-wide activities, as well as face-to-face and distance learning. The whole learning process was technologically supported by means of MediaWiki and Google applications, requiring a total amount of 77 files. The main challenge of this scenario was the complexity of the design: many interrelated activities occurring in a short period of time that demanded much attention from the teacher to avoid problems that could jeopardize the scenario.

4.2 Application of the proposal

The application of the proposal started with the design of the learning scenarios, following the *monitoring-aware design process* (see Section 3). This process aims at giving the *responsibility* of the learning analytics process to the teacher and provides means to address the *validity* of the analysis. Besides paying attention to the pedagogical aspects of the learning activities, the design process supported the teachers' articulation of their monitoring concerns. Based on the information provided in the design, and following the proposed design process, the teachers were informed about the data available to verify the constraints of the envisioned learning scenario, of whether there was enough evidence to evaluate them, and which complementary data sources could be used to improve the analysis. This information gave the teachers the opportunity to reflect on the monitoring process and enhance it. In both scenarios, the teachers decided to triangulate the data coming from the ICT tools with data provided ad-hoc by the students and the teachers themselves. These aspects are illustrated in the reflections made by both teachers when they were interviewed after the design phase:

> "It has helped me to first reflect about which were the most conflictive points of the design. Once they were identified, and knowing which technological tools I'm going to use in each phase, I could know what kind of information they can provide and what the most adequate moment to get that information was. [...] In the original design it was not foreseen to control in a systematic manner the classroom attendance, nor to administer a questionnaire to find out the collaboration, task distribution and workload aspects, for each of the phases of the script. [...] The design process has made me appreciate the importance of including new information sources that enable the gathering of additional evidence. " [HE1, Teacher interview after the design phase]

> "In case that the tools that I had in mind did not provide monitoring information, I would have substituted them by other tools (provided they have similar functionality to support the students work, of course)." [HE2, Teacher interview after the design phase]

Thus, throughout the monitoring-aware design process, the teacher was responsible of the data gathering and analysis, defining which constraints needed to be evaluated during the enactment, selecting the data sources, the information to be retrieved, and when it should be collected.

A second ethical aspect addressed in the proposal regards *transparency and consent.* Once the

teachers defined the analysis to be carried out, the students were informed about the data that could potentially be gathered, the metrics, the purpose of the analysis and the impact. Afterwards, we asked them whether they allowed us to collect it or not: almost all the students participating in the learning scenarios agreed on it (150 out of 165 in HE1 and 15 in HE2). The tools supporting the design process allowed us to specify which students were taken into consideration, focusing the analysis on those students that gave their consent. Therefore, our proposal was able to address, at least from a technical point of view, the problems derived from letting learners opt out from the analysis.

A third issue relates to the *stewardship* of data. During the scenarios, the students' data regarding the actions registered in the different platforms (e.g., accesses, editions, uploads, etc.) was gathered from the technological environment. The data came from the VLEs (Moodle and MediaWiki), the Web 2.0 tools (e.g., Google Apps) and the architecture that supported the integration of the tools in the VLEs (GLUE!). On the one hand, both the VLEs and GLUE! were hosted on our own servers. Thus, we did not have to deal with permission issues in order to connect the data gathering tool (GLUE!-CAS) with these platforms, which normally constitutes an obstacle when working with institutional or third-party platforms. On the other hand, GLUE!-CAS allowed us to collect the data from the third-party Web 2.0 tools integrated in the DLE. Thus, even if the information is initially controlled by the owners of these tools, we made it available for the teachers to use it for their analyses. The integration of these data by GLUE!-CAS enabled teachers to control these data, and use it even if it is removed or no longer available in the original tools.

The integration of data in GLUE!-CAS is also important to increase the *validity* of the analysis. As aforementioned, this focus on validity is addressed by the design process, which promotes teachers' reflection on the accuracy of the data and enables them to include new data sources to enhance this validity. Following these design decisions, teachers and students contributed actively providing their own data. The teachers informed about the student attendance to the face-to-face sessions together with a few notes, and the students, by means of questionnaires, described how they had participated in the learning activities (how they had interacted, which tools were used, how much time they had devoted to the tasks, etc.).

Via GLUE!-CAS and GLIMPSE, the data generated by the multiple data sources were collected, integrated and analyzed according to the teacher's decisions. Based on the data gathered, the teachers received the corresponding monitoring reports taking into account the relevant data sources, the actions to be logged, the timeframes, and the indicators to be verified. **Error! Reference source not found.** shows one of these monitoring reports sent to the teacher (only 3 groups appear due to space reasons). The columns show from left to right: the groups and their members, the data sources employed in this case, and the warnings issued by GLIMPSE when a condition specified at design time is not met. The cells colored in green refer to students or activities that have complied with the specified constraints, while the red cells highlight the points where there is no evidence supporting the teacher's expectations about the students' involvement or the use of resources. For example, Figure 2 shows that no access by *StudentName6* to the *Final research proposal* had been registered. The teacher had specified at design time that this resource had to be used at least ones by each group member, as the lack of access could entail a lack of participation of that member in the authorship of the report. This problem was visualized in the report by means of the red cell

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corresponding to *StudentName6*, and the warning that appears on the right hand side of the table. As it can be observed, the reports summarized the evidence collected, highlighting potential problems that needed to be checked.

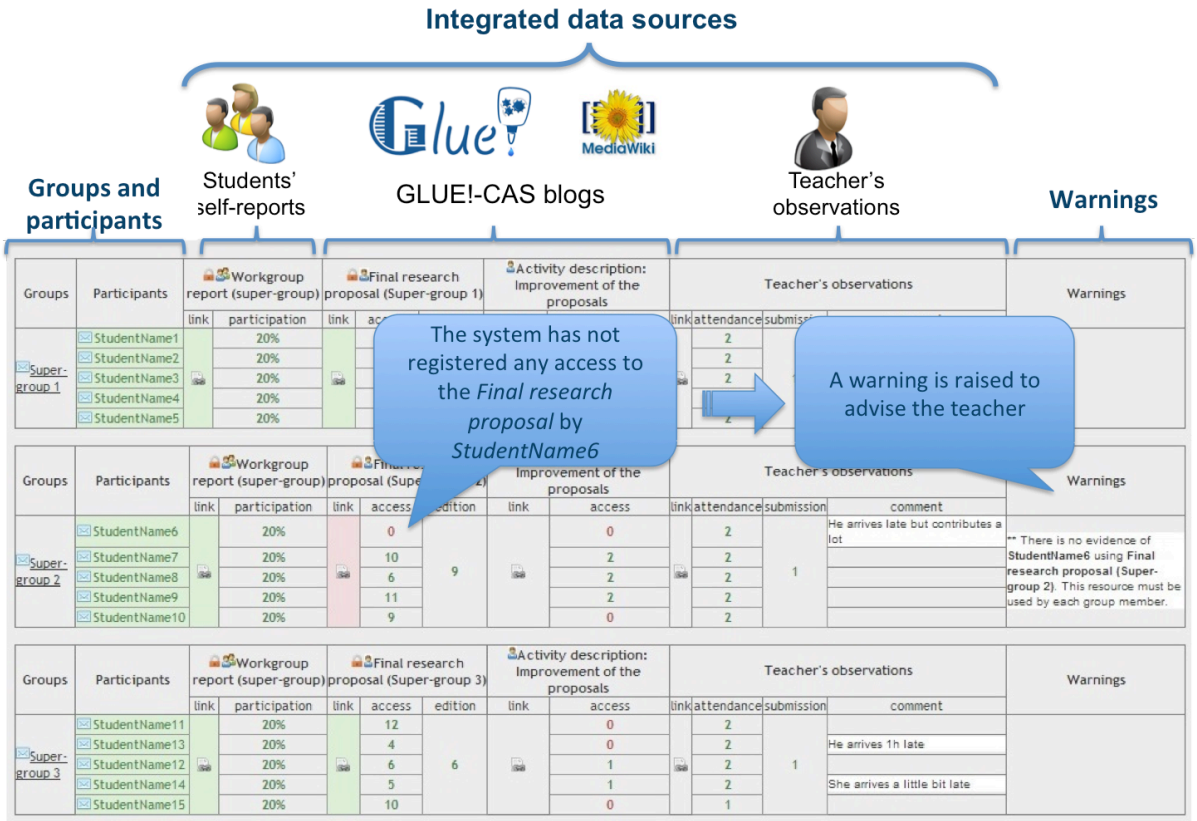

Figure 2. Excerpt of the monitoring report sent to the teacher the HE2 study (Anonymized version).

The integration of multiple data sources in the analyses had a crucial role in the success of the proposal. First, it significantly increased the *accuracy* of the results. The fact of complementing the evidence from the ICT tools with the teacher's observations and the students feedback, allowed us to take into account not only the computer-mediated interactions but also the face-to-face ones.

> "The students' report has been very useful, in order to take into account their perspective. [...] Being able to incorporate my notes with the comments received from students has simplified a lot my work. [...] Having all the data gathered in one place simplifies the monitoring. Having the information centralized helps avoid misunderstandings and keep the situation under control." [HE1, Teacher interview after the enactment]

> "The integrations is not only useful, it is necessary. It gives you a complementary view of an activity that happens in different settings/moments. It uses blended sources to inform blended activities." [HE2, Teacher interview after the enactment]

We evaluated the *validity* of the monitoring reports, by comparing the results obtained to the complementary teachers' observations, the additional students' comments, the researcher's

observations, and the learning outcomes in the tools. Despite the existence of errors, we could state that the monitoring reports provided a perspective of the learning process close to the real facts (in 99.67% and 97.81% of the evaluated conditions).

As already discussed, our approach gives the *responsibility* of the analysis (both the design and the interpretation) to the teachers. One aspect that has to be addressed with regard to responsibility is whether teachers are able to appropriate the analyses and act upon them. As it can be seen in Figure 2, the information provided to teachers was direct and contextualized in their designs. Both teachers agreed that interpreting the reports was quick and did not present any problem.

> "Interpreting the monitoring reports was very easy, with one look I knew whether there had been any problems. [...] I dedicated 10 minutes at most: 5 minutes to read everything, plus another 5 minutes to take the corresponding measures." [HE1, Teacher interview after the enactment]

> "Interpreting the reports was simple and immediate. The information provided is clear and does not lead to misinterpretations." [HE2, Teacher interview after the enactment]

During the learning scenario, the teachers used the information to identify potential problems as well as to *intervene* and regulate the scenario in case it was needed. Afterwards, once the activities ended, the teachers employed the monitoring reports for reflection on the learning process.

> "When I detected a problem, I contacted students. In fact, I have sent quite a few emails with wake up calls, reminders, and asking what had happened. This is something we normally not do because we do not have means to closely follow the students' work." [HE1, Teacher interview after the enactment]

> "The monitoring reports entailed regulatory tasks only in two cases. In general all students/groups followed the plan, except for the development of the report in small groups (which I commented verbally with them in the classroom) and in the last activity, in which three students forgot to send the peer-assessment report, and thus I had to send a reminder to them via email. It was critical because neither they nor I would have remembered (until the moment of the final assessment), since that moment coincided with the end of the course. The rest served to check that everything was going well." [HE2, Teacher interview after the enactment]

Regarding the student *access* to the data analyses, we should remember that our approach is devoted to support teachers. Thus, during the scenarios the students did not have access to the monitoring reports by default. However, the messages sent to the teacher in the reports made explicit that the results had to be checked. Therefore, any non-expected result should be discussed with the student, who could clarify the reasons behind it. The teachers' comments during the interview presented before illustrate how they proceeded when they identified an eventuality.

In summary, the two university cases illustrate how our classroom-based learning analytics approach provides teachers with tools to become *responsible* of the data analysis; how data *stewardship* was solved by the use of GLUE!-CAS and the fact that we could use our own servers at the university; how we faced the need to provide *transparent* information to the participant and how the technical solution enabled the teacher to exclude from the analysis those that did not sign the consent form.

We have also shown our emphasis in the *validity* of the analysis by means of the integration of several data sources, planned at design time and addressed technically by GLUE!-CAS; and how the results were shown by GIMPLSE in a contextualized manner which teachers could appropriate to intervene in the learning situations when needed. The students did not receive the data directly, but teachers were prompted to confirm with any information they can gather any result before acting, as the whole proposal makes teachers aware of the weaknesses inherent to data analysis in blended scenarios.

5 SECOND SCENARIO: PRIMARY SCHOOL

As we described in Section 3, our proposal was designed to help teachers in blended CSCL scenarios supported by DLEs. Although all our previous studies had been carried out in higher education, we realized that in other educational levels, teachers faced similar problems. Thus, we set out to apply our proposal in a primary education setting, with the aim of checking its capability to adapt to this new context, and to unveil the potential limitations and constraints imposed by such a learning context. This section provides a brief description of the learning context including an analysis of the different ethical issues that we had to face during the study.

5.1 Learning Context

The case study was run at a first grade class (6-7 years old) with 24 students at a school sited in a rural area in Valladolid, Spain. This school has 300 students and 29 teachers. The teacher involved in this study used Blogger in his classes in combination with external Web 2.0 tools (such as Youtube videos or Educaplay games). In spite of a general positive experience with this approach, one of the main worries of the teacher was that these blogs did not inform him about who had read or accessed the pages. This precluded him from knowing whether the students were using the learning materials offered to them in the blog.

In order to face this problem, we used GLUE! to build the DLE. Blogger was considered as the VLE where the third-party tools (e.g., the videos and games) were embedded. With this technological setting, it was possible to trace the students during their learning process and then inform the teacher about their accesses to the tool.

The intervention ran between May 14th and June 2nd, 2014. The teacher proposed two lesson plans, involving a blog and several external resources, in which the teacher asked the students to carry out some activities at home such as watching a video, reading an online text, or playing educational games.

5.2 Application of the proposal

Similarly to the previous study, during this design process, the teacher described the learning activities, chose the resources to be used and configured how to monitor the learning scenario: he decided which constraints should be checked, specified the student's actions to be monitored, the timeframes and the delivery dates of the monitoring reports.

Once the teacher configured the analyses, we proceeded to inform the different participants

involved, namely: the school principal and the legal representatives of the students, since they were not adults. A detailed explanation about the data, metrics, purpose, and impact of the analyses was given to them. Both the school principal and the families supported this kind of innovative practices and gave their consent on the data collection.

As regards the collection of identified data, we met an unexpected legal obstacle. Blogger can be configured so that only registered users access the blogs, but this requires having a Gmail account. However, the students, 6-7 year old children, were not legally allowed to own an email account on that server. In order to overcome this obstacle, we had to look for a workaround, asking the families to open an email account on behalf of their children, and access the site using that account. Even in this case, we did not find any major obstacles to get the consents and the support by the families to create and use the dummy e-mail accounts. However, we have to note that obtaining consent when working with minors is a very delicate issue and has to be carefully addressed.

Another issue we encountered was related to the kind of data that could be collected and analyzed. In upper educational levels the input and interactions with the technologies may be very rich. On the contrary, at the age of 6-7 year old, students frequently do not have the skills to carry out very complex tasks (e.g., the students barely wrote till the end of the course). Thus, the kind of data available is prone to be very simple, and many online educational tools do not even offer data about the learner work. In fact, the data gathered from the technological environment were mainly the actions logged by GLUE!, concretely the **student accesses** to the Web 2.0 tools. This information was easily accessible first because GLUE! was **hosted on our servers** and we could access the systems without requiring additional bureaucracy.

During the enactment of the learning scenario, the teacher received the monitoring reports according to the plan configured at design-time. Figure 3 shows a piece of information from those monitoring reports. These reports simply presented the evidence collected (accesses to the tools) highlighting potential problems that needed to be checked, e.g., students who had not accessed the tools, and therefore, could not have used the resources. The monitoring report presented in the figure refers to the number of times in which the students accessed the activities in one of the monitored lesson plans. It can be seen that only 3 students of 24 completed all the activities, while 9 out of 24 did not access any. The same kind of visualization was shown to the teacher for the second lesson plan. The results related to the participation of the students were similar. Only 5 students out of 24 completed all the activities, while 11 out of 24 did not access any. When the researchers shared these results with the teacher, he felt confused, as we can see in the following extract:

> "Honestly I did not think this could happen. I mean, I thought that the most part of my students could complete the activities. I think that it is important to communicate these results to the families." [PE, Teacher interview after the enactment]

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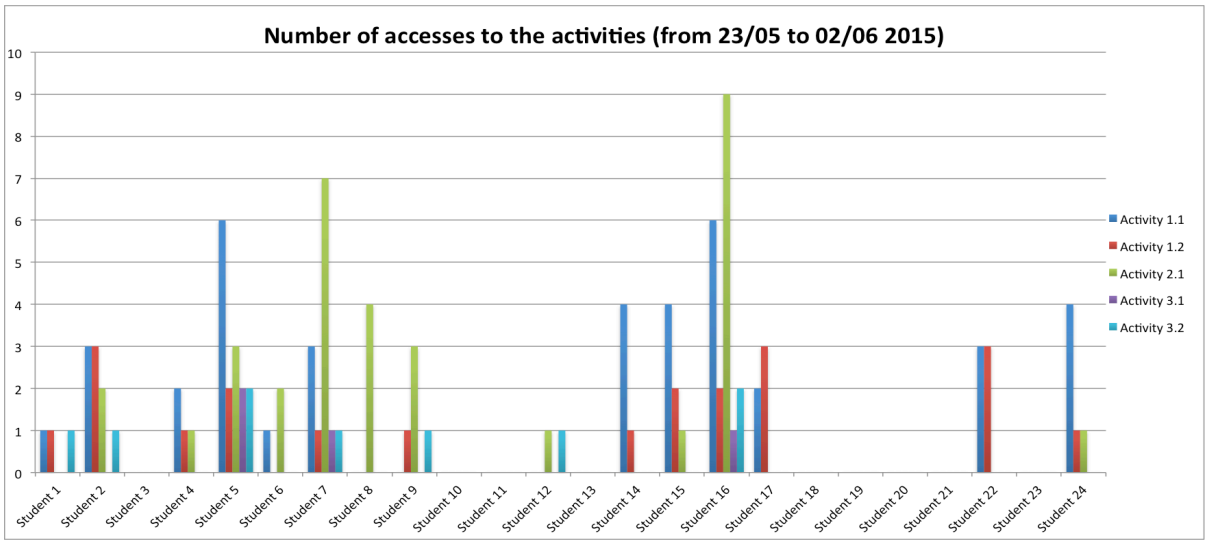

Figure 3. Output shown to the teacher about the number of students who accessed the activities in Lesson Plan 1.

Then, during the face-to-face sessions, the teacher asked the students whether they had made their homework in order to compare their answers with the monitoring reports. The information was generally accurate and helped the teacher to intervene accordingly. However, one of the issues that we faced was related to the students' virtual identities. As noted by the teacher in the second interview, not all the families knew how to solve some technical difficulties, and some of the families accessed the site using the parents' own accounts.

> "When I had the meeting with the families, many of them said to me that they have had a lot of problems to access the activities embedded in the blog. They said that they had read and followed all the indications given by me, but finally it was impossible. Moreover I have noticed when I have reviewed the monitoring report, that there were families that had accessed to the activities with a different e-mail account." [PE, Teacher interview after the enactment]

As can be seen, the technical difficulties met by the families, together with the workaround we had to use to be able to identify the children by a surrogate account, resulted in a case of "enmeshed identities" (Greller & Drachsler, 2012). Aware of this problem, in the final interview, the teacher expressed that if he were to apply a similar activity in the future he would devote more time with the families to provide training to access the on-line activities with the e-mail login, as well as supervise their accesses.

In spite of this simplicity and all the restrictions related to the quality of the data, the teacher was very positive about the obtained feedback:

> "It is important to provide students with other ways to learn, as well as to assess learning. I can say that these teaching and learning practices are innovative for students and we have the opportunity to motivate them and engage the families in the educational process." [PE, Teacher's reflective diary]

In addition, the teacher identified several potential uses of the analysis. Among other uses, he highlighted: knowing in advance whether the students have done their homework, being able to send reminders, identifying more/less attractive resources, detecting which days of the week the students are more active, analyze the students' evolution in relation to their homework, etc.

Regarding the student access and privacy, we should recall that the teacher is the target user of the approach presented in this paper. Nevertheless, the results, especially in case of unexpected behaviors, should be checked with the students/parents, who can clarify why some result has appeared. Especially in this case, the meaning of the reports might not be easily understandable by children due to their age. But the teacher could share it with the parents or the institution itself as an "evidence" of the learning process to be discussed. Therefore, teachers are in charge of sharing the data analysis with those who legitimately need to view them, and this sharing has to take into account the privacy and legal issues applicable in each case.

6 DISCUSSION

The studies presented in Sections 4 and 5 illuminate our discussion about how the current frameworks about ethical issues in learning analytics apply to the analytical interventions we are envisioning, as well as how they depend on the educational contexts where we applied them. We identify three levels of discussion: i) implications related to the *learning analytics approach* to which this work belongs, i.e., small-scale analytics to help teachers manage their classes; ii) implications derived from the actual *solutions* we propose to support this learning analytics approach, and iii) issues related to the *educational contexts* where the solutions are applied. After the discussion at these three levels, we propose a set of guidelines that could be taken into account by teachers aiming to conduct learning analytics scenarios of the kind discussed in this paper.

6.1. Implications related to the teacher-centered classroom-based approach to LA

As aforementioned, our approach to learning analytics is oriented to support teachers' reflection to help them in the management of their classrooms. This is one of the possible approaches to learning analytics identified by Griffiths (2012). The other two approaches are i) institutional approaches that seek the efficiency in the wider functioning of the institution; and ii) approaches that look for enhanced regulation of the teaching and learning environment.

As mentioned in Section 2, the framework used to structure our discussion responds to an institutional-led approach. This focus can be observed on the kind of questions posed to analyze the concepts, and in the responsible stakeholders identified. The questions included in the framework are oriented to ask what the role of the institution and/or the students in the overall process of Learning analytics is. Teachers appear only as secondary actors or –marginally– as potential providers of data. On the contrary, in our approach the teacher plays the role of the institution –in control of the data and the analysis– and of the receiver of the information –role played by the students in the reference framework.

Due to these differences, we had to adapt the questions posed in the framework to better fit our approach. This translation was rather straightforward and was not an obstacle for the purpose of this paper. However, the need of adaptation could be an obstacle for a practitioner that aimed at employing the framework to analyze an learning analytics intervention of the kind discussed in this

paper. This justifies the need of refining the ethical framework to adapt to the characteristics of the learning analytics approaches.

A first element of refinement would be the inclusion of teachers as responsible stakeholders, and of questions related to their role as data providers and receivers. A second aspect on which the framework could be extended regards the emphasis given to different aspects. For example, while privacy issues are paramount in an institutional approach, they have different implications in a closed system, where the teacher uses already available data to be shared with the students. In fact, in these cases, new ethical issues may arise, more related to classroom orchestration, which should also be identified and included in the revised framework.

6.2. Implications of the design-aware Learning analytics approach

Our approach to learning analytics is strongly based on the participation of the teacher from the beginning of the life-cycle of the learning activity, and takes into account the need to integrate data from different sources –including data provided by teachers and students— that offer a complementary view to the evidence registered by the technological infrastructure. This design-aware learning analytics approach helped to face a number of ethical issues common in these contexts.

First of all, the approach has a strong impact on the *validity* of the data in these blended learning scenarios based on the use of DLEs. The integration of different kinds of data by means of the GLUE!-CAS architecture, has proved to enrich the analysis. The fact that the design process helps teachers reflect on the missing data and enables them to introduce data provided by the participants when needed is also important to increase this validity. The results of the two cases show that the output given to the teachers, based on this combination of data, was accurate in most of the cases.

The second issue addressed by our proposal refers to the *responsibility* of the analysis. The approach helps teachers take decisions about the data and the analytics that will be applied to the setting. This schema makes teachers fully aware of the purpose of the analysis, and avoids possible negative known effects of systems that demand new competencies that teachers are not expected to have to be able to interpret the results.

The possibility of *adverse impact* is minimized because, in our case, the analysis does not entail any negative effect on the students. Indeed, the way the approach is presented to the teachers makes them realize that the information available is not complete, and they are responsible for asking or looking for other data sources to complement it. Thus, no decision is made automatically based on the results. The analysis only aims to detect potential problems in order to address them as soon as possible. To be more precise, it is the teacher who, aware of the information, should verify the situation and intervene if it is necessary.

6.3. Issues that depend on the educational contexts where the approaches are applied

Our experience applying learning analytics to two different educational levels (see sections 4 and 5) showed us that ethical issues also depend on the kind of learning analytics processes that can be normally expected in these contexts. As pointed out by the cases discussed in this work, we found new legal and ethical concerns in the primary school context that we had not met in the higher

education scenarios.

A first issue affected by this change of context refers to the *stewardship of data*. At the higher education settings, it is usual that the institution owns the servers where the learning environments reside and the activities take place. Teachers can access these platforms, and count on technical staff to configure the analysis. On the contrary, schools often do not have easy access to this kind of learning platforms, or, if they do, they do not have access to the technical staff that supports the analysis (Blakcwell, Lauricella, Wartella, Robb, & Schomburg, 2013; Lim, Zhao, Tondeur, Chai, & Tsai, 2013). Due to these problems, teachers and schools are increasingly relying on cloud and Web 2.0 tools. The dependency on these external Web 2.0 tools poses new legal problems and ethical issues, as it has been illustrated in the school case. Students (minors) cannot legally have their own accounts in these tools, leading to a conflict with the need of learning analytics processes of identifying their users. One solution, as described in the case, is to rely on the families of the children to get a surrogate identity, but this adds more complexity to the analysis and new threats to validity of data. In the case discussed in this paper, some families were not able to help their children to perform the tasks, while others used the parents' identities to access the activities.

In both cases, this had an effect on the *validity of the data* collected and displayed to the teacher. As discussed in the previous section, the teacher knew in advance the limitations of the implemented approach, and did not take any direct action based exclusively on the monitoring reports provided to him. In spite of this, he found the information provided useful, as it gave him a general overview about how the students worked at home with the virtual environment he had set up.

When working with lower level courses (like the first graders studied in this paper), children are not autonomous in the use of the computer, and families are to be considered an actor to take into account at many levels (permission, training, collection of data, etc.). The inclusion of families requires a reflection on how it affects the rest of the ethical issues discussed in the field. For example, the possibility to show the results to the students –and therefore to their families– has to be analyzed against issues such as privacy, transparency, and action, as they are prone to be an issue when the families are aware that the tasks done at home are being analyzed and used by the teachers.

A final issue relevant for the application of learning analytics to school contexts is the simplicity of the interactions between the children –especially first graders– and the system. This poses some questions about the kind of inferences that can be drawn from this very basic information. In principle, considering the limitations imposed by the data available, a simple learning analytics approach showing basic data to the teacher seems more coherent than more sophisticated types of analyses. However, we are not strong in this statement, as future developments in the field could challenge this intuition.

Overall, our analysis suggests that the work being done by the learning analytics community to define a general framework or code of practice for Learning analytics has to take into account the approach and the educational contexts where learning analytics is applied. Further work in analyzing the particular characteristics common to the different approaches and educational contexts would help to identify these new aspects and to refine the proposed frameworks.

6.4. Proposals for a new framework taking other types of learning analytics

As a final result of our reflection, we propose a set of recommendations that could be taken into account to extend or complement the existing frameworks of ethical issues in learning analytics. As discussed in this section, the existing frameworks are oriented to institutions, and therefore, they apply to large and medium-scale institutional-led learning analytic approaches. If we consider that learning analytics can be applied to small-scale scenarios, there is a need to adapt the existing frameworks to these approaches currently coexisting in the learning analytics field. A possible way to address this goal is to define different itineraries depending on the approach to learning analytics, so that practitioners can focus their view on the most important questions of their approach. A similar approach is taken in Kay et al., (2012), that defines the different legal and ethical priorities in six use cases of learning analytics in higher education.

One of these itineraries could be defined for the learning analytics approach discussed in this paper, i.e., classroom-based learning analytics oriented to support teachers' regulation of their classes. In order to provide an initial proposal, we have gone through the questions posed by Sclater's framework (Sclater, 2015), and we have adapted them to a set of guidelines that could be taken into account by teachers willing to apply learning analytics from this perspective. The list of guidelines is presented in Table 1, ordered by the same categories used in the code of practice (Sclater & Bailey, 2015).

Contrary to the framework proposed by Sclater (2015), these recommendations assume that, from this perspective to learning analytics, teachers will take responsibility of most of the aspects mentioned in Table 1. Therefore, teachers must appear as a main stakeholder in the itineraries addressing these learning analytics approaches.

Table 1 List of recommendations for small-scale teacher-led learning analytics derived from the studies presented in this paper.

Category	Recommendation
Consent	• If there is information already being tracked, inform the students (or families) about it, otherwise, ask for formal consent/agreement before data can be collected and/or analyzed • Be explicit about what you might do with that information and, if possible, agree it with the students • Provide students the option to update their digital dossiers and provide extra (possibly qualitative) data but triangulate it to verify they do not "fake" the system • Data should be deleted when individuals no longer want them to be processed or when it is no longer of use for its original purpose, as any other student's data. • Reflect on the consequences that opting out of the analysis would have on the participants (e.g. lack of feedback due to the lack of analytics) and inform them. • Reflect on the consequences that opting out of the analysis would have on the analytics and inform the participants.
Transparency	• Be explicit regarding which data is collected, how it is interpreted, why and how it will affect the learning process.

Access	• Reflect on whether the students should access the data held abut them, the analysis of the data, the labels attached to them, and if so, in which format this information should be provided to them. • Consider the possibility to let students correct the data stored about them.
Responsibility	• You are in charge of interpreting and validating the analyses as well as deciding what to do based on the analytics (e.g., how to regulate, intervene, etc.)
Privacy	• If some data has to be anonymous, be sure it cannot be re-identified by contextual information available to the users. • If you use data coming from external sources, (e.g. Web 2.0 tools) be sure you can manage it to identify properly the owner, and that not other ethical or privacy issues are put at risk when using those sources.
Validity	• The evidence obtained may be incomplete. Try to involve students (and families) to increase its accuracy.
Stewardship	• Use the data strictly needed for the analysis, not more. • Be sure that you comply with the data protection laws applicable in your region or country. • The data should be preserved, secured and shared as any other student's data
Avoiding negative impact	• Consider that your analysis may led to un-expected findings that led you to intervene as a teacher with the student, and which kind of obligation do you think will have on that.

The recommendations presented in Table 1 should be considered as a first attempt to structure reflection on ethical issues and logistical concerns in small-scale teacher-led learning analytics. They should be subject to refinement by their application to other cases, and by public discussion with experts in the field. These discussions could take place for example in the frame of recent initiatives promoted by some governments (Hylen, 2015) which highlight the creation of policies and sharing practices of learning analytics in schools.

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7 CONCLUSIONS

The interest in addressing ethical issues in learning analytics is starting to flourish in the form of ethical frameworks that guide codes of conduct for practitioners. These frameworks are useful instruments to structure the discussion and promote a more mature application of LA. However, these frameworks are fundamentally devoted to institutionally oriented higher education Learning analytics. There is a need to extend and adapt these frameworks to the characteristics of different learning analytics approaches and educational contexts. Through two studies in primary and higher education contexts, this work has analyzed the ethical and privacy issues according to three different dimensions that may affect them: the overall learning analytics approach, the particular solution to learning analytics adopted, and the educational contexts where the analytics are applied.

The reflection presented in this work shows that the concerns in smaller-scale teacher-led learning analytics require at least considering, in an explicit way, the role of teachers as main actors in the application of the learning analytics processes. Aspects such as *action* and *impact* have a particular

dimension, and are closer to general ethical issues related to classroom orchestration, where teachers play a crucial role. In this kind of educational contexts, it is necessary to analyze from the ethical point of view what kind of actions should trigger the learning analytics information, how to proceed and what the impact is in terms of classroom management, intervention, regulation and assessment.

We have shown how our approach to learning analytics, involving teachers from the very beginning in the design and enactment of the monitoring process helps to overcome issues that can appear also in these smaller contexts, such as control on the analytics, awareness, etc. The teacher participation in the design of the monitoring process contributes to introduce "ethics by design" (parallel to the idea of "privacy by design" (Schaar, 2010)) in the application of learning analytics solutions. According to this schema, the teacher is the one who defines the educational purposes of the analysis, reflects on the available data sources, contributes to improve the validity of the results (adding new evidence coming directly from teachers and students), and is aware of the limitations of the results obtained.

Finally, the application of the approach to two educational contexts shows that the reflection on learning analytics has to take into account the specific ways of working on the different contexts, and even legal aspects that apply to the particular case of schools, where work with minors poses specific challenges, and make us include families as new actors in the framework. The cloud-based tools that are becoming widespread at these educational levels, do not cover information needs required by LA, and may pose legal and ethical problems related to data ownership and virtual identity, difficult to solve when working with minors. Not only LA, but also the wider technology-enhanced learning community have a big challenge in providing appropriate tools to these educational levels.

This work can be considered as a first step towards further work in the refinement and adaptation of ethical frameworks to the different approaches currently coexisting in the learning analytics field, for example defining different itineraries depending on the approach to LA, so that practitioners can focus their view on the most important questions for their approach.

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