LEARNING ANALYTICS: LEARNING TO THINK AND MAKE DECISIONS

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ABSTRACT

The research aims at a specific analysis of how learning analytics as a metacognitive tool can be used as a method by teachers as reflective professionals and how it can help teachers learn to think and come down to decisions about learning design and curriculum, learning and teaching process, and its success. Not only does it build on previous research results by interpreting the description of learning analytics as a metacognitive tool for teachers as reflective professionals, but also lays out new prospects for investigation into the process of learning analytics application in open and online learning and teaching. The research leads to the use of learning analytics data for the implementation of teacher inquiry cycle and reflections on open and online teaching, eventually aiming at an improvement of curriculum and learning design. The results of the research demonstrate how learning analytics method can support teachers as reflective professionals, to help understand different learning habits of their students, recognize learners' behavior, assess their thinking capacities, willingness to engage in the course and, based on the information, make real time adjustments to their course curriculum.

Key words: learning analytics, metacognition, reflective professionals

INTRODUCTION

Learning analytics can be defined as the measurement and collection of extensive data about learners with the aim of understanding and optimizing the learning process and the environments in which it happens. Recently researchers have started a fundamentally new direction of learning analytics by addressing big data (Picciano, 2012); educational data mining (Siemens & Baker, 2012); academic analytics, social learning, and action analytics (Ferguson, 2012); as well as issues of student dropouts and ways to increase student success (Arnold & Pistilli, 2012), with the purpose of developing a method of how learning analytics may enhance teaching and learning (Gasevic, Dawson, & Siemens, 2015). This shift revealed a completely new area of research in education with the prospect of reconsidering how learning analytics may contribute to better teaching and learning and address, in particular, issues in higher education (Zilvinskis & Borden, 2017) and massive open and online learning.

There is sufficient data available on virtual learning environments provided by learning analytics on student and teacher behavior and performance, but there is no common practice among teachers in open and online learning in higher education of using this data to improve the learning and teaching process. Stewart's (2017) research proves that there are inhibitors, such as a lack of training, a fear of exposure, too much or too little data, a lack of ability, cultural vs procedural behavior of teachers, and a lack of resources and practices among teachers, that hinder them

from applying learning analytics in practice. How learning analytics and data may inform and improve open and online learning from the point of view of teacher and learner awareness about their behavior and their learning and teaching methods has been addressed by several researchers, thus putting forward the idea of describing learning analytics as a metacognitive tool (Durall & Gros, 2014), suggesting a development of metacognitive decision-making skills in teacher education (Griffith, Bauml, & Quebec-Fuentes, 2016), and focusing on learning design in higher education by using data from learning analytics (Nguyen, Rienties, & Toetenel, 2017).

Metacognitive activities in open and online higher education learning created by using learning analytics data enhance a better organized reflection by the teacher on the process and the outcomes of the choices of learners and lead to better decisions made by the teachers during curriculum and learning design. Learning analytics focuses on the measurement and collection of data about learners in order to understand and optimize their learning and the environments in which it happens. Regardless of the advantages, teachers do not yet use learning analytics as a common practice to examine the link between learners' expectations and curriculum and learning design.

This research is focused on how learning analytics as a metacognitive tool can be applied to developing a learning analytics method for reflective teacher practice. It builds on the description of learning analytics as a metacognitive tool for teachers as reflective professionals, but it also opens new prospects for investigating the process of applying learning analytics as a metacognitive method in open and online learning and teaching, for using learning analytics data for the implementation of teacher inquiry cycle and reflection on open and online teaching, and for improving curriculum and learning design.

It must be noted that there is insufficient empirical evidence available in the research literature on the use of learning analytics data among teachers. Thus, the authors initiated a pilot research project by addressing a number of teachers all over the world and asking them to provide evidence on how they apply learning analytics data in teaching and learning. The pilot project, contacting a number of academic departments at open and traditional universities, resulted in a low response rate, which, in its turn, revealed that the teachers were aware of the possibilities of accessing learning analytics data, but it was still quite challenging for them to use it. Therefore, this empirical research focuses on an international expert interview.

LITERATURE REVIEW

We looked at research covering the process of applying learning analytics as a metacognitive tool in open and online learning and teaching by focusing on learning analytics data for teachers' inquiry cycle implementation, reflecting on open and online teaching, and discussing learning analytics data analysis for curriculum improvement and learning design.

Process of applying of learning analytics as a metacognitive tool in open and online learning and teaching

The ability to monitor thinking and use appropriate skills and strategies to achieve desirable outcomes is defined as metacognition. It is considered a critical component of successful learning, which involves self-regulation and self-reflection on the learning process and guides the thinking process (Medina, Castleberry, & Persky, 2017). Brown (1987) presents it in two coherent components: metacognitive knowledge and metacognitive processes. Metacognitive knowledge refers to the perception of one's cognition strengths, weaknesses, learning habits, task characteristics, and task solving strategies (when, where, and how to apply them). Metacognitive processes allow monitoring and regulating cognition, and all the latter processes are divided into three subcategories: planning, monitoring, and evaluation (Brown, 1987). The above-mentioned processes can be used for setting goals, selecting needed cognitive strategies, planning decision-making or learning steps, monitoring cognitive activities, evaluating outcomes, and reflecting on the processes (Brown, 1987).

Griffith et al. (2016) state that teachers make instant decisions when evaluating pedagogical knowledge and pedagogical content knowledge. As a result, they are able to refine their teaching expertise. Teachers need opportunities to think systematically about the complexity of the classroom and its participants (Griffith et al., 2016), i.e., teaching and learning behavior as well

as curriculum and learning design. Teachers as reflective practitioners and professionals do reflect upon teaching and learning process. However, research shows that teachers (McKown & Weinstein, 2008) and students (Borghi, Maindardes, & Silva, 2016; Koc, 2017) have different expectations of the learning and teaching processes. Teachers are inclined to be more interactive with students because interaction should improve student learning. From the learners' perspective, the research reveals that autonomous and self-directed learners and learners with high academic performance have an internal locus of control, i.e., they are inclined to internally control the situation surrounding them (Shehu & Bushi, 2015). Open and online learners have the characteristics of autonomous and self-directed learners (Bonk, Lee, Kou, Xu, & Sheu, 2015), thus they need more flexibility and asynchronous learning, which allows them to use learning resources to their preference in terms of pace, time, and choice. At this point curriculum and learning design strategies seem to be peripheral, though they should be discussed as critical factors influencing student behavior. Learning analytics can then be used as teachers' metacognitive tool to reflect on two different decisions accepted in terms of curriculum and learning design:

a) The learning scenario realized through curriculum design shows the path that learners need to go along in their learning journey. Predefined curriculum suggests a clear step-by-step scenario through the course (Hong & Sullivan, 2009), so it is easy to predict this path, and the data retrieved from online learning environments are predictable. In such a case, learning analytics data may be useful for identifying problem areas—namely, what students failed to do. The teacher's reflection on the problem may focus on the question "why" students failed their tasks and what can be done to change the situation.
b) However, there is a different approach to curriculum design that allows students to make their own choices when they are able to construct their own learning paths. Such curriculum and learning design has been researched from the point of view of self-directed learning environments and personalized and self-regulated learning (McLoughlin & Lee, 2010). The fundamental question, in this case, is how teachers can help students think critically and metacognitively about their own choices, while understanding why these different choices occur. Learning analytics may be one of the best metacognitive tools to visualize these paths, to help teachers better prepare students for metacognitive activities in learning, and to clarify the reasons for different student choices.

In both cases, learning analytics as a metacognitive tool can be applied and empowered by data mining from online environments to benefit both teachers and students, with the aim of improving the teaching and learning experience.

If we analyze scenario a) as a prescriptive curriculum solution, the learning analytics data collected from open and online learning environment can be predicted quite easily, and it may provide little space for the analytic behavior approach. All students would follow the same preplanned learning path developed by the teacher—i.e., one size fits all. Griffith et al. (2016) argue that it is important for teacher educators to understand teachers' beliefs, goals, and knowledge related to planning, assessing, and revising. This helps equip prospective teachers with the knowledge and skills to make effective teaching decisions by drawing attention to the thinking processes—the metacognitive processes—related to teaching.

However, if we interpret the data collected from the open and online learning environment and analyzed it by learning analytics from scenario b), there may be very broad interpretations possible, giving rich and fundamental behavior clustering models as the basis for metacognitive decision making (Griffith et al., 2016). Generating such data and analyzing correlations among data serve as direct agents for the teachers' continuous process of reflecting upon teaching and learning scenarios, student choices, as well as investigating, reflecting, inquiring, and discussing the efficiency of curriculum, learning resources, and the teaching and learning process.

This short overview of the theoretical research adds to the existing knowledge and shows that we have tools to enhance our ability to identify our learners' behavior, track their learning scenarios, and visualize the process of teaching and learning. There are multiple possibilities to enhance learning

and teaching for faster, slower, individual, or group learning, but we, as professionals, need to rediscuss the application of these tools in terms of process and its participants and its application in teaching and learning. This is the focus of this paper: to discuss the application of learning analytics as a metacognitive tool for researching theory and practice in order to define the principles of applying learning analytics to enhance our teaching decisions for learning improvement.

Learning analytics data for the implementation and reflection of teachers' inquiry cycle on open and online teaching

The question regarding the application of learning analytics as a metacognitive tool in metacognitive processes may be leading to informed decisions. This question has been addressed by Check and Schutt (2012) through the description of the teacher inquiry process. Sergis, Sampson, and Pelliccione (2017) adapted this process by describing how it can be implemented with learning analytics to accompany the teacher through a continuous process of investigation, intervention, questioning, and reflecting upon teaching practice with the aim of improving it.

Theoretical research findings reveal that learning analytics as a metacognitive tool can be used in the teacher inquiry cycle for an informed metacognitive decision-making process. To build on this, we may also use as a reference the perspective of a teacher as a reflective practitioner (Schön, 1983) and use experience-based research to analyze how teachers practice reflection in communities (Cochran-Smith & Lytle, 1999) for their own learning, how they act as reflective practitioners seeking harmonized achievement of competence-based learning results (Cheetham & Chivers, 1998), and how reflective practice should be embedded in teacher training and different professional competence frameworks.

Open and online learning can promote new hybrid models of teaching practices with new types of learning experiences (Freitas & Paredes, 2018). The use of learning analytics as a metacognitive tool may help teachers to examine students' success and curriculum constraints in order to design new teaching and learning practices. Moreover, all observation and inquiry methods—including participatory observation, dialogue and case records, diaries and memos—and all curriculum design and teaching and learning interaction data (video records, personal action logs, checklists, analytic memos, etc.), as well as learner behavior data (chronicles, recordings, personal action logs, protocols, and more) are highly important data revealing curriculum design action research (McKernan, 2006).

However, the questions of how we decide, how much information from learning analytics should determine our decision and how to recognize the real reasons for change in learning behavior that lead to success remain open for deeper investigation. Curriculum and learning design solutions are important factors that go hand-in-hand with teacher intervention process and are important elements in learning to think about evidence-based learning.

Learning analytics data analysis for curriculum improvement and learning design

In the era of flexible learning driven by student needs, learning efficiency is reflected by the self-efficacy of teachers, elevating their performance, interactive pedagogy, and self-confidence (Solangi, Shahrani, & Pandhiani, 2018). Learning analytics constitutes an ecosystem of methods and procedures to collect and report readable data about the learning process that seeks to forecast learning results in the future and thus improve it (Papamitsiou & Economides, 2014). It creates possibilities to access logs and data regarding learners' behavior and their engagement with learning processes. Therefore, it could provide significant insights for teachers by giving directions to improve course development and customize curriculum according to learners' needs. Through the application of learning analytics, teachers can reasonably adjust and adapt their teaching methods by taking into account the students' needs and abilities to improve learning experiences in online learning through the awareness of students' cognitive learning and a stronger sense of community (Trespalacios & Perkins, 2016). Therefore, it can improve the way one teaches and learns by using structured analysis techniques to provide the necessary input for making decisions. From the institutional perspective, it can help higher education institutions understand the previous and ongoing processes of learning and, based on that, predict future scenarios and provide evidence-based recommendations by simulating and comparing data.

These observations are very important for the application of learning analytics data for the improvement of curriculum and learning design. Nevertheless, to specifically analyze how a learning analytics tool can be used as metacognitive for reflective professionals it is important to be able to read the data and make predictions and hypotheses to understand what they can tell us about learners' behavior. Learning analytics is identified as one of the measurement tools in the context of learning, which reflects the behavior of learners. Based on the analysis of the behavior, a lecturer or the entire academic community can provide timely assistance, while a learner has an opportunity to take his/her behavior into consideration (Gasevicet al., 2015). With the assistance of learning analytics, the institutions can immediately identify, reduce, or even avoid the risks of student dropout. Teachers may regulate their own performance and curriculum and learning design solutions to reach better learning process efficiency, as the data provided by learning analytics may inform teachers which activities designed in curriculum work well and which need to be improved. Timely response to learners' problems can lead to fundamental interventions, which could encourage and help students to absorb learning materials better, involve them in the learning process, improve learning achievements, and successfully complete their studies in a timely manner.

Furthermore, when learning analytics indicate that teachers should no longer deliver a predetermined knowledge or predefined curriculum, teachers have to analyze, collate, and respond to complex data about real learners and make decisions about how to organize learning and teaching (Buckingham et al., 2016). Information and awareness of what is not working can provide significant metacognitive research background information for reflective professionals.

However, theoretical research in open and online learning also proves that teachers experience time and resource constraints when improving the curriculum and learning design (Christensen & Spackman, 2017). Therefore, researchers suggest limiting investigation to a narrow scope of the course by identifying the "course walls" (Christensen & Spackman, 2017). With the help of learning analytics, teachers could be informed about the most problematic elements of the curriculum that might cause problems in learning and teaching.

To summarize, the potential of learning analytics to provide evidence of students' learning performance and behavior in educational settings should enable teachers to be aware of existing problems or challenges in learning and teaching, to analyze the situation, and to question and reflect upon their teaching practice with the aim of improving learning, either by making interventions or by deciding to change the curriculum and learning design.

We must acknowledge the fact that sometimes our decisions are biased by regular experience and available data that may reveal evidence about the performance at large, but not about the factors influencing learner or teacher performance as such. If we agree with this position, it means we need a contextual factor analysis of learning and teaching events, learning and curriculum design and learning and teaching organization circumstances. This research has limitations in terms of its scope, but the focus of our research is to see how the application of learning analytics as a metacognitive tool may help teachers learn to think over data in order to make decisions by taking into account as many factors as possible. Due to the complexity of the problem addressed, a semistructured expert interview method was chosen to leave the possibilities open for collecting broader qualitative data on as concise a process description as possible.

METHODOLOGY

In this section will explain the research context, research question, data collection and analysis, research participants, and research ethics.

Previous research has been done in analyzing the basic principles for training future reflexive teachers (Biktagirova, 2016), searching and distinguishing complementary endeavors between learning analytics and teachers' inquiry into student learning (Mork, Ferguson, & Wasson, 2015), and revealing the added value of learning analytics to the pedagogical planning phase by offering a learning design framework covering three main spheres: representations, approaches, and tools (Persico & Pozzi, 2015). This study adds to previous research by representing the potential of learning analytics as a metacognitive tool for teachers' reflexive practice from the point of view of international experts working with learning

analytics in higher education institutions and providing insights into the use of learning analytics data for implementing the teachers' inquiry cycle and reflections on open and online teaching, as well as improve curriculum and learning design.

Research context

This paper is a part of the bigger research project that aims to identify the needs of a digital and networked society for open and online learning through transforming open and online learning curriculum and its environment. A qualitative research design (Creswell, 2013) was chosen to understand how learning analytics can be used as a metacognitive tool in teaching practice by revealing the insights of international experts working in this research field. When discussing the phenomena of metacognition and reflection in teaching practice, qualitative methodology is the most appropriate approach as it allows the capture of important information during the interview and the collection of more in-depth data of the researched object.

Every institution is different in its background, therefore different views on the potential of learning analytics could emerge, and trying to have a productive discussion about how it could be used in the work of teachers as reflective practitioners, we wished to engage with experts representing different educational and research institutions who had different experience and backgrounds in researching and analyzing learning analytics data in the work. Interviews with experts allowed us to collect data representing the state-of-art on how learning analytics data is interpreted and used in different international educational and research institutions during the recent years.

Research question

In this paper interviews were conducted with experts working and researching in the field of learning analytics. They were asked to describe learning analytics as a metacognitive tool applied in open and online learning and to share their knowledge conforming to the main research question—How could learning analytics as a metacognitive tool be used for reflective teacher practice?

Data collection and analysis

Semistructured interviews were used to collect the data. This method is one of the most convenient methods for data collection as the interviewer can follow at his own pace and reconsider a sequence of questions based on interviewee's flow of ideas. At the same time, the interviewees are able to provide answers using their own words and concepts in the way they understand it themselves (Kvale & Brinkmann, 2009). Interviews were guided based on the questions guided by identified themes. Several themes were covered during the interview that helped to direct and facilitate conversation on the issues that the interviewers wanted to learn about:

1. Characteristics and application of learning analytics as a metacognitive tool. Could you name the most important (or several) characteristics of learning analytics as a metacognitive tool? In your opinion, can learning analytics be used to reflect on teaching and learning processes, and how? If yes, could you mention any characteristics of it? What are the biggest challenges that you see in using learning analytics as a metacognitive tool?
2. Curriculum and learning designing based on learning analytics data. How should the learning analytics method be used as a metacognitive tool in designing curriculum so that it generates student behavior data that are important for teacher interventions to student learning? On the basis of which data and with which tools should learning behavior interventions be happening (in order to improve awareness, reflection, and motivated change in behavior)?
3. Application of learning analytics data for raising teachers' awareness on their teaching practice. What kind of data generated by learning analytics tools could be the most important for teacher awareness? Could you give an example/case or reference a success story?

Face-to-face interviews and skype meetings were arranged to collect the data February through May 2018. Data analysis was conducted based on the descriptive content analysis method.

Research participants

There were eight research participants that represented the group of international experts in open and online learning with at least ten years of experience implementing open and online learning in higher education and at least three years of experience in researching learning analytics. The characteristics of research participants is presented in Table 1.

Table 1. Characteristics of Research Participants

Participant code	Gender	Work role	Type of institution	Country
Expert 1	Male	Administrator, researcher	University	Spain
Expert 2	Male	Administrator, researcher	University	Spain
Expert 3	Male	Administrator, researcher	University	Spain
Expert 4	Male	Administrator, researcher	University	Spain
Expert 5	Male	Administrator, researcher	University	United Kingdom
Expert 6	Male	Researcher	University	Austria
Expert 7	Male	Researcher, policy maker	Company	Norway
Expert 8	Male	Researcher, policy maker	Research Council	Italy

Research ethics

Informed consent, right to refuse or withdraw from the study, confidentiality, and anonymity of the participating managers were ensured in the research (Moore & McCabe, 2003).

RESULTS

Experts working with learning analytics and researching this field unanimously remind education stakeholders not to forget that learning analytics provides only a compendium of data, i.e., statistical indicators. But this data itself does not yield information on how the learning process is happening, how the curriculum should change, etc. It is the teacher who brings life to these indicators by reflecting on them and deciding how these data should be used and analyzed for teaching and learning process improvement and designing curriculum.

The findings of this study summarize experts' in the learning analytics perspective on how this data should be used as a metacognitive tool for reflective professionals. The data were analyzed by using qualitative data analysis. The following categories and subcategories were derived based on the interview data that corresponds to the main research question mentioned above.

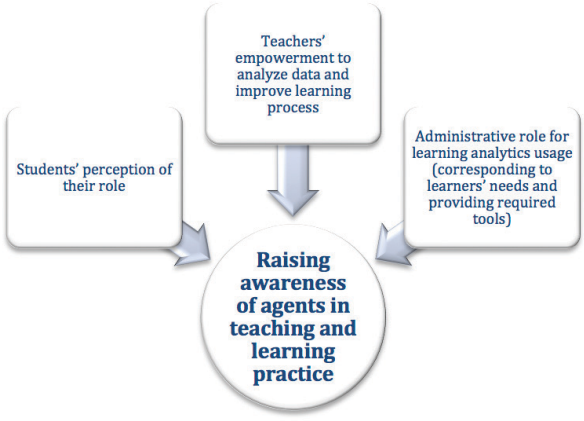
Table 2. Categories and Subcategories of Content Data Analysis

Categories	Subcategories
Raising awareness of agents in teaching and learning practice	Administrative role for learning analytics usage (corresponding to learners' needs and providing required tools)
	Teachers' empowerment to analyze data and improve the learning process
	Students' perception of their role
Recognizing students' behavioral patterns as metacognitive knowledge	Habits of students' engagement in an online course
	Useful data about behavior for course improvement
Metacognitive processes for planning and designing curriculum	Systematic thinking about the course development (long term)
	Ad hoc decision making (short term)
	Learning analytics as an indicator for a deeper understanding of the learning process

Raising awareness of agents in teaching and learning practice

As was mentioned before, learning analytics helps to monitor learning and teaching processes by providing data on how and what learners do

Figure 1. Raising awareness of agents in teaching and learning practice



or do not do during course implementation. Data analysis revealed that in order to get most of the learning analytics and apply it for teaching and learning purposefully, three groups of stakeholders should be considered: learners, teachers, and institutional administrators (Figure 1).

Administrators' role for learning analytics usage is seen through helping to create a unifying system and provide required tools corresponding to specific learners' needs for personal learning monitoring and improvement, as well as teachers' needs for curriculum development:

> *Work from learning analytics perspective allows < ... > educational administrators the possibility to organize the way to collect this information, and what the most relevant and important information is, to achieve the main goal: improve teaching and learning process. (Expert 2)*

> *< ... > we can use analytics to identify what the profile of our students is and the way they learn. That will be very relevant to see what techniques we should use to facilitate the learning towards students. (Expert 1)*

Using learning analytics for curriculum design and improving the learning process is a two-fold process that should be supported by the institution itself by seeing learning analytics as an important tool for learning and teaching development:

> *In order to be successful when applying analytical approach in the university it's very important to be mature as an organization, < ... > to move the organization to a data-centric organization or to analytic organization. So people should be aware of the importance of data and the importance of information we can get from the data. (Expert 1)*

> *I would say, it has to be top-down < ... > in the sense that you can't do learning analytics on a sustainable scale without really substantial support from senior managers and also substantial investment, because learning analytics, unfortunately, costs a lot of money to set up the systems, to develop the systems, to understand where the real magic of learning occurs. So you need that infrastructural support before you even start to use learning analytics. (Expert 5)*

On the other hand, despite the institutional support, teachers' personal involvement and an interest to work with the data and find the best ways to use it for curriculum development play a crucial role in this process as well:

> *< ... > bottom-up is that no matter how great we design our tools, if teachers don't believe me, then they won't use it. (Expert 5)*

The administrators' role is seen more on the institutional level as being the facilitators and decision makers regarding the technical and financial support for different tools and systems that help to make the best use of learning analytics. Simultaneously, they are motivators and supporters for teachers by encouraging them to learn how to analyze learning analytics and recognize its importance for teaching practice.

Teachers' empowerment to analyze data and improve learning process is revealed through enabling teachers to observe and monitor trends of learners' behavior and learning pathways:

> *< ... > how the learning is improving: is it improving enough, is it increasing enough or is it decreasing or something? That's more for the teachers. (Expert 6)*

> *it gives more information to the teachers, to see what is happening and what actions of intervention they can make to make things happen and what is the output of this intervention. (Expert 1)*

In parallel to the process of curriculum development and the integration of different communication and interaction tools for learners, teachers should be the ones raising learners' awareness on their learning behavior by encouraging them to follow and recognize their own learning behavior and make predictions for success or failure in the specific course. Teachers should analyze and reflect on the data, make decisions, redesign their course, and introduce this data to students in a more reflective rather than prescriptive way.

< ... > there is a role for the teachers to help our students reflect on where they are in their journey < ... >. (Expert 5)

As it was mentioned by the research participants, by mastering learning analytics, teachers can make an intervention at different stages of the course and on different levels, e.g., adding interactive tasks, moderating and activating tools for discussions or networking, changing formats of learning materials, etc.

< ... > learning analytics [can be used] to empower both teachers and students to really help maximize the potential of our students. (Expert 5)

It should be noted that learning analytics can help teachers get information about learners' behavioral statistics but then the teachers themselves needs to be aware whether this information is relevant and valid in terms of metacognitive knowledge.

Students' perception of their role distinguishes different approaches on how students can make use of the data provided by learning analytics. It is important to note that the learners' role is seen as a very important one in these processes, and it is important to develop students' analytic skills and encourage them to reflect and be aware of their individual learning process.

Usually it seems that learning analytics is important for institutions and for teachers, but, of course, it should be useful also for students. I think it is a very good practice to show the data collected to the students and offer them the possibility to analyze their own evolution. This data should be useful to improve the learning process, not only to know how each student works or learns. (Expert 2)

Learners can benefit from this information by monitoring their personal learning pathways, behavior, and achievements, or by comparing it with colleagues' learning progress and behavior.

< ... > sometimes its application is just for students to show their results and again compare with students, for example, for themselves. (Expert 6)

However, the possibility of stimulating learners' sense of self-responsibility and self-awareness of their personal learning process and making them feel responsible for their choices during the learning process is seen as an aspiration by experts in learning analytics.

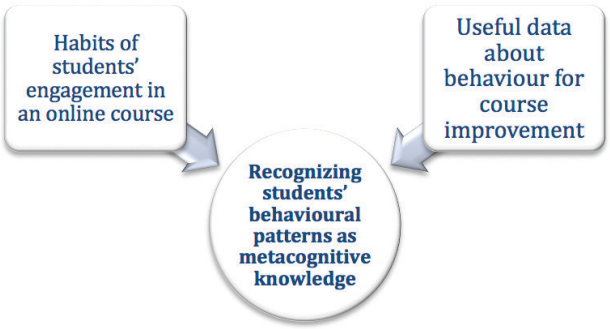
< ... > it also can give information to the students about what is his state, what is his or her weaknesses, or strengths, and make him more self-responsible for his or her learning. < ... > We want the student to be more self-aware and more responsible for his learning, and the data should be provided to one or another according to the expectations of each student, and expectations might be different according to different subjects. (Expert 1)

As it can be seen, the application of learning analytics is possible only when all stakeholder groups (administrators/institutional managers, teachers, and learners) are actively involved and demonstrate their interest and the need for learning analytics in teaching or learning development.

Recognizing students' behavioral patterns as metacognitive knowledge

The student's role is very important for teachers and learning analytics can help teachers recognize different behavioral patterns as students engage with a course (Figure 2).

Figure 2. Recognizing students' behavioral patterns as metacognitive knowledge



Experts also indicate that there are specific habits of students' engagement in an online course:

< ... > we can analyze data about everything because any kind of habit that a student manifests in the learning process may be useful, < ... > we can use information about the accesses of the student to the virtual learning environment, when they

access, in what frequency, and what are the navigation patterns. (Expert 1)

When discussing the most useful data about behavior for course improvement, it is important to consider different types of information that learning analytics can demonstrate:

> *I guess data that provides information is in three fields: (1) learner information: in particular learning style and IT expertise; (2) interaction information: in particular related to the teaching and learning process and with learning materials; (3) evaluation information: in particular related to the academic achievement. You can cross this data with learning styles and interaction information. (Expert 2)*

> *< ... > the data is just supporting us in a kind of way, and we would like only to help, for example, students: you say okay, your behavior currently is a little bit behind, or a student maybe has to engage more, because then you have to figure out that maybe you are not passing the next examinations, instead of asking. < ... > (Expert 6)*

Teachers as reflective professionals should understand the different learning habits of their students, recognize learners' behavior, and understand their thinking capacities and willingness to engage with the course etc., and, based on this information, make real time adjustments to their course curriculum.

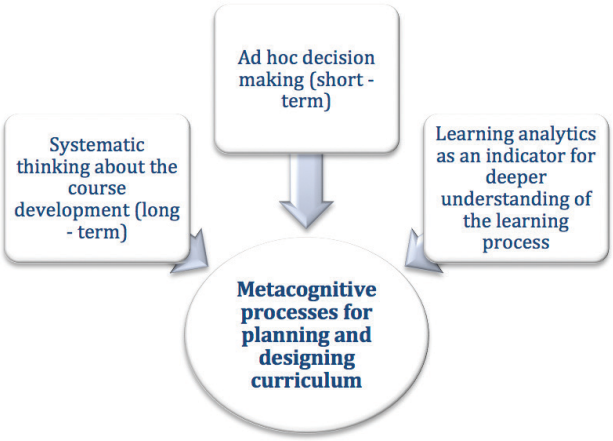
Metacognitive processes for planning and designing curriculum

As was mentioned before, it is the teacher who can use learning analytics for curriculum development and improvement of various learning activities (Figure 3).

According to the interviewed experts, teachers could put learning analytics into practice for long-term decisions, which is thinking systematically about the course development, and short-term decisions, which are those ad hoc decisions that they make as soon as they see the students' activity data.

Systematic thinking about the course development is described through thinking about the proposed learning activities in the course and

Figure 3. Metacognitive processes for planning and designing curriculum



questioning whether those activities are right for these students, or if there is a need of a change, which will affect the entire course:

> *< ... > two different levels: program level (long-term goals, namely obtaining a degree) and semester level (mid-term goals, namely passing a course). Regarding the latter, any course should be designed as a sequence of proposed learning activities and then, for each activity, the course instructional designers and teachers should try to describe what relevant data can be used to derive any evidence that a student has tried and has "executed" such activity. (Expert 3)*

> *< ... > more assignments in Moodle yield better results. However, the reasons for that are the teachers who are more motivated to engage students with more assignments in Moodle. Therefore, increasing the number of assignments in Moodle will not [automatically] make other subjects work better. (Expert 4)*

According to the experts having participated in the research, teachers should be aware that each student is different and by thinking about course development it is important to formulate personalized learning experiences for the students:

> *< ... > we can use < ... > [learning analytics] to choose what the right contents are or the right skills that we should teach. (Expert 1)*

That information should be personalized for each student because every student is different. In order to do so we need several tools, we need analytical tools like R commander, SPSS, or whatever you can imagine to analyze data and to find out what the student habits are, and then we will need to create a recommender system by using programming languages. (Expert 1)

The other important decision teachers should consider is that learning analytics data could help them decide about the importance of students' interaction with each other and integrate collaborative learning methodologies into the course:

The information we get here will affect the content of the program we are creating, and what collaborative methodologies we will need to use, for example, we find out that in the curriculum design we want to create < ... >; it's important to be able to work collaboratively, then we shall put some collaborative methodology into the curriculum. (Expert 1)

Learning analytics also can be seen as the right tool for teacher to get involved in ad hoc decision making as it was disclosed that it helps to identify students' habits in real time:

< ... > it's a tool for teachers that they can use right away < ... > and maybe giving them some good practices in which you can show the tool can be used to improve learning but it's up to them to use the tool for doing whatever they want. (Expert 1)

Also, there could be developed a recommender system, which could help teachers instantly reflect on students' learning and improve learning processes:

With this information we can create a system, a recommender system that in real time identifies what are the habits of the student in each subject, because students might present different habits in different subjects according to the level of engagement they have, and to propose improvements to every student according to the objectives they have and what they can adopt in order to improve the way they learn in a given subject. (Expert 1)

Our participants also revealed that teachers could be restricted in their choices, and it is better to use learning analytics for instant decisions than those for long term, as the outcomes of the course are provided in advance:

< ... > I think that learning analytics can help more in the path than in the main outcome, since the main outcome, many times, governments form. (Expert 4)

Metacognition could be seen through different perspectives in this case: first, how teachers are using learning analytics to better understand students' learning process; second, how we as teachers evaluate our own activities and how we design our work, which leads us to learning analytics as an indicator for deeper learning process understanding:

To learn about the learning process, I think that we would need, on one side, more qualitative approximations, like interviews; and on the other side, using neuroscience techniques, to learn what is really happening. < ... > learning analytics can help us to make the diagnosis, but not to know about the true process. (Expert 4)

< ... > then learning analytics can give us insights of which activities we, as teachers, design work well and which activities we may need to improve. (Expert 5)

When planning and designing a curriculum, it is very important for teachers to see different data about students' learning and engagement in a course and to reflect on what helped students achieve better results and where students were not engaged in the course. This deeper teachers' thinking about students' learning process and better understanding can lead to designing other courses differently and making instant teaching decisions.

DISCUSSION AND CONCLUSIONS

This study has been able to identify some of the main factors that reveal how learning analytics can be used as metacognitive tool for reflective teacher practice and how it can help teachers to think and make decisions related to teaching and the learning process. When discussing the application of learning analytics in higher education institutions, institutional administrators' roles should be considered as being equally important to those of

teachers and students. Administrators should be motivators and supporters of the process, especially in recognizing the need to apply learning analytics to reflective teacher practices. Institutional managers should initiate and develop strategic decisions oriented towards the development of data-centric or analytic organization, where departmental administrators, teachers, and students know how data provided by learning analytics can be applied in order to monitor and improve curriculum and teaching and learning processes.

This research contributes to the analysis of the learning behavior of autonomous and self-directed students (Bonk et al., 2015) by emphasizing the possibility to enhance learners' sense of their self-awareness of their learning process and self-responsibility for the choices and decisions they make. Moreover, this research supports the idea of how curriculum design can be improved based on the data from learning analytics (Nguyen et al., 2017) by demonstrating that timely interventions at different stages of the course and on different levels can improve learners' involvement and success. At the same time, it confirms that teachers should be the agents directing learners' behavior and making predictions for success or failure in learning.

Data provided by learning analytics empower teachers to analyze and improve the learning process. Learning analytics stimulates metacognitive processes and allows teachers as reflective professionals to recognize learners' behavior, understand their thinking capacities and willingness to engage in the course, and so on, and, based on this information, make real time adjustments to their course curriculum.

On the whole, this research distinguished two different perspectives on how metacognition could be seen in this process. From the first point of view, we can see how teachers use learning analytics for a better understanding of their students' learning process, and from the second point of view, we can observe how teachers design their work—which leads to learning analytics as an indicator for deeper learning process understanding.

This research augments previous research by presenting the results from the experts' working with the learning analytics point of view. It reveals the main characteristics and potential of learning analytics data for teachers' metacognitive processes. Table 2 shows the categories and subcategories of learning analytics data content analysis and crossing over the categories allows for an interpretative approach to learning analytics as one of the metacognitive methods leading to enhanced processes and outcomes in an educational environment.

These results are limited to interviews with experts working with learning analytics, thus further research on the application of learning analytics as a metacognitive tool would be significant, especially if the teachers who use learning analytics data for a course improvement, as well as teachers who are novices at working with learning analytics, were involved. A more in-depth analysis of different metacognitive processes could be a prospective research topic that helps to disclose more detailed characteristics of learning analytics application as a metacognitive tool and method, especially evidence-based empirical research on the use of learning analytics as a metacognitive tool in teaching with good practice analysis of a variety of learning design solutions.

The application of learning analytics is possible only when all stakeholder groups (administrators/institutional managers, teachers, and learners) are actively involved and demonstrate their interest and the need to use learning analytics for teaching or learning development:

- The institution should consider the application of learning analytics as an important tool for learning and teaching development. Institutional administrators are motivators and supporters of the process, especially in recognition of the application of learning analytics in reflective teacher practices.
- Teachers' personal involvement and interest to work with learning analytics data plays a crucial role in the process. Teachers are empowered to analyze data and improve learning process by applying learning analytics as a metacognitive tool. They should be the agents raising learners' awareness of their learning behavior and making predictions for success or failure in learning.
- Learners' role is seen as a very important one in these processes as it is important to develop students' analytic skills and encourage them to reflect and be aware of their individual learning process.

Teachers as reflective professionals should understand the different learning habits of their students, recognize their learners' behavior, understand their thinking capacities, see their willingness to engage in the course, etc., and based on this information, make real time adjustments to their course curriculum.

Metacognition could be seen through different perspectives in this case: first, how teachers use learning analytics for a better understanding of students' learning process; second, how we as teachers evaluate our own activities and design our work—which leads us to learning analytics as an indicator for a deeper learning process understanding.

Further research on the application of the learning analytics metacognitive tool as a method would be very significant, especially bringing evidence-based empirical research on its use in teaching with good practice analysis of a variety of learning design solutions.

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