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STUDENT-CENTRED DESIGN OF LEARNING DASHBOARDS

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Abstract

This paper presents preliminary ideas, process and results related to the design of a learning analytics dashboard for supporting student engagement with learning during a course. Understanding students' needs is important in designing effective learning analytics dashboards. Thus, the design should follow a user-centred or student-centred approach as understanding the needs of the user represents a significant part of the first stage in a user-centred design approach. Students needs are defined in relation to students' activities and context of use of the system to be designed. A learning analytics dashboard (LAD) is designed to support students' learning in a course scenario. Students needs are conceptualized based on literature and collected evidence. Among other things, students need meaningful feedback on their performance in various study tasks and support of progression of studies. These student wishes are discussed in what follows from the perspective of LAD design. The paper proposes a student-centred, theory-driven design framework for eliciting and including the students' needs in the design. Implications for design and pedagogical practice and research are discussed.

Keywords: learning analytics, learning dashboards, student-centered design.

1 INTRODUCTION

Learning analytics (LA) is a multidisciplinary field at the intersection of education, computer science, and human-computer interaction. It is concerned with *measuring, collecting, analysing, and reporting data about learners and their contexts, for the purposes of understanding and optimizing learning and the environments in which it occurs* [1]. This definition is adopted by the Society for Learning Analytics Research ([1], [2]). LA is also a tool or process that uses, analyses, and communicates student-generated data to support learners from two main perspectives: cognitive and administrative (Slade & Prinsloo 2013: 1512) [3]. The definitions do not state clearly who the intended users of the LA are (students, teachers, management, administration, policy makers, society in general or all of these). This lack of clarity in the LA definitions indicates that the field of LA is currently data-driven rather than user- and goal-driven. Inspecting the literature and the LA application landscape, one can observe that most of the LA solutions are data- and technology-driven rather than being focused on the users' goals and needs. Existing LA examples often show unintuitive and limited-value visualizations and dashboards, that do not seem to take into account *the real needs* of students, teachers, or management ([4], [5], [6]).

Various reviews demonstrate that students' needs are rarely analysed in the LAD design process, and the dashboards are rather simple ([7], [8]). Ferguson's [2] review on learning analytics field points out that one of the future challenges is to integrate in LA the learners' perspective and the learning sciences. In addition, effective LA should be designed based on sound *technical*, *pedagogical*, as well as *human-centred principles* [9]. These and challenges regarding human agency, ethical and social issues [10] position the LA field in early stage of development that requires more systematic and critical approaches.

In a more general definition, Cooper (2012: 3) excellently states that analytics is "*the process of developing actionable insights through problem definition and the application of statistical models and analysis against existing and/or simulated future data*" [11]. Starting with the "problem definition" in the analytics process is crucial; LA should define a specific goal to be achieved or a particular problem to be solved before applying data collection models and statistical analysis in order to provide authentic value to the users. Problem definition necessarily includes the definition of the application stakeholders, users, and goals. Furthermore, Cooper's definition of analytics contains other important aspects, namely "actionable insights", "statistical models and analysis", and "data". These aspects indicate that LA apps are oriented towards offering practical solutions to identified problems, solutions that should be obtained rigorously using validated statistical or analytical methods and be based on existing or simulated data (e.g., historical data, target learning scenarios, alternative learning or education scenarios) [11].

In this paper, we address this gap and lack of alignment in the LA field between learning goals, LA goals, and current design solutions. The gap can be the result of a wrong perception of LA being focused on data and analytical methods, rather than learners and their goals. Thus, we present preliminary ideas, a process model, and results related to the user-centred design of an interactive learning analytics (LA) dashboard for supporting *student engagement* with learning during a course. Student engagement and retention are key-performance indicators in higher education and long-standing issues of concern world-wide [12]. Using literature review and collected evidence, we apply the proposed design process model to identify students' needs related to a LAD. The design framework is theory-driven, based on both system design theory and learning theory.

2 METHODOLOGY

The study builds primarily on the user-centred design (UCD) methodology which is both a methodological approach to system development with specific techniques and tools and a philosophy whose principles are at the core of the aforementioned techniques and tools (see e.g., [13], [16], [17], 18], [19],[20]). UCD philosophy places the user in the centre of system development [13], where different techniques are being applied systematically to integrate the users' needs, values and characteristics in the design and evaluation of the interactive technology. UCD principles have been developed, refined, and validated in time, currently being proposed several rules, guidelines, principles that define and guide the UCD process [18].

In this paper, we provide a systematic framework for student-centred LA design and apply it to a hypothetical scenario in higher education. The application of the framework is preliminary, as the UCD paradigm requires multiple iterations and active user involvement until an adequate design solution is generated. *The main contribution is in providing and illustrating a systematic, theory-driven approach to the user-centred design specifically adapted to the learning context.* The UCD principles are applied at this stage using selected literature that documents students' needs in relation to learning analytics, as well as using our own experience as learners, teachers, learning evaluators, users of different learning technologies, and usability researchers and practitioners.

In the following, we describe the UCD characteristics and how the UCD approach has been adapted and applied in this study. We adopt the LAD definition by Teasley [21] and present a learning-based model based on Matcha et al. [22] and Winne and Hadwin [23] that is further combined with UCD in a design framework for student-centred design of learning dashboards. The proposed framework is then applied to a hypothetical scenario [24] of a higher-education course. The design is presented in this paper at conceptual level [14] and it is illustrative, serving as a research tool for future work. For identifying students' needs, theories and empirical studies (e.g., [12], [15], [21], [25], [26]) on student engagement and learning analytics are reviewed.

2.1 User-Centred Design

A generic UCD process consists of stages such as understanding and specifying the context of use, specifying user and organizational requirements, producing design solutions, evaluating the design solutions against the user and organizational requirements [16]. Each UCD process stage is evaluated against predetermined criteria and the overall process consists of iterative and incremental cycles and their evaluation against user and organizational requirements. UCD principles are defined to guide the system design, development and evaluation to ensure that the generated design solutions meet the users' needs, values, requirements, and context of use. Thus, 12 principles are formulated by Gulliksen et al. [18] as follows:

> *"1. User focus - the goals of the activity, the work domain or context of use, the users' goals, tasks and needs should early guide the development.*
>
> *2. Active user involvement - representative users should actively participate, early and continuously throughout the entire development process and throughout the system lifecycle.*
>
> *3. Evolutionary systems development - the systems development should be both iterative and incremental.*
>
> *4. Simple design representations - the design must be represented in such ways that it can be easily understood by users and all other stakeholders.*
>
> *5. Prototyping - early and continuously, prototypes should be used to visualize and evaluate ideas and design solutions in cooperation with the end users.*

6. Evaluate use in context - baselined usability goals and design criteria should control the development.

7. Explicit and conscious design activities - the development process should contain dedicated design activities.

8. A professional attitude - the development process should be performed by effective multidisciplinary teams.

9. Usability champion - usability experts should be involved early and continuously throughout the development lifecycle.

10. Holistic design - all aspects that influence the future use situation should be developed in parallel.

11. Processes customization - the UCD process must be specified, adapted and/or implemented locally in each organisation.

12. A user-centred attitude should always be established - all people involved in the project must be aware of and committed to the importance of usability and user involvement, but the degree of knowledge may differ depending on role and project phase."

UCD has been explored and applied as a design or evaluation paradigm in many studies concerned with higher education ([27], [28], [29]) or specifically with LA and LAD (see e.g., [8], [9], [30]). Different UCD approaches have been explored such as co-design [31] and value-sensitive design [32]. However, the LAD research area is still in an exploratory stage and more research is needed to bridge the gap between students' learning goals and LAD design solutions (see e.g., [9]).

There are two main types of designs: *conceptual and physical* [14]. Conceptual design clarifies the overall purpose of the system including its context of use and users' needs. On the other hand, the physical design is a representation of how the system functions and looks. At this stage, the user interactions are structured into logical sequences, and the functions are defined and modelled. The physical design includes requirements for hardware, software, and knowledge of users, their needs, tasks, and activities. Physical design includes the design of operations, representations, and interactions. *In this paper, we address the conceptual design of LAD and, in particular, we clarify the needs of the students in a higher-education course and how these could be supported by LAD design.*

We adopt in this paper the definition of design as a process with three activities: *understand, observe, and visualize* [14]. More formally, design is defined as a process of four activities: 1) understanding, 2) design, 3) envisioning, and 4) evaluation ([14], [16]). *Understanding* refers to understanding the problem and context of use. It is about collecting requirements; what the system should do? who are the users? what characteristics do the users have? what do users need? what is the context of use? what are the technical, social, and environmental constraints? There are two main types of requirements: functional (what the system will do) and non-functional (usability, user experience, ethical concerns, privacy, and security, etc.) (Benyon 2014: 49-50) [14]. *Observation* refers to different forms of evaluation or design: observing how the designed system is used, the user-interactions, system functions, their sequence, their level of understanding by users, etc. Finally, *visualizing or envisioning* refers to the final or intermediate design solution, a visual representation of the problem solution that is translated in a system. Various media can be used to render the design solutions. Examples of techniques used for visualization are sketches, fully functioning prototypes, mock-ups, and scenarios. *Evaluation* is central in the design process as every other activity can and should be evaluated. [14]

We will apply this UCD process concept when designing the learning dashboard. Understanding students' needs is important in designing effective learning analytics dashboards and represents a significant part of the first stage in a UCD approach. However, the LA literature often overlooks this aspect (see [7], [9]). For LAD design, students' needs are defined in relation to students' activities and context of use of the system to be designed [14], namely student learning in the context of an individual course, course module, and academic path. *In this paper we focus on the students' learning needs in the individual course context.*

To manage the complexity of the design and to structure the issues that need to be taken into account, Benyon assembles the design process into a framework called *PACT (People, Activities, Context and Technology*) [14]. *People* are the users and stakeholders interested in the system, and their characteristics and mental models that determine the experience with the system. In the current study, people are the students that will use the dashboards and the teachers that need to consider the course tasks, learning outcomes, practices, and materials in relation to the dashboards. *Activities* are the tasks, actions, goals that are undertaken by the users of the system; people use the system to perform some relevant activities, and the designer needs to consider these to different levels of detail when designing the system. In the education context, activities can refer to the stages of learning as described in the studying model by Winne and Hadwin [23], namely: task definition, goal setting and planning, enactment, and adaptation (see also [33]). *Contexts* are the environments (physical, social, organizational) in which people's activities take place. For example, the dashboard can be used in the classroom, at home, in group and has temporal dimensions (there is a certain time allocated for using the dashboard and for learning). *Technologies* are the available software and hardware and their characteristics that are put into use when designing and implementing the system. For the current study, technology comprises the digital ecosystem of a learning management system. It includes the visualization and graphic displays, the machine learning algorithms and programs, the data requirements, the user interface, the computing system (mobile phone, desktop computer), etc.

2.2 Learning-Centred Design of Learning Analytics Dashboards

A learning analytics dashboard (LAD) is a type of LA that provides the information and means of user interaction via a visual display or visualization application. Besides visualizations, a LAD can provide recommendations [34]. LADs present "important information needed to achieve one or more goals, consolidated and arranged on a single screen so the information can be monitored at a glance" [21]. LAD concept is similar to that of business analytics dashboards that seek to discover knowledge in large amounts of data by the means of statistical methods and advanced data analysis algorithms. LADs aim to reveal new, interesting, non-trivial, and otherwise undetectable patterns in educational data. Often LADs are based on data generated by or collected through learning management systems [21], but it can also use other sources (including surveys or self-reports). Typically, LADs include log data about students' interactions with course resources in the learning management system and data from learning artifacts [35]. LADs can also include data about the interaction with the dashboard itself [7]), and assessment, time spent, social interaction, and sensor data [7]. Depending on the intended user of the application, there are student-facing LAD (where the performance data is presented directly to the student) or teacher- or advisor-facing analytics [21].

To be effective in sustaining students' motivation and engagement (behavioural, emotional, cognitive, and agentic engagement) ([25], [26]), LAD use should be integrated with the *learning experience and context*. And to ensure this, *LAD design should be driven by theory and be integrated in the pedagogical practice in a meaningful way* [22]. Theory-driven design implies two principles: 1) grounding the design in learning theories and learning science, and 2) adopting a user-centred design [22]. Hence, we follow this principle, and *adopt the theory-driven design approach for designing the LAD and the pedagogical practice around it*. To this end, *we first assemble a design framework to guide us in the selection of aspects to be modelled.* This framework will have the primary layer the UCD model [14] (see Figure 1) and as the secondary layer the model by Matcha et al. [22] for developing LA dashboards (Figure 2).

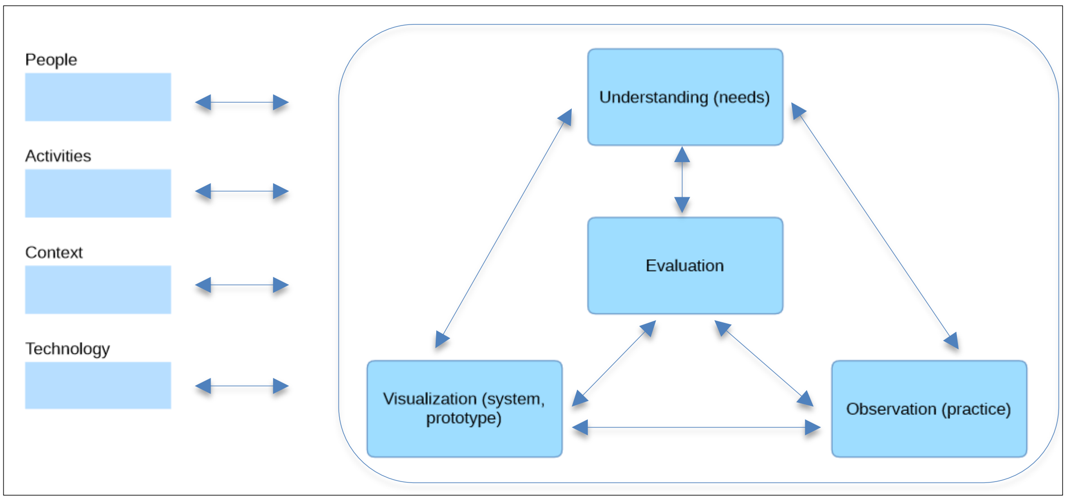

Figure 1. UCD approach integrating the PACT (people, activities, context, and technology) framework (based on [14]).

A *UCD process model* is utilized to identify and structure the main aspects to be modelled: people, activities, contexts, and technologies (Figure 1) and acts as an overall paradigm. In the first stage of the UCD cycle, the needs of the users are identified and understood. This stage conceptualizes how LAD can support the identified student needs. In the second stage, observation, the LAD concept is applied and examined in practice. Finally, the third stage, visualization, proposes different solutions of how the LAD concept can be communicated to users and developers and realized in a physical design and application. The UCD process is recursive and iterative. One cycle can be repeated until the obtained design fulfils the requirements and expectations for which it is created. Every stage can be repeated several times until the next stage is initiated. A stage provides input to the next stage and is evaluated against a set of criteria that should be defined a priori. Typically, UCD requires user participation, but for this study we use for evaluation only our own reflection for one iteration and cycle.

The *LA development model* [22] (Figure 2) acts as a secondary layer or cycle in the overall framework, meaning that it is utilized to model the aspects relevant to *learning and LA* for each main phase in the UCD model. This cycle corresponds to integrating learning science and learning theories into the UCD design. Figure 2 represents the basic model adopted (based on [22]).

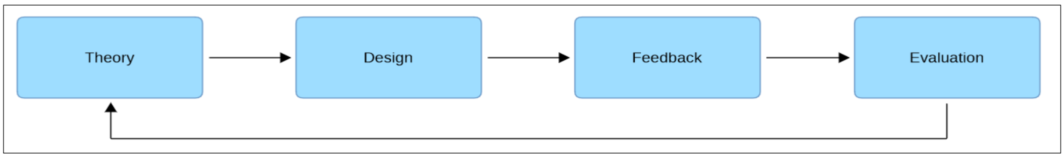

Figure 2. LA dashboard development model (adapted from [22]).

3 RESULTS AND DISCUSSION

The results of the study are twofold, namely a framework for the design of student-facing learning analytics dashboards, and the illustration and discussion of the framework on a course scenario.

3.1 Learning-Centred Design Process Model

In this section, we present a systematic framework for the design of student-facing, learning-centred dashboards. This framework combines the UCD, PACT and LA development models in an *overall process framework for learning-centred design* (henceforth, *LCD process model*). In this paper, the terms model and framework are used interchangeably – they refer to a systematic approach to design by following predefined steps, cycles, and iterations. The model is depicted in Figure 3. At the top level there is the UCD process, where each stage is informed by the corresponding subprocess at level 2, focused on learning (learning theory, learning design, and learning feedback, respectively). Down the model hierarchy, at the lower level, the design is informed by specifying and modelling the PACT aspects (people, activities, context of use, and technology). Cycles comprise all stages at a certain level.

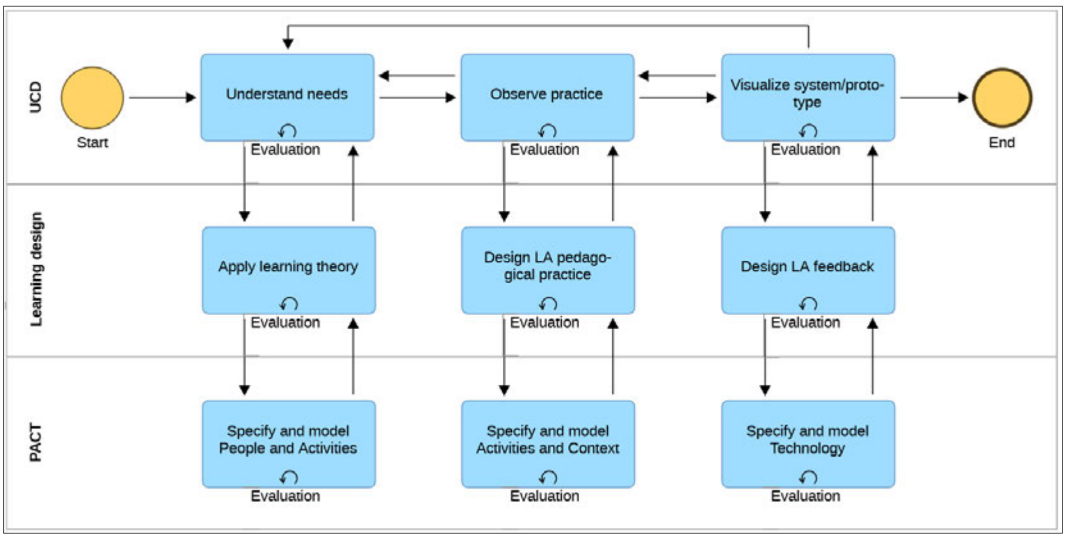

Figure 3. Learning-centred LA design framework (LCD).

When applying the LCD model in practice, at first step, for understanding students' needs *a suitable theoretical framework of learning* is selected and with the help of this framework people and activities are specified and modelled. For this study, we use the *self-regulated learning (SRL)* model by Winne and Hadwin [23] as the theoretical framework for understanding students' learning needs. According to the SRL model, learning takes place in four stages: task definition, goal setting and planning, enactment, and adaptation. These stages should be taken into account when designing LADs.

Furthermore, Winne and Hadwin [23] theorize that the studying tasks can be characterized in terms of five dimensions: conditions, operations, products, evaluations of products, and standards for products. Conditions refer to both cognitive conditions (students' skills and domain knowledge, interest, motivation, etc.) or task conditions (including the course environment, teachers, learning platform, learning materials and resources, time constraints, etc.) [22]. Operations are the activities that students engage in for learning, and these can be primitive operations (opening a file, reading, answering, writing), but also acquired or coordinated operations such as learning tactics and strategies [22]. Operations will result in products by transforming the conditions [23]. Products can be stored internally (understanding, memorizing, structuring the information, connecting the information with previously held views), and can be represented also on external media (essay, exam answers, software code, etc.) that others can observe [23]. Products are evaluated both internally by the student (cognitive evaluation) or externally by other evaluators such as peers and teachers (external evaluation; [22]). Finally, the standards represent the criteria for evaluation which can be set by both the teacher and the student [23]. This framework and terminology should be used to characterize and describe the pedagogical practice where the LA dashboard are integrated and applied in the LCD model in the learning design cycle. To apply the LCD model to design, first a course scenario is created.

3.2 Scenario of Using LAD in Higher Education

Scenario is one method of design ([14], [24]). We have created a scenario to illustrate a situation where LAD is used to support learning and provide students with actionable insights. Scenario in this case is used as a basis for overall design [24], that is, encompassing all steps (understanding, observing, and visualizing). A scenario is a description of a situation with the purpose to characterize users, context of use of a system, and possible interactions with the system. The following scenario is a hypothetical illustration of a learning context because it combines features of different courses. The purpose is to illustrate a challenging and critical situation, and to solve the tensions between teachers and students' views on the goals of such a course. The hypothetical course is challenging for students because it consists of multiple activities, interactions tasks of different nature (quizzes, small essays, individual work, group work, independent and interactive activities, face to face and online), and multiple, weekly deadlines. The course uses Moodle as the learning management system. Students enrol to the course, and engage with different study materials, activities, and tasks on a weekly basis over three months. They need to complete several weekly assignments in written form and also using a software tool for modelling and analysis. Some tasks are individual and other are done together with a team of other students. The teacher workload and organizational resources do not allow to give timely, individual, and substantial feedback that would motivate and engage students in the course in an optimal way. Therefore, teacher feedback is sometimes given late or it can be too brief. The students' workload also includes other courses at the same time. Thus, LAD could compensate for these challenges and maintain or improve the student engagement with the challenging course. Based on voluntary basis, student could access LAD functionalities and get the desired support to learning and progression.

3.3 Understanding and Visualizing Students' Needs for LAD to Support Them in Learning

Observations in our own pedagogical practice, organizational-level experiences, and related research (e.g., [6], [15]) indicate that students wish to have, among other things, 1) *meaningful feedback* on their performance in various study tasks, and 2) *support of progression of studies*. These student wishes are discussed in what follows from the perspective of LAD design.

3.3.1 Meaningful feedback

According to the literature, a LAD designed for providing meaningful feedback supports students in effort regulation, identifying gaps in knowledge, and increasing motivations and skills to learn [15]. Research findings ([15], [25]) suggest that the design of such dashboard should facilitate different learning strategies (e.g., summarizing, organizing, understanding, memorizing the material and concepts). Feedback support is associated with cognitive engagement in studying [25] because it can trigger intrinsic motivation to learn more. As a result, students will experience deep learning, and this is observed when students make better and more connections among ideas and concepts [25]. Thus, LAD focused on meaningful feedback should support for example strategies such as summarizing, organizing, and understanding the learning material.

If the aim of the LAD is then to increase cognitive engagement through meaningful feedback, the level of cognitive engagement must be measured and depicted formally in the dashboard. Fredricks et al. refer to the notion of *substantive engagement* as a proxy for cognitive engagement in terms of quality of discourse. Substantive engagement describes the "sustained commitment to the content of schooling" [36]. It can be created by teachers by providing frequent high-level evaluation (feedback) and authentic questions at classroom level increasing the quality of discourse, but it can be triggered and quantified also at individual level [36]. These approaches will build a substantial, continuous, prolific dialog between teacher and students. In this conceptualization, substantive engagement is observed in face to face or traditional learning situations; however, we apply this concept in the context of LAD, where the evaluation, feedback, and teacher-student dialogue is realised in a digital form and can be operationalized in terms of substantive engagement.

In the literature, substantive engagement is contrasted with procedural engagement in a similar way that deep learning is contrasted with surface learning (see [36]). Thus, a LAD that focuses on depicting feedback on learning could inform the students to what extent these two approaches (substantive vs. procedural engagement) are found in the student's learning. Procedural engagement refers to complying with classrooms rules and regulations, including fulfilling course requirements regarding assignments length, deadlines, terms used, or other formal or practical requirements [36]. On the other hand, substantial engagement refers to the deep connection of the student with the contents, topics, issues, problems, and methods of the academic study [36]. Self-report measurements of students preferences for hard work, their learning strategies, and patterns can be included to assess the cognitive engagement [36].

For a course that uses written assignment for learning and evaluation, one possibility to depict the feedback is using a concept map and frequency table highlighting relevant concepts used, and their relations as derived from the learning tasks, as well as linking these concepts and relationships into the course learning outcomes (LOs) and learning tasks in the LAD. The learning tasks should also be designed so that the LAD can capture the extent of substantive engagement in contrast with procedural engagement. The LAD then could contrast these with desirable outcomes and highlight missing concepts and connections that could have been reflected in the learning. This would allow students to get meaningful feedback on their level of learning in comparison to the learning tasks and course LOs and visualize the strengths and weaknesses in their level of learning in the course. In the scenario outlined above, this would help students to better understand the degree to which they have achieved the LOs of the course learning tasks and the course in general, as well as the concepts and their relations they should learn more. The LAD can also recommend further reading materials as well as small set of light assignments, so that the student has an immediate opportunity to act on the feedback and the weaknesses or strengths identified in their learning.

A short questionnaire (2-3 questions) could also be integrated to indicate the preferences for hard work, and the strategy used for the course completion. An indicator of substantive versus procedural engagement would be calculated and reported. The dashboard could for example inform the student on the type of engagement during the course such as through a text message of the form "Your type of engagement for this assignment tends to be substantive (75%) because ….". Visual feedback on how the engagement was calculated will offer further guidance on what aspects are positive and what aspects in learning require further attention. Recommendation for further reading could be provided based on the concept map and concept frequency table obtained from the assignment.

3.3.2 Support for Progression

The need for support for progression is associated with behavioural engagement [15]. Though this type of support can be designed at academic path level [15], it is often useful at the course level especially when there are many and various tasks designed for the students to complete in the course. Some students drop out of class, and the dashboard can help motivate them to continue and pass the course. The support for course progression should be designed so that to motivate students to 1) engage actively in the learning tasks, and 2) manage better their time to complete the learning tasks and avoid missing deadlines [25]. The design for supporting the progression in the course will rely on data regarding task completion, deadlines, duration of tasks. A dashboard could, for example, be implemented in Moodle highlighting the next learning task to be completed (as well as its deadline and estimated time for completing it, and to show how many tasks are to be completed in total, how many have been completed), what was the score of the tasks completed, how much time is estimated to complete the tasks. Furthermore, the tasks should be linked to learning outcomes (LOs), and the LAD should also provide means for reflection and self-regulated learning in relation to the course LOs. Similarly, as in the previous example of dashboard, a short survey to measure the effort allocated in the learning could be implemented and the obtained data contrasted in the dashboard with the actual progression and estimated effort required to pass the course. The information provided by the dashboard will help the student in metacognitive monitoring and self-regulated learning which in turn will increase study performance [23]. Progression data and engagement can be also corroborated, to provide feedback supporting metacognitive performance. It has been shown that both the cognitive engagement and behavioural engagement are correlated with other types of engagement (e.g., agentic engagement; [26]) and influence positively the academic performance and satisfaction ([25], [26]).

In the scenario outlined above, this type of support for progression would help the students to keep a track on learning tasks, their deadlines and required work to complete, therefore making it easier for them the schedule their learning activities, but also to increase their metacognitive skills which will improve their academic performance and independence on the long-term. One of the major problems that students have on different courses is the difficulty of keeping track on which learning task they should work on now, based on deadlines and the amount of work needed for completing the different learning tasks. The LAD could be integrated to the students' calendar, automatically adding the learning task deadlines and allocating the time to do these tasks well before the deadline, taking also into account the time needed to learn about the concepts. Other aspect is the differences in the size of learning tasks and the time required. In the course scenario the students need to remember to do their learning essays weekly, but also to work on their final individual and group essays over several weeks. The LAD could learn the daily and weekly patterns of the students as well as their preferred learning strategies and personalize the scheduled learning activities in the students' calendar accordingly. Furthermore, some learning tasks are conducted individually, while others are group work, so LAD could help the students to schedule the required amount of time for joint group work.

3.3.3 Ethical Requirements

An important user-centred requirement of LAD refers to ethical issues, such as privacy, voluntariness, consent, confidentiality, security [3]. Several studies indicate that ethical aspects of LA regarding privacy, informed consent, transparency are crucial for students (e.g., [6], [15]). Privacy and informed consent are important requirements that need to be adopted in the design. Data that students will not consent sharing and processing should not be used in the design. Furthermore, for a proper informed consent, the principle of transparency should be designed and implemented so that students are able to freely, voluntarily, and autonomously decide whether they give or not their consent for the data usage. Thus, the learning dashboards should be used and activated on a voluntary basis. Human agency and social impacts should also be taken into account when designing LADs [10]. General Data Protection Regulation legislation provides additional limitations about what kind of information is forbidden being processed such as political, religious and philosophical views and how personal data should be processed [37]. The regulatory framework on artificial intelligence (AI) categorizes applications by risks (unacceptable risk, high-risk, limited risk, minimal risk) and provides guidelines on what measures have to be taken into account when designing high-risk applications that use AI [38]. Moreover, issues such as equity, inclusiveness, visual, data, and digital literacies will pose further requirements on the design to ensure the system is easy to use by different groups of users.

4 CONCLUSIONS

We have compiled a systematic, theory-driven framework for student-centred design of learning analytics dashboards. The framework has been illustrated and discussed as one iteration cycle on a hypothetical course scenario in higher education. The contribution of the paper is methodological-theoretical in the classification referred in [9]. This contribution could be utilized when designing LADs and pedagogical practices. The work continues to further design and develop the proposed LAD with the involvement of students and teachers, as well as to integrate the dashboard into an adapted learning design for the targeted scenario. Both teachers and students should be involved in the design, as the students cannot act as expert learners, experts in the subject matter, and expert educators to know the kind of feedback and learning design that are adequate for a learning situation [9].

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