Designing Human-Centered Learning Analytics Dashboard for Higher Education Using a Participatory Design Approach

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Abstract—Higher education institutions (HEIs) are looking for new methods to assess and monitor student learning outcomes, as well as objectively determine the circumstances that contribute to their growth in different courses. Advances in new analytics tools that put visualizations and dashboards on top of live student data are making learning analytics more powerful than ever. This study utilized a participatory design (PD) technique to formulate an analytics dashboard intended for higher education. The rationale behind the study lies on the belief that an information system must be designed for users, rather than users having to accommodate a wide range of adjustments just to utilize such application. Students and teachers were recruited for their feedback and observations, respectively. After multiple PD sessions, four main crucial factors were derived: (1) who has access to data, (2) importance of time, (3) learning analytics should help students make the transition to university life, and (4) it should be discipline-specific. This study opens up a discussion on the importance of human-centered design through the use of PD and how learning analytics dashboard can be maximized to its potential when deployed in the academe.

Keywords—Academic Analytics, Learning Analytics Dashboard, Participatory Design, Higher Education, Human-Centered Design

I. INTRODUCTION

Higher education institutions (HEIs) are always interested in new measurement techniques to monitor students' progress, as well as new methodologies to objectively examine the different factors that support learning. Academic analytics, for instance, is particularly focused on managing an academic enterprise by placing an emphasis on data usage, information, organizational culture, and technology. Large datasets, statistics, and modeling are all brought together by maximizing the usage of technology. In some organizations, options like registration management are deployed as administrative tools, which can be utilized to benefit teaching and learning as well [1]. Nevertheless, such a transition from one field to another requires direct feedback from its new target users. One technique is participatory design (PD) method, which involves stakeholders (e.g., administrators, teachers, and students) into the design process to better understand, fulfill, and occasionally anticipate their requirements. PD likewise provides an opportunity for individuals to connect and collaborate toward a shared goal. In addition, it is a technique in which developers, representatives, and users collaborate to create a solution [2] and ensure that the product fits the customers' criteria by playing an active role throughout the design process and project in general.
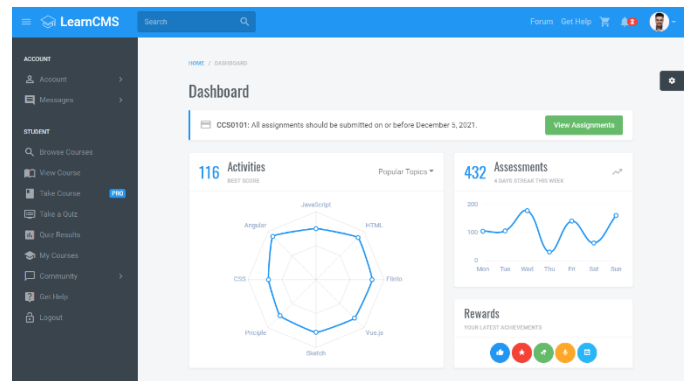

Fig. 1.   Learning Analaytics Dashboard for Online Courses

Learning analytics is a new technique that aims to enhance learning outcomes by aggregating and illuminating student data via visualizations and dashboards (Figure 1). Despite long-term studies attempting to determine long-term implications of these analytics dashboards, it appears there is a wasted chance to build them using human-centered design techniques that incorporate real-world use cases. Meanwhile, neither learning analytics nor research programs focus on how students could engage with the data or how teachers may use the data to better their instruction. In this paper, PD methodologies were used to create a computer-based dashboards that display learning analytics data by getting the design framework from the feedback of its stakeholders. The long-term goal of this study is to deploy such learning analytics at the core of a learning management system. To ensure that the final product is compliance with the needs and requirements of its primary (i.e., students) and secondary (i.e., teachers) users, a series of PD sessions were conducted together with these users. This study contributes to the existing threads of discussions on academic analytics, human-centered approach, and PD method. More importantly, it attempts to extract the most effective way of designing learning analytics dashboard by using stakeholders to contribute throughout the design process. Many studies have incorporated such technique to develop various software artifact such as an educational computer game [3] and augmented reality for history education [2], to name a few. The employment of PD approach through the principles of human-centered design may produce more stimulating insights most particularly when target users are the source of feedback and information.
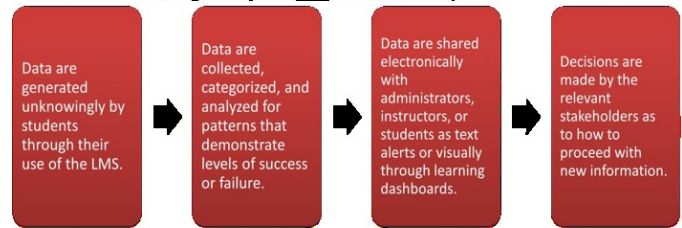
II. Review of the Study

A. Learning Analytics

Learning analytics is an interdisciplinary endeavor to collect and analyze evidence about the results of networked interactions and utilize such information to improve teaching and learning. While this definition is inspired by data like course management systems, assignments, and social networking connections, it is also derived from the use of Big Data Analytics practices that offer personalized visualizations, called learning dashboards, to encourage students, instructors, and administrators to act [4, 5]. There are no concrete conclusions about what this implies for the teaching and learning experience of students, teachers, and administrators, and this is still presently up for debate. The work that remains is considerably greater, with a much larger gulf remaining between developers, designers, and academics that are working on this project [6]. Furthermore, and this is even more concerning, there is an obvious lack of users engaging with field researchers. Meanwhile, technological advancements like learning analytics have the potential to revolutionize education by connecting data, delivery, and results in a focused dialogue. All stakeholders must be engaged in the development for it to be successful, and learning analysis must take into consideration how findings are presented to promote comprehension and in-depth learning [7]. To achieve that objective, one of the primary functions of analytics research is to help learners, and that is by designing visualization tools commonly referred to as learning dashboards. Educational experts and dashboard tool producers are in agreement that better student motivation, effectiveness, autonomy, and efficiency are all crucial factors [8]. Building a technology-based system that allow learners to evaluate their performance, compare it to a benchmark, and then respond with the feedback loop supports learner self-efficacy [9] in addition to self-regulation [10] and, the application of technology aiding assessments, in which a learner may monitor their performance, compare it to a standard, and respond [11]. On the other hand, vendor-developed solutions at the core of learning management systems, which are utilized by the majority of HEIs, have made significant progress in assisting at-risk students. Hanging in the balance, one approach has limited instructional value and little significance in learning while another has extensive value and significance for teaching. Unfortunately, research shows that the interest of academic leaders in the development of teaching and learning-oriented tools has significantly decreased.

B. Human-Centered Design

One study [12] explains that participatory learning analytics must include design-based research, educational action research, and PD approach application. A design practice that focuses on understanding people and creating creative products is known as human-centered design. The question now is: *"What role does this play in analytics education?"* Students' learning preferences are complicated and bound to change over time and interactions of people with printed text, especially online and/or multimedia content, are analogous. In addition, when it comes to academic analysis, the hardest components are non-technical in character [7]. There are also other issues related to data quality, collection, privacy, and analytics ethics that must be put into consideration if the educational experience is to be successful. Consequently, it prompted many experts in the field to seek for methodologies to include users in the research and design process.
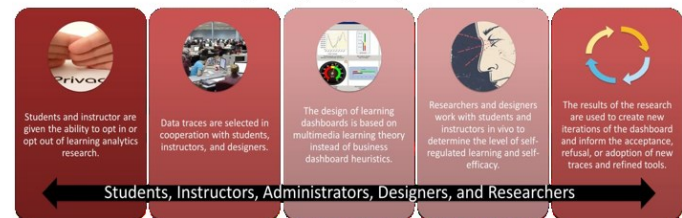
Fig. 2. Human-Centered Learning Analaytics Approach

Figure 2 illustrates the conventional practitioner analysis of learning, in which data is produced without students' knowledge via their usage of an online learning management system. Most importantly, data is being gathered, organized, and analyzed in order to spot patterns that indicate success or failure. As written warnings or graphically via learning dashboards, data may be shared electronically with administrators, teachers, and students. The relevant stakeholders make choices on how to proceed with the new knowledge when all of the procedures are completed. The analytical study of learning provided by users (i.e., students and instructors), on the other hand, may be used in the analysis of human-centered learning and they could all help choose data traces. Learning dashboards are based on a multimedia learning theory rather than heuristic business dashboards as far as design aspects are concerned. Meanwhile, researchers and developers collaborate with students and teachers to assess self-control and self-efficacy in the classroom. The findings are utilized to build fresh dashboard iterations and to determine if new research and improved tools should be accepted, rejected, or adopted.

III. Methods

This study reports on the progress made with target users of a learning analytics dashboard. Specifically, university students under the information technology program where recruited. The sampling technique was purposive, and PD sessions were done during the second trimester of the academic year 2020-2021. In the first session, the primary goal was to illustrate the PD process and provide instances of discoveries that have arisen from such a conceptual approach to learning analysis, which may have failed conventional methods to learning analysis. Conversely, in the succeeding sessions, the primary focus was components and features to be included in such a dashboard. Aside from students, experts from different departments of the university were also recruited to observe and record field notes during conferences. It was also their role to contribute in the evaluation of feedback as well as the activities given to students. Following the design thinking approach [13], students were divided into teams in the final third of the class, and each team then developed a personal learning dashboard based on their preferred application features. Data visualizations, data streams, and variables were frequently explored and examined. Ideas and concepts on how to include

these different parts into a dashboard for a variety of users were often examined. Specifically, they underwent a method aimed to gather the following information.

1. Define achievement as a university student.
2. Identify possible data flows and information.
3. The utility of peer-reviewed benchmarking data.
4. Issues of credibility and ethics in learning analysis.
5. The use of technology by students in learning.

The PD session was examined in a variety of ways and all experts participate in the summarization of field notes. They also put out their recommendations, first impressions, and recurring themes of the sessions. Qualitative data was initially transcribed and entered into *NVivo*, a qualitative data analysis application, which assists with appropriate analyses. The inductive, constant comparative technique, which was utilized by aforementioned individuals, enabled other ideas to originate, since there were several additional concepts discovered as a result of this process [14, 15]. The team was able to evaluate themes in a methodical manner as a result of this approach and talk over the codes and come up with a unanimous results. Faculty members and an instructional design and technology PhD student completed the work of the coding portions, whereas graduate students were solely responsible for coding the entire transcript. Three coders met and agreed on a final, coded transcript with consideration to each coder's independent analysis. Using multiple coders makes the analysis more accurate and consistent [16].

IV. RESULTS

This preliminary research contributes to the specific design of a student-centered learning analytics dashboard, which could be used as the core analytics of a learning management system. It also identifies additional data traces that could aid researchers in developing quantitative models for learning analytics. These include class schedule, access to the internet and downloads to university servers, participation in various *listservs*, academic performance, personal backgrounds, and social profiles [17].In the next section, topics that arose from the focus groups, as well as qualitative data from focus groups, were addressed in further detail (indicated in Figure 3). These themes and issues may not have been addressed if PD method was not employed.
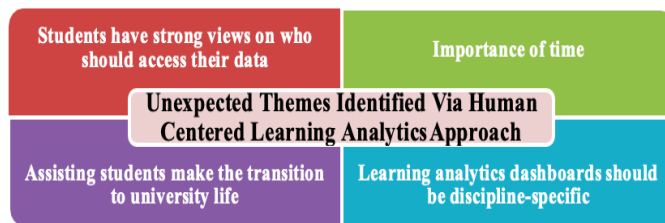
Fig. 3.   Identified Themes Using Human-Centered Approach

A. On who should have access to data

Excluding theme that (1) students have strong views on who should access their data, all themes such as (2) the importance of time, (3) help students make the transition from high school to university, and (4) employing learning analytics dashboards that can be customized to a particular subject were unexpected findings. Data security and certain ethical concerns related with learning analysis were discussed as part of the PD session. This opens up the discussion on who should have access to the data.
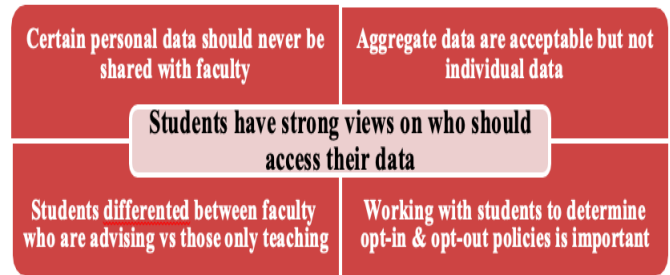
Fig. 4.   Recurring Topics on Theme 1

Students usually leave their student ID numbers and personal health information on their desk. Other school officials likewise emphasized the critical need of students having direct control over their personal information. As one of the students put it:

Even some students who want to help others may feel timid about telling everyone everything they know. Not everyone knows everything that they should know. As a student, it is one's job to complete such work. – [Student 7]

As a result, students felt more comfortable with the learning dashboards, since they could decide whether or not to engage in each area as well as have the ability to protect their data:

The attribute of enabling data to exist even when a student does not participate is what we mean by universal access. It's useless. Nobody would care, though. – [Student 2]

Several students presented ideas on academic-specific data that faculty members could have access to, and the scenarios in which they should not. One student was a little more cautious:

For that reason, the faculty member must determine whether or not to provide access to the student's information. I don't know who asked for that. You may not want faculty members to view you as biased or stereotyping since their evaluation of you will not be unbiased or based on earlier or other work. that's Nevertheless, instructors are constantly present, and their obligation is to know about all aspects of educational pursuits. In order to ensure such data is freely available to others, they require access to it. – [Student 8]

Students also agreed that when serving as a faculty member in an advising position, the academic data must be available, but not if serving only in a teaching capacity. Thus, this study also collected alternative data access ideas from students depending on their intended use of the data. One student commented:

This faculty member is actually aware of varied opinions in the department yet will approach the issue from a different perspective. They utilize it for what purpose? The point is, when undertaking study, everything in life becomes a single million dots arranged in a row that is why it really makes no difference to me. They're just doing so if it's a teacher, and they just want to see if she's completely incompetent in all of her courses or just this one, or whatever the reason is they want to know. – [Student 13]
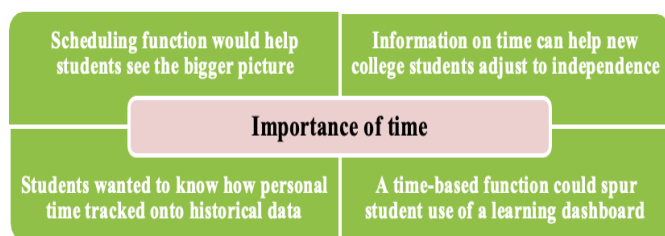
Fig. 5.   Recurring Topics on Theme 2

B. Importance of Time

As seen in Figure 5, many students appreciated a dashboard's ability to measure time and set schedule goals as part of their overall value. Students who use the dashboard's scheduling tool may avoid the temptation to focus on their particular classes. One of the kids described it in these words:

Two days after you have a test in three different classes, you have another test coming up. No, you don't consider how you approach every piece of content nor examination. You think just about yourself and how to pass. – [Student 5]

The topic was likewise brought up by other students and how smartphone alerts could be used to assist them stay on top of deadlines and other appointments. Email dates and times in the curriculum or course materials are needed to be imported into a calendar program automatically. Students also had to examine how their time on tasks stacked up against that of their peers', along with previous data, and statistics that account for past performance. Informing students about these interrelationships might increase their metacognition and enable them to control their own learning processes. When presented with previous student achievement data, a student reported that the information aided him in understanding lecture topics better. Many students felt that it was useful to have this data available in a form that was accessible through a dashboard. To that student, it looked like a good opportunity to locate aid partners.

I'm wasting time if my classmate spends half an hour on a project and I dedicate twice as long. My animals are giving away my time as though it's theirs to spend. Since that is the case, if I am the one waiting for something for 30 minutes, I would assemble a group with the other party members and speak with them about the reasons I am waiting for so long, as well as gaining their point of view on stuff. – [Student 1]

In contrast, another student considered class averages to be only moderately useful, if used at all:

In that regard, my sole question is how long it takes for the full class to complete the assignment. To my mind, anyone else's time spent on it will be an inaccurate gauge of where I'm at in terms of how far I must go on the project and how much time is required. Even if someone can describe in great detail how much time is required to complete a task, I will still remain doubtful. – [Student 12]

Students, who were just a year into their studies, commented that a dashboard could assist with their transition, especially in regards to how they're studying and living on their own. A dashboard that collects information that might be used to help

individuals make time-management decisions initially resulted in a long wait for their implementation. One student noted:

To keep things simple, I'd like to see how many people have recently used the gym's entrance so I can see if it's too busy. If you want to know if your washing machine and dryer are both full, you should also know if the washer and dryer are both full. Only one is not enough. – [Student 9]

Other student expressed similar opinions, for example, "*it will be easy to determine how long it will take to arrive using the schedule*" [Student 2] and "*what buses are arriving, you can easily figure out how long it will take to arrive using the timetable.*" [Student 9]. The researchers noted that each set of students included time-based elements in their designs during the design section of the PD session. Originally, the analytics dashboard was not meant to give a feature like this. However, during the PD session, it was recommended as a way to bring students to the platform. This means that faculty members being capable of leading students to the dashboard should be a critical component of its effectiveness.
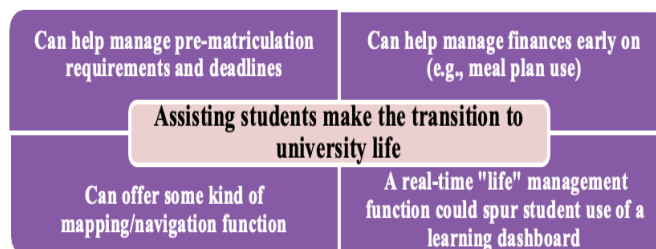

Fig. 6.   Recurring Topics on Theme 3

C. Assisting Students Make the Transition to University Life

To make university life simpler, a dashboard was proposed as a possible teaching and learning analytics application (Figure 6). When students were encouraged to make "life" proposals to assist them move on from high school and live in college with their parents, they offered a wide range of ideas. One student was quoted as saying that a single dashboard could have come in handy when applying for admission prior to registration time:

No checklist I found was truly adequate. That was rather disheartening because I was clueless. I wanted to make sure I didn't miss anything, so I was jumping around to see if each item had a due date. – [Student 13]

This may be an essential approach to help students recognize the benefits of dashboards later on for learning-related tasks. Students discovered numerous dashboard applications to assist them with transitioning to university life after they arrived on campus (e.g., building locations). Students stated that they found it difficult to stay on track with their eating plans because there was no accessible place to go to get the necessary information.

Other than that, I had no issues with your menu. In short, I had a single lapse, like skipping steak every day. When I headed to the dining area, I visited a smoothie shop. Geez, geez, geez, geez, geez, To get to this conclusion, I needed to know how much 150 pesos costs each day. Didn't that disappoint you?" In October, I only had 75 pesos because I had to spend 150 pesos every day. – [Student 8]
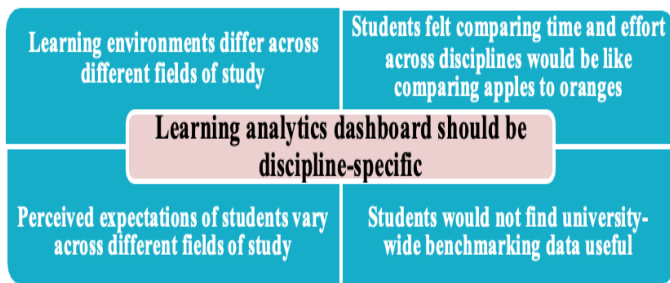
Fig. 7.   Recurring Topics on Theme 4

D. Learning Analytics Dashboards as Discipline-Specific

Students who took part in the discussion stressed the need of creating an analytical learning dashboard tailored to academic degrees (Figure 7). For many participants, it was obvious that the learning context and students' expectations of academic rigor were different. When speaking about the comparison of students from different colleges, one student noted that "*I could not say that I believe I could measure up to that comparison*" [Student 10]. Another student echoed the sentiment, saying:

> *You may want to compare yourself to others in your major when it comes to evaluating your strengths and weaknesses. That is why I say that, since it inspires me to do better than that student (when compared to myself). – [Student 9]*

Another student also carefully noted:

> *Although I don't want to downplay my friends' majors or their work, you can see how well they're doing compared to what I'm doing here, in IT education programs. The fact that their data is different implies that I may assert that their data is different. It's the reality. – [Student 3]*

Participants focused on describing academic disciplines as they spoke about the leisure time they had and how a dashboard may be useful to organize and manage their time outside of class. Students also believe that it is vital to have learning dashboards that enable data benchmarking available for different academic areas to be valuable. One student compared their major:

> *To be honest, in our course, there will be far more work and time required than in any of the other majors, so it's hard to evaluate how much free time we have. – [Student 17]*

For such reason, teachers attempt to lessen the activities by employing different strategies such as cooperative learning [18]. This is to ensure that students have the support especially when the topic is difficult. Others used interesting pedagogy like game development [19] to make the class more interesting.

V. Conclusion

This study proposed human-centered design strategy using the PD approach in creating a learning analytics dashboard for online education. Rather than trying to establish a framework for students, this approach collaborates with them to craft a solution. With this technique, learning analytics dashboards will be made easily and their utilization may be sustained over time. Students in our pilot PD session shared with us what they perceive to be necessary features that must exist in these dashboards, and our findings indicated these features. By discovering several themes

of qualities that students expressed, the researchers showed how a human-centered design approach yields innovative insights. Among the topics were: 1) students are strongly committed to knowing who should have access to their data, 2) significance of time, 3) support students in their transition to university life, and 4) learning analytics, dashboards should be discipline-specific. Students were vital to this process during the initial PD session.

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