Assessment Innovation in Higher Education by Integrating Learning Analytics

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***Abstract*—With the rise of social networking sites and the arrival of an open education era characterized by Massive Open Online Courses MOOCs, learning is undergoing a paradigm shift which requires new assessment strategies. The boundaries between what we know, how we know it and the ways we assess and evaluate knowledge in formal and informal settings are now blurred [1], [2]. In these environments, students often interact with one another to produce and reproduce knowledge and transfer it into a new context to reach a mastery level of learning [3]. The massive amount of data being generated by learners makes it easier to assess performance than ever before [4], [5]. Every learner action is logged and factored in as a source of evidence to contribute to the overall learner assessment both from a summative perspective, and also in a formative way where immediate feedback is actionable. The integration of learning analytics tools and machine learning techniques can facilitate the process of assessment. In this paper we present a case study to show how the integration of learning analytics benefited learners and improved their performance in an online educational course at the University of Illinois Urbana-Champaign, while also holding them accountable for their own learning. The study utilized a survey method for data collection and quantitative and qualitative data analysis to interpret learners' experiences after taking the course.**

***Index Terms*—assessment, learning analytics, big data, e-learning**

I. Introduction

Assessment in higher education has been a controversial topic since its inception and the adoption of formal assessment instruments in the late nineteenth century. Educators use assessment instruments and collect assessable artifacts that will provide evidence to evaluate and report the learners' academic achievement at a particular point in time, usually the end of a learning sequence, assigning a numeric value that often translates to a alphabetic grade. This methodology often distributes grades across a "normal," bell-shaped distribution curve, assuming that about half the learners are average achievers while the other half to be divided into high and low achievers [3]. This assumption is based on the premise that academic achievement and learner intelligence are directly related, thereby predestining a number of learners never to achieve a high grade. This assessment and grading system to a large degree alleviates the educators' task of having to identify, measure and report against defined learning achievements. Some employed verbal descriptors of grading levels, others opted for a crisp pass/fail methodology, while others deemed short narrative reports sufficient to document learners' achievement [6].

These assessment processes and grading systems have since turned out to be one of the most controversial topics in higher education. A lack of consensus in best assessment practices and a wide variety of grading techniques employed have a great deal of uncertainty in higher education institutions as to how best to evaluate learners' academic achievements, intellectual progress, and skills mastered. Particular problems arise when it comes to higher level cognitive abilities like critical and creative thinking [3].

As an alternative, we have been developing and evaluating an embedded assessment system where each piece of effort, minor or insignificant as it may seem at the time and in isolation from others, counts towards overall learner academic achievements. Every artefact, comment, post, contribution, whether originally authored, curated, or referenced, contributes to the bigger picture. Every data-point that is semantically legible and that has been generated by the learner influences and has an impact both on formative academic assessment and final grade based on summative data. The collection of such learner-generated data produces massive amounts of information that is today referred to as "big data" [7]. These in turn can be processed through specifically-developed learning analytics tools to extract valuable information related to the work performed by the learner.

This paper is organized as follows. The next section reviews the literature related learning analytics especially in light of the changing higher education sphere. We argue that new and transformative ways to assess learners, especially in the e-learning domain. This leads to Section 3 where we present a case-study based on the e-learning environment that we have been developing and

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researching. Grounded within new learning theory [8], the CGScholar environment has been purposely developed to effectively take advantage of e-learning affordances that take into account all learner-generated data to deliver a formative assessment as well as a summative overview of progress. The next section goes through the analysis of the data from the case study as we evaluate quantitative and qualitative data in an effort to shed light on the entire process. We also take into consideration the learners' feedback in relation to the use of the environment as a means to collect their data and generate an assessment through the learning analytics tool. The paper comes to a close with evaluative considerations while drawing conclusions regarding the use of big data and learning analytics. Insights about future research will also feature as the feedback provided by the learners turned out to be instrumental and essential within our research methodology.

II. Literature Review

The ubiquity of technology innovations we witness in our everyday life from smartphones, wireless connections, digital media apps, online learning models such as MOOCs and big data bring an urgent need to rethink assessments for the of 21st Century learners. Assessment has become an increasingly pressing educational priority to measure learners' performance and assess teacher and school accountability in K-12 and higher education settings alike. Often times, summative assessment has predominated, at the expense of formative assessments. It is important to distinguish between these two approaches to aim for innovative assessments.

As Cope and Kalantzis [6] put it, "summative assessment is retrospective assessment of learning, typically a test at the end of a unit of work, a period of time, or a component of a program". As a consequence, this mode of high-stakes standardized testing puts both students and teachers under pressure to pass the examinations, but not necessarily assist in making sense of learning and knowledge construction. In this mode of assessment, teachers are worried about how to help students pass the exam and in turn students become traumatized by the stresses such high stakes hurdles [9]. Furthermore, the meaning of these assessments is limited to a one-time assessment measuring some facts and abstract ideas that have been memorized or procedures faithfully re-applied in order to generate a correct answer. In this context, students are framed as knowledge consumers and rigid replicators of processes, rather than knowledge producers, or flexible real world problem solvers [10], [11].

Effective assessments should focus on students' progress as they produce knowledge through ongoing activities until reaching mastery level of learning. This should also take into consideration potential differences in their learning pathways, tracked via the process of formative assessments [3], [8]. "Formative assessment is assessment during and for learning, providing feedback to learners and their teachers which enhances their learning" [6], p. 207]. A key aspect of formative assessment is to offer recursive feedback from multiple sources such as learning analytic tools, crowdsourcing peer judgment, teacher feedback, as students themselves produce knowledge step by step throughout the course [12].

To innovate assessments, we need to take advantage of big data and learning analytic tools. These collect and analyze tremendous amounts of data generated and recorded related to learner behavior. Learning analytics can be used to make sense of these data, tracing the ways in which students learn and what they do in an online platform and how to direct them to achieve their mastery level of learning, while holding them accountable of their own learning with the support of instructors [5], [7].

Recent developments in these tools have included adaptive and diagnostic testing, the use of natural language processing technologies in assessments, and embedded formative assessments in digital and online curricula. As a consequence, formative assessment is becoming much easier than before, and with this, the capacity to assess performance in meaningful and equitable ways. Integrating machine learning tools allows feedback to become instant, ubiquitous, more accessible, recursive and meaningful for all learners to advance at their own pace and develop a mastery level of learning [6].

An example of using learning analytics tools to promote better performance in higher education level is seen in CGScholar platform which we will discuss below in more details. This paper presents a case study of integrating learning analytics in an online course to innovate and improve assessments in higher education settings.

III. The Case Study

We present here a case study of a higher education course in the College of Education at the University of Illinois, Urbana-Champaign. The targeted course addressed issues of pedagogy and it was taught in 58 graduate level students during the first 8 weeks of the Fall semester 2018.

The main course structure includes weekly Updates (like blog posts based on the topic of the week) created by users in a place called "Community." Learners need to comment each week on their peers' Updates and on the Update of the instructor with the various topics, which is distributed in the beginning of each week. Finally, the course requires students to create two multimodal Works (one theoretical, the other practice-oriented) that are peer-reviewed and revised before the final submission and review by the instructor.

The peer reviews are based on rubrics, that are created by the instructor, and guide students both in the requirements of their Works, but also in the reviewing process of peer Works.

The design and delivery of course were based on the social learning platform CGScholar (Fig. 1), created by Dr Bill Cope and Dr Mary Kalantzis. The theory that supports the functionality of this platform is termed "reflexive pedagogy." This is a pedagogy that addresses the needs that education presents in the contemporary

society, where learners need to be active participators of the learning process and knowledge producers, instead of passive consumers [12]. Through this lens, knowledge needs to be created collaboratively, based on learners' interaction. The web-based learning environment makes extensive use of social collaborative skills that learners are encouraged to adopt throughout their course of study as they join dedicated communities, posting updates and following the activities of their peers as well as their instructors. This rich environment also allows learners to provide feedback through social-media like comments together with generating knowledge through a typical online editing console.

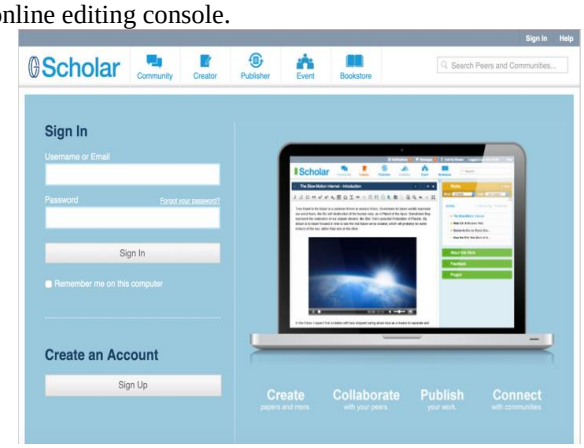

Figure 1. CGScholar interface.

Reflexive pedagogy in online environments is constructed with a view to optimizing the use of seven affordances of the digital, introduced by Cope & Kalantzis [12] as follows:

- Ubiquitous learning (learning anywhere, anytime),
- Active knowledge making (learner as knowledge producer),
- Multimodal meaning (multiple digital media used in texts and representations),
- Collaborative intelligence (peer-to-peer learning),
- Metacognition (thinking about thinking),
- Differentiated learning (addressing all students' needs),
- Recursive feedback (formative and constructive assessment).

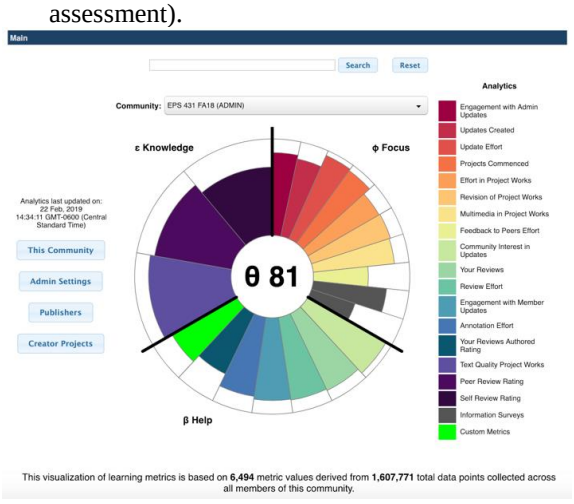

Figure 2. Aster Plot – Learning analytics tool of CGScholar

This paper is centered around recursive feedback and its realization in CGScholar. To provide students with constructive feedback during the process of learning, the aforementioned platform utilizes Learning Analytics, which refers to "the measurement, collection, analysis and reporting of data about learners and their contexts, for purposes of understanding and optimizing learning and the environments in which it occurs." [5, pp. 252]. This process in CGScholar is realized through a visualization application that is an the form of an "aster plot" (Fig. 2).

The platform gathers millions of data points for every single activity that students do in the course and these points are analyzed and displayed to students in the aster plot. Thus, every time a student does an activity in the platform, for example the creation of an Update, the Aster Plot shows that information.

The way this diagram is constructed corresponds to the principles of reflexive pedagogy with its measures of Knowledge, Help and Focus. Each of the petals represents a kind of task that students have to achieve in the course. In the middle of the aster plot, there is an average score of all the points the students gather through their various activities. By giving the opportunity to learners to have an instant visual representation of their progress in the course, the platform shows them how their learning is evolving and what more they need to do to improve. This is feedback that comes continuously during the course, rather than at the end of it.

IV. Data Analysis

A. The Quantitative Analysis

Twenty-three participant answered the survey out of 30 enrolled students. Below are the results from three survey questions expressing students' opinions using the learning analytics tool to improve their performance, which was used in this course.

Q1: I felt that the analytics Tool in CGScholar gave me useful information about my progress in the course.

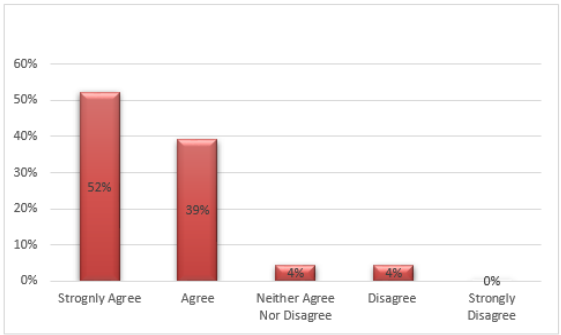

Figure 3. Level of agreements regarding the use of learning analytics to provide useful information students' progress.

Findings have shown high level of agreement among students that the learning analytics tool was helpful to provide information for them to know where they are in the learning process and where they need to be to master learning. On average, 52% of the students were in strong agreement and 39% of them were in agreement with this

statement. Only 4% of the students did not agree with the usefulness of the learning analytics tool (see Fig. 3 above).

Q2: The analytics tool in CGScholar motivated me to contribute more than the requirements indicated.

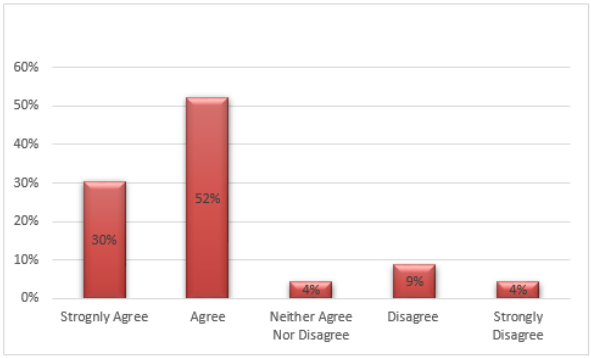

Figure 4. Level of Agreements regarding the use of learning analytics for motivation purposes.

Results indicate that nearly 82% of the survey respondents agreed that the learning analytic tool has motivated to a higher level of learning beyond their intended educational goal. Only, 13% of the students were in in disagreement with this statement (see Fig. 4).

Q3: I am more motivated by courses or study materials that allow me to work at my own pace.

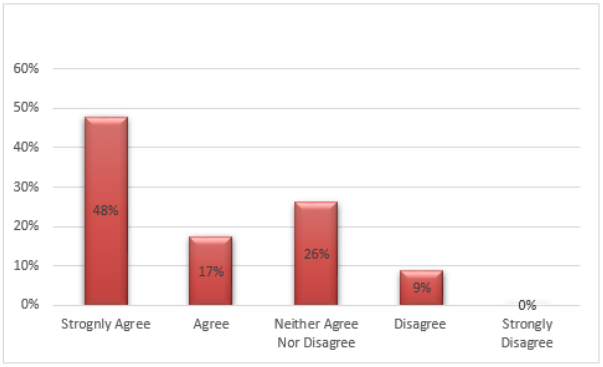

Figure 5. Level of Agreements regarding the use of learning analytics to optimize educational experiences.

Moreover, students reported a high level of agreement in regard to the potential benefits of this tool to optimize learning according to their needs and time availability. As it appears in the data analysis in Fig. 5, nearly 65% of the survey respondents were in agreement with this valuable feature of the learning analytic tool. Only, 9% were in disagreement with this statement and 26% of the students had a neutral opinion, neither agreeing nor disagreeing.

B. The Qualitative Data Analysis

In addition to the quantitative analysis, this study incorporated qualitative analysis of the open-ended questions of the survey. The purpose was to provide a comprehensive analysis of students' experience using the learning analytics tool embedded in the software CGScholar that was used to facilitate the process of learning in the course. Data analysis of this section have shown why students like this tool. Also, students indicated some concerns and challenges that can be taken into consideration to improve this tool in future courses.

Here are some quotes of students' responses regarding their experiences of using the learning analytics tool. One of the students commented: "[This learning analytics tool] *made the grade I earned in the class my responsibility and highlighted routes for how I could improve*." A second respondent wrote: "*I enjoyed the analytics. There was an easy way to see accountability on what I have accomplished and what I needed to continue to do to achieve the score.* " A third student added: "*It was a big motivating factor to me to make sure I'm on track regarding all the updates/works/comments. It works like gamification element and makes me looking forward to 'level up' and fill all the petals*." A fourth student responded: "*I liked the analytics area because it allowed me to see how I progressed through the course as more assignments were completed. The fact that I was able to see my grade continuously improve let me know that I was achieving the goals of the course*." A fifth one mentioned: "*The analytical area was a great way to know where I was and what I needed to do through the course, instead of when it's too late.*"

While most of the students valued the analytics tool in CGScholar, some others have indicated issues of concerns associated with understanding how to use it at the beginning of the course. The phrase "*It was confusing at first*" was used by only five of students in the open ended question that we analyzed. Understanding this concern is significant to improve the tool in future courses or provide additional user instruction and support.

V. Conclusion

In this paper we have attempted to discuss the needs of new assessment to transform teaching and learning in the era of big data and learning analytics. We presented a case study from an online course at the University of Illinois Urbana Champaign to show how both big data and learning analytics can be integrated in an online learning platform to produce immediate feedback to learners, so they are aware of their progress and what to do to achieve mastery level of learning while proceeding at their own pace. Although this is a work-in-progress study, data analysis from the survey revealed interesting and promising results regarding learners' experiences using the analytics tool. This study suggests that big data and learning analytics have the potential to improve assessments and optimize learning for all learners in online educational environments. Future research will include additional courses from various disciplines, including medicine, veterinary medicine and engineering to have a better understanding on how big data and learning analytics tools work in different contexts, and if there is any similarities or differences from learners' perspectives.

Conflict of Interest

The authors declare no conflict of interest.

AUTHOR CONTRIBUTIONS

Samaa conducted the research; analyzed the data; wrote the literature review; the data analysis section and the conclusion. Anastasia presented the case study and the platform we used in this paper. Kerasto conducted the quantitative data analysis, Matthew wrote the introduction and edited the paper. Both Mary Kalantzis and Bill Cope both have reviewed and edited the paper. All authors had approved the final version.

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