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Research paper

Demystifying Learning Analytics in Personalised Learning

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Abstract

This paper presents learning analytics as a mean to improve students' learning. Most learning analytics tools are developed by in-house individual educational institutions to meet the specific needs of their students. Learning analytics is defined as a way to measure, collect, analyse and report data about learners and their context, for the purpose of understanding and optimizing learning. The paper concludes by highlighting framework of learning analytics in order to improve personalised learning. In addition, it is an endeavour to define the characterising features that represents the relationship between learning analytics and personalised learning environment. The paper proposes that learning analytics is dependent on personalised approach for both educators and students. From a learning perspective, students can be supported with specific learning process and reflection visualisation that compares their respective performances to the overall performance of a course. Furthermore, the learners may be provided with personalised recommendations for suitable learning resources, learning paths, or peer students through recommending system. The paper's contribution to knowledge is in considering personalised learning within the context framework of learning analytics.

Keywords: *learning analytics; framework; personalised learning.*

1. Introduction

In recent years, there is a change in the way students learn, as the emerging connected learning pedagogies [1][2][3] suited online learning and improved the learning experiences of students. As a result, it reduced the need for direct involvement of teacher [4]. Online learning has changed the ways in which education has been conducted [5]. Online learning is also known as e-learning, and having the majority of the people on this planet being aslightly addicted to their devices. Online learning and blended learning have been increasing and being more personalised. Blended learning can be characterized as the blend of many approaches to pedagogy and a large variety of technology or media integrated with traditional classroom activities (face-to-face) [6][7].

In relation to ways of how blended or online learning environment can be personalised, it lays on the values of personalised learning by putting the learner at the heart of the education system [8]. Personalised learning shifts the role of students from being simply a consumer of education to a co-producer and collaborator of their learning pathway [9]. For a student, personalised learning actively engages students in the process of learning, leading to improved learning outcomes and learning experiences. For institutions, it enhances their reputation as one that values and supports individual student's learning [10]. Personalised learning is a three-part process, which include instructional planning that promotes deeper student learning; understanding of each student's learning needs and interests; and provisioning of appropriate learning experiences that match each student's unique learning profile [11].

Learning analytics is receiving increased attention, in part because it offers to assist educational institutions in increasing students' learning retention, improving students' learning success, and easing the burden of accountability [12]. By using learning analytics and optimizing it in the learning environment, tutors for example, can predict the students' future performances in their study courses [13]. Learning analytics are distinguished by their concern in providing value to learners, whether in formal, informal or blended settings [14]. Principally, learning analytics deals with the development of methods that leads to effective use of educational data sets to support the learning process. Learning analytics refers to the application of analytic techniques to analyse educational data, which includes providing data about learner and teacher activities, identifying patterns of behaviour and providing actionable information to improve learning and learning related activities. It is used by educators to obtain insights and optimize the learning processes of their students. Learning analytics is the third wave of large-scale developments in instructional technology that began with the advent of the learning management system [15].

2. Personalised Learning: A Summary

With regards to personalised learning, the use of the term personalised learning dates back to at least the early 1960s [16]. Within earlier era, personalised learning is often depicted as a one-to-one tutoring system with a teacher being assigned a small group of students. As such, it remains for many a privileged system of tutoring [17].

In a more recent definitions and application, it indicated variance, which may be due to the applicability and extension of personali-

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zation, especially through the usage of technology. Information technology can modify the style of teaching [18]. Jenkins and Keefe [19] defined personalization as a way for educational institutions' efforts to in considering students variants needs and characteristics within the teaching and learning process. In addition, it focuses on the usage of "*flexible instructional practices"* in order to further facilitate their personalization endeavours. On the other hand, a more technologically inclined personalization may be as defined by Chatti et al. [20], focusing on the usage of algorithm within an online system in order to personalize students' learning experiences, based on, among others, their needs, learning preferences and available online materials. Finally, in 2010, the U.S. Department of Education published the definition in the National Educational Technology Plan, whereby personalization refers to instruction that is paced to learning needs, tailored to learning preferences, and tailored to the specific interests of different learners. In an environment that is fully personalised, the learning objectives, content, pace as well as the method may all vary [21].

Sampson, Karagiannidis and Kinshuk [22], indicated that there are a number of personalization parameters that needs to be considered, including the students' requirements, abilities, schemata and interests. The learning should not be time bounded and ideally, focuses on the progress of individual students. As it reduces teacher-centredness, it is anticipated that the learners are self directed as well. Focusing on the online variance of personalised learning, the extent of technological use influences its usage and functions within the learners' learning process. To illustrate, ChanMin Kim [23] demonstrated how the usage of VCA or virtual change agents assisted students personally in driving students' motivation in attempting their remedial mathematics course by providing motivational responses throughout their learning process. There are also other experiments, involving usage of adaptive hypermedia tool; and web-based learning system [24][25]. While LMS and MOOC is not traditionally considered a personalised learning environment or platform, the advancement of INTUITEL, study conducted by Henning et al. [26] indicated of the possibilities of these media to be more personalised through added technological dimensions.

In a more advanced side of personalised learning is the PLE, or personalised learning environment. Multiple studies has been done relating to it, including the usage of Personalised Visual Narratives to enhance students' learning engagement [27]; the use of Concept Maps in PLE to subdue students' learning difficulties [28]; the use of PLE to advocate learners' empowerment towards their own learning process and progress [29] and the use of microcredentials offered in PLE for teachers' professional advancement [30]. An element that should be noted is within the technologically inclined personalised learning environment, there is a need to monitor the students' details and progress, which becomes the main function of learning analytics.

3. Defining Learning Analytics in Personalised Learning

The term learning analytics came into use in 2009 [21]. Siemens and Gasevic [31] defined learning analytics as a specialty area whereby it focuses on students' data, in terms of collecting, analyzing and reporting in order to understand and improve the learning experiences to an optimum level. While the use of analytics and data analytics is relatively new in education, in the past, this was typically driven by the needs of the education sector to support data-driven decision-making and planning [32]. Learning analytics are defined by the Society for Learning Analytics Research (SoLAR) as the measurement, collection, analysis and reporting of data about learners and their contexts, for understanding purposes and optimizing learning and the environments in which it occurs [33]. Learning analytics is also related to academic analytics. The term academic analytics was first described by Goldstein and Katz [34]. In contrast to learning analytics, academic analytics focuses on the improvement of organizational processes, workflows, resource allocation, and institutional measurement, through the use of learner, academic, and institutional data. Academic analytics also helps address the public's desire for institutional accountability with regard to students' success, given the widespread concern over the cost of higher education and its challenges in terms of economic and budgetary conditions, which is prevailing worldwide compassionate based learning enhancement [35]. By replacing academic with learning, the definition of academic analytics could also be used for learning analytics.

However, learning analytics is more specific than academic analytics, focusing only on the learning process and service learning engagement [36][37]. At academic institutions, learning analytics concentrates on data relevant to students and instructors at the level of the individual learner or course and on using analytic techniques to improve students' learning outcomes by targeting better instructional, curricular as well as supporting resources, interventions and learning culture empowerment [38][39][40]. Learning analytics empowers learners to understand the wealth of data related to learning [41]. The idea of learning analytics provides a new model for college and university leaders to improve teaching, learning, organizational efficiency, and decision making and as a consequence, serve as a foundation for systemic change. Learning Analytics allows stakeholders to understand and apply the use of intelligent data, learner-produced data, and analysis models in order to discover information and social connections, and to predict and advise on learning [42]. Learning analytics mainly intends to help teachers and students to be involved based on the evaluation of educational data [43]. Learning analytics places a greater emphasis on the qualitative data that originate from learning behavior [44] while analyzing quantitative metrics.

In a personalised learning system, pursuing many study paths can give students the interest and engagement that will support higher levels of learning in the basis of counselling service to enhance learning culture [45]. Students can acquire competencies by tapping into resources both in and outside of school with an innovative learning environment [46]. Broadened learning openings, for example, apprenticeships, group administrations, autonomous examinations, online courses, entry level positions, performing gatherings, and private guidelines and also double enlistment programs, offer students the chance to fabricate authority toward abilities in ways that match their styles and premiums as guided, observed, and surveyed by educators with an innovative teaching adaption [47]. Group based, work-based, and benefit based learning not just give students a road to exhibit learning in true settings, however students likewise have genuine chances to have any kind of effect in their neighborhood, state, national, and worldwide groups. However, personalised learning is still of value as it is a promising path to differentiate learning for all students and as such, prepares them for college, career and community in the 21st century [48].

In a system that values personalised learning, students play an increasingly active role in designing their own education path as they develop and mature, while being held increasingly accountable for their own learning success [49]. Personalised learning increases motivation and engagement by encouraging students to take charge of and design learning experiences that are meaningful to them to engage into sustainable learning with traditional wisdom [50]. Educating with creative quality [35][47] and familiarity with watchful abilities transmitted into the setting of higher education [35][45]. Personalised learning aims to build a profile of each student's strengths, weaknesses, and pace of learning, similar to how learning analytics monitors student performance, looking for patterns likely to predict how students will fare, and customize educational experiences and support accordingly. For the scope of this research, learning analytics can be used to scaffold personalised learning and make it feasible to embed at the mass scale required within a higher education institution [51].

4. Learning Analytics in Personalised Learning

Educational data is the foundation of learning analytics process and learning is an iterative process that results from an active participation in a self-guided and externally supported process. Learning analytics is a multi-disciplinary field involving machine learning, artificial intelligence, information retrieval, statistics, and visualization [52]. According to Suthers [53], learning analytics is an emerging field that combines the areas of computational sciences and education, using computational techniques to capture and analyse data from within the learning environment. Learning analytics have been used for a range of applications, for example Purdue signals for student retention [54, LOCO to provide educators with feedback on students' learning activities and performance [55], and LASyM to analyse students' behaviours with the intent of increasing the impact of analytics on teaching and learning in such environments [56]. However, predicting students' learning success and providing proactive feedbacks have been two of the most frequently adopted tasks associated with learning analytics [57].

Personalised learning and advancements in technology have the potential to empower students to take greater ownership over their learning and to empower teachers to personalised learning based on individual students' needs. The concept of personalised learning environment has emerged as a concept in line with the Web 2.0 tools that serves to integrate essential learning outcomes such as lifelong learning and self-directed learning [5]. Personalised learning combines the how and what of learning. A personalised approach recognizes that there are still core requirements and expectations. A strong focus must remain on foundational skills, including reading, writing, oral language and numeracy. Additionally, there will still be a required body of knowledge in various subjects or disciplines. However, learning is the focus of attention rather than instruction; the focus is on nurturing curriculum based on learning preferences with the learning ability [58] and innovative teaching competencies [35][80]. The design or the curriculum and teaching cycle is set in such a way that it is not time bounded and it allows students to interact to content in multiple ways.

According to IMS Global Learning Consortium [59], there are three characteristics that is required in a technological platform innovation, which are seamlessness: focusing on the usage and integration of variable of available digital tools and resources; agility: the *plug and connectivity* of apps to educational institutions in just-in-time manner for the purpose of personalizing students' learning; and *effective investment* towards the viability and usage of technology for maximum learning impact. Due to this, IMS standards focus on the need of interoperability standards, which allows a variety of digital curriculum resources to be integrated within the educational institutions, based on the available enterprise software in a seamless manner. Through such innovation, it will provide opportunity for the students to experience personalised instruction with global connectivity [60].

Abel, Brown and Suess [61] indicated on the onset of connected learning, whereby students are in better position to personalize their learning in terms of connections, collaborations and the use or available resources. Another edge that connected learning may be able to offer it to connect what was once thought to be *unconnectable*, through the interplay of all of the educational institutions' stakeholders, and is founded through the usage of IT infrastructure as its underpinnings. Additionally, such collaboration is anticipated to grow organically, making it seems to be more natural, and requiring the students to be on the outlook and having more agility in seizing any opportunity to learn [36]. It aims to shy away from the current standardized curriculum and assessments. The use of learning analytics, is among others becomes the gateway to the attainments of these endeavours. Figure 1 shows IMS learning analytics measurement framework [62].

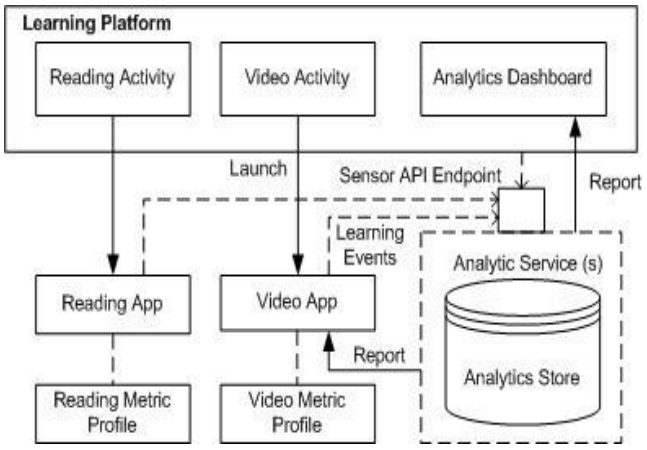


Fig.1: IMS learning analytics measurement framework (Adopted from IMS Global Learning Consortium)

The Learning Platform Administrator designs two learning devices interoperability Apps. The learning devices interoperability design URL/XML shows the Learning Platform that these Apps bolster, which incorporates a Reading and Video Metric Profile separately. The Learning Platform Administrator designs the Sensor API Endpoint URL in the learning devices interoperability settings. This is a URL gave by the Analytics Service. The URL could have an implanted API Key approving access. An Instructor includes a Reading and Video Activity utilizing the learning devices interoperability Apps, keeping in mind the end goal to include two exercises; the Instructor starts a learning devices interoperability dispatch. Amid the dispatch, since the Apps bolster IMS Metric Profiles, the LMS includes the Sensor API Endpoint URL as one of the dispatch parameters. The App gets the Sensor API Endpoint as a major aspect of the dispatch and stores this for sometime later. A student begins getting to a course in the Learning Platform and as a component of the assignments starts utilizing the Reading and Video. Amid this utilization, the student plays out a few run of the mill activities, for example, Reading a page, Highlighting an area, Adding a Bookmark, Viewing the video, Taking a note on the Video at a specific time amid playback. The learning devices interoperability Apps record the student's activities. Since the Learning Platform gave a Sensor API endpoint amid dispatch, each App begins presenting Learning Events on the Sensor API endpoint. The Analytics Service is an intermediary for a commonplace devouring administration for measurements caught and marshaled by means of the IMS system. The investigation Service records the Learning Events to its store and underpins and gives more definite examination of the measurements to yield higher request usefulness, for example, dashboards, suggestions/alarms, versatile sequencing.

A personalised learning system uses assessment to guide learning. Figure 2 indicates the function of learning analytics within personalized learning environment. These assesments will prompt the arrangement, understanding, creation, or conclusion and the clarification or avocation that prompted the outcome. Developmental and summative assesments are a piece of a characteristic learning process as students turn out to be more responsible for what they realize, when they learn it, and how they are showing what they have realized. Developmental evaluations give data to students and instructors about the students' present execution in connection to a learning target. This is of significance, with the goal that suitable instructional changes can be made. In a personalised learning framework, developmental assesments are intended to uncover singular student qualities and shortcomings so as to make and alter an arrangement for progress. Summative assesments give data to assesments, their families, and staff of the assesments' authority levels in connection to given capabilities. By and large these assesments happen toward the finish of a unit, or course [63].

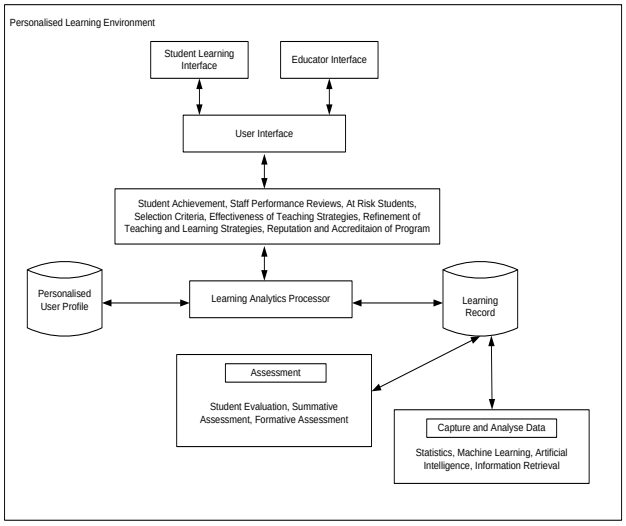


Fig.2: Learning analytics in personalised learning environment

Student learning is positioned as constant in the personalised learning environment, with time positioned as a variable resource in support of the personalised learning process. Data and data systems allow for historical student data and formative data for teachers to use to differentiate for each student. The student and the teacher regularly discuss feedback, progress, and next steps as they both demonstrate commitment to learning and growth [43]. In addition, user interface provides a user friendly and adaptive interface for communicating with learner and educator. User interface generate reports and dashboards using a drag-and-drop interface and a rich library of visualizations and chart types. The results are published and distributed in PDF, Word, Excel or Power Point format. Reports are automatically updated when data is refreshed. The analysis of data collected from the interaction of users with educational and information technology has attracted much attention as a promising approach for advancing our understanding of the learning process. The initial value of learning preferences with interaction [64] to give insights into innovative learning environment [65] has to be involved with the assurance of measurement process [66] in incorporating the diagnostic procedural stage [67]. In particular, this initiative refers to enhance the learning expertise among the students [68], in trying to give then the chance in urging to achieve the civic based leadership within the service learning [69] through maximizing the learning resources together with learning environment [70][71]. Moreover, the social concern in sustaining the learning outcome [72][73] should be engaged with digital application of guidelines in driving the technology adoption [74][75][76]. In this view, the potentials of personalised learning will give insights into collaborating with the learning achievement through expanding accentuation on capabilities. In terms of accommodating the abilities together with information in creating the way of circumstances, the learning could be combined with skillful adoption in the sense that can be explored into the stage of considering critical thinking assigned with computerized proficiency. As a result, both individual and social level in incorporating the entire duty is applied through consolidating the level of creative imagination advancement in looking at in a whole on social comprehension [77][78]. Both self-coordinated and self-guided learning [79][80] together with comprehensive learning [81][82] associated with ethical competence [83] should be achieved in entire look into the powerful inclusion towards the stage of conditions on personalised learning with professional and ethical balance in creative learning.

5. Conclusion

Learning is really a lifelong journey. Learning happens in sustainable educational programs. Personalised learning models encourage all students to grow to their fullest potential and leave school prepared for meaningful futures. In personalised learning framework, personalised learning approaches concentrate on reinforcing the sudents' learning procedure by urging students to effectively partake in encouraging a solid learning condition, fortifying associations with grown-up partners, getting to be plainly mindful of their individual adapting needs, and recognizing and applying learning methodologies that work best for them. Personalised learning perceives that no two students learn similarly or at a similar pace. Be that as it may, with personalised realizing there will be expanded accentuation on capabilities. By applying their abilities and information in new, frequently interdisciplinary circumstances, students will create skills, for example, basic considering and critical thinking, joint effort and administration, correspondence and computerized proficiency, individual and social duty, imagination and advancement, and worldwide and social comprehension. Powerful personalised learning conditions give apparatuses and learning assets that students use in self-coordinated and self-guided learning. Moreover, student engagement and freedom are the center objectives. Incorporated and drawing in learning investigation devices can increase information obtaining, aptitude advancement, and whenever utilization of learning in extensive assignments. Adjustment to the pace and teaching method would expect access to substance and apparatuses for adapting, anyplace, and on any gadget. The structure thought of learning examination gives a model to enhance instructing, learning, authoritative proficiency, and basic leadership and as a result, fill in as an establishment for fundamental change. This implies the learning procedure is centered around the requirements, qualities and yearnings of every individual student. As the framework esteems personalised learning, students assume an undeniably dynamic part in planning their own training way as they create and develop, while being considered expanding responsible for their own particular learning achievement.

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