Personalizing Learning with m-Technologies to Improve Students Performance in South African Higher Learning

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Abstract— **Personalized Learning (PL) is recently being endorsed by higher institutions of learning as a strategy for improving students' engagement and academic attainment. Although existing PL technologies offer some flexibility, there is still room for further innovation to extend this learning support. However, PL still lacks fully adaptive and timely content, which can enhance their flexibility further. Often times instructors are faced with a challenge of giving students attention in the undergraduate courses. This limitation is a consequence of fewer contacts sessions between lecturers and students due to timetable schedules. Therefore, it is imperative for institutions of higher learning to consider integrating PL through use of mobile devices to extend learning beyond the institution's geographical boundaries. Some theoretical foundations already exist for learning through personalisation and learner perceptions on using technologies to develop effective PL environments. However, there exists the need to develop models for mobile computing personalized learning in the African context to best suit the needs of students from the socio-economic backgrounds in support of their learning environments. The study aims to develop a mobile computing model to enhance PL for students in South African context with the aim of improving their academic performances. Content analysis was used to evaluate the factors that had been identified in the literature and were tallied according to their frequency. The results indicated that device factors that relates to technology use along with pedagogy predominantly impact on the effectiveness of PL using mobile technologies.**

Keywords- Mobile computing, Personalized learning, Technology-supported personalized learning environments, M-Learning

I. INTRODUCTION

Education in the 21s century takes into cognizance of the fact that students think differently, where their thinking is influenced by their social, cultural and technological environment [3]. This suggests that their learning is a constructive process of acting within an environment full of ubiquitous computing devices. These devices are supported by wireless communication networks, which make possible to access content anywhere anytime. Information and Communication Technology (ICT), which has presented opportunities for knowledge creation and easy access to information, has modified the conception of time and space in the learning environment. Mobile computing play an important role not only to education, but to society, and it is further making a positive contribution to other areas outside the learning spheres such as health, management, scientific research and business administration [23]. Mobile technologies lay a good foundation for expanding teaching and learning that goes beyond the confines of classroom and university campus. It further provides a platform that support student collaboration, sharing of information, and flexibility in learning if employed effectively, which can support social constructivist approaches to learning [7]. PL through use of digital resources has promoted new version of learning by tailoring learning to suit learner needs, where emphasis is on supporting the learner [21]. The combination of these two learning strategies can offer an impending educational innovation that is significant for the flexible delivery of learning content. This mix of learning strategies allows for the customization and personalization of student's learning process.

In essence, integrating mobile technologies and personalization in the formal learning will enable a learning environment that is ubiquitous where students may be leaning without even being fully aware. This will be due to the social and personal aspects of mobile devices, where the limits and distinctions between work and play, learning and entertainment, formal and informal learning are no longer relevant. This research will identify key components that contribute to the implementation of learning tailored for a specific set of learners. This takes into consideration student's learning needs, interests and preferences. More so, the study is seeking to make a contribution to higher education (HE) by combining both PL and mobile technologies to ensure that learning is made flexible, fun, and seamless with the aim of improving student's academic performances.

This study investigated the factors that impact on the effective implementations of PL using mobile technologies to improve student's learning and their academic performances. The paper was structured in a form of sections indicating a brief description of what each section entails. In Section 2, the study highlights PL background in the context HE and its impact on student's learning processes. Section 3 specifies the gaps that exists in PL environments along with the goal and objectives the study. Section 4 gives a brief literature review indicating PL in higher education, PL challenges and the opportunities it brings to academia, this is followed by related works

indicating various factors that need to be taken into consideration to ensure the effectiveness of PL using mobile technologies in HE. A buildup of a conceptual framework that underpins the study is then described concluding the section. In Section 5, the methodology adapted for the study is explained in detail followed by a table of results that identifies the key factors that are sort key to the implementations of PL environments using mobile technologies. Section 6 provides future works and a conclusion of the study.

II. BACKGROUND

PL facilitates both formal and informal education since it supports collaboration and communication between the learner and his or her instructor and between learners. In addition, PL shifts the role of students from being simply consumers of education to co-producers and collaborators of their learning pathway [21]. Through use of technologies, the style of teaching and learning can be modified to suit a group of students with diverse backgrounds and experiences [1]. More so, institutions of higher learning are able to consider a variety of student's needs and characteristics within the teaching and learning process through personalization. The emphasis of PL is on the usage of flexible instructional practices in order to facilitate students' personalization endeavors.

PL can blend different forms of learning and techniques to cater for learners who learn in different ways. The focus of PL is on the choice of what to study, how and when, whilst considering the pace at which the student learn, tailored to students' learning preferences and specific interests of different learners. Bingham et al. [6] points out that PL, powered by technology, can allow for more productive time-on-task. However, its extensions are sometimes limited by lack of resources such as internet accessibility, PCs or laptops due to their cost.

Phillipson et al. [24] noted that currently PL lacks the mobility aspect that allows learning to reach higher pedagogical level, where constructing and absorbing knowledge becomes life long, breaking the boundaries of time and space. This can be achieved if PL is designed based on mobile computing technologies and through the use of portable devices such as Mobile phones, PDA, iPads and other devices built on mobile technology.

III. PROBLEM STATEMENT

There is an increased pressure on higher institutions of learning by higher education department to meet quantitative performance targets [11] which had led to a massive numbers of students enrolled in African Universities. Often times instructors are faced with a challenge of giving students attention in the undergraduate courses [26]. This limitation is a consequence of fewer contacts sessions between lecturers and students due to timetable schedules. More so, there is lack of instructional goals that involves high levels of cognitive skills, low self-esteem among learners, and minimum opportunities of individual feedback. While ICT has the potential to provide higher institutions with such learning opportunities, its use is still limited in the SA context. As a result, there is a demand for instructors to reach every individual student by incorporating ICT interventions such as mobile technologies. To recap, mobile tools have the inherent ability to connect with information tools and communicate in a networked manner and this makes them valuable in a situated learning context [11]. There is a need for constant connectivity in order for just-in-time learning and students' collective knowledge sharing to be leveraged to promote collaboration [3].

On the other hand, studies have built theoretical foundations that address learning through personalization and learner perceptions on using technologies to develop effective PLEs [19]. However, due to PL in formal learning being a relatively new technological enhancement, there seems to be few studies that have explored this area of research [4]. As a result, little guidance has been given to enhance interactions that support extended flexibility, mobility, reachability and accessibility for teaching and learning in PL environments [2]. Therefore, there is a need for personalized learning models that caters for a specific set of learners and their supporting environments.

To solve the highlighted problem, the following goal and research objectives have to be met.

1) Goal

To design a Mobile Computing model to enhance Personalized Learning for students in South African higher learning

2) Specific objectives

1. To determine and analyse the influence of PL to effective teaching and learning of students in higher learning institutions
2. To investigate and analyse technology-based PL models for higher learning institutions
3. To investigate the determinants that influence the incorporation of mobile computing for PL
4. To develop a mobile computing model that can be used to enhance PL for students in higher institutions

IV. LITERATURE REVIEW

This section provides an overview of PL in HE, its benefits and challenges. Furthermore, it previews works that have been done in light of presenting key factors that impact the effective implementations of PL in academic institutions of higher learning.

A. Personalized Learning in Higher Education

PL extends learning through a mix of pedagogies such as student mentoring, incorporation of learners' personal and social experience, using ICT, and other learning strategies such as flipped learning. This provides learner support which reforms learning from a 'fixed content and fixed timing' concept. Accounts of pedagogies relating to PL and ML

overlap to some extent but reflect different ways of offering flexibility in the learning processes. However, their distinct difference is in the learning mode of delivery and information filtering to cater for individual needs [29]. While they both incorporate ICT tools to offer blended learning, ML with PL adds just-in-time, on-the-go learning, and easy access to PL resources due to its mobility and portability capabilities.

Ross et al. [25] supports this active learning strategy that puts the learner at the center of teaching and learning with students' independently exploring, generating, and applying ideas in and outside the classroom setting. These instructional methods have proven to show amicable improvements in student's conceptual understanding when correctly applied.

Waldrip and Vaughan [28] also highlighted note-worthy facts in their meta-analysis review of the effects of integrating mobile devices with teaching and learning on students' learning performance. They alluded to various scholars' resulting consensus that to exert maximum effect of learning with technologies in higher education institutions, there should be reconciliation of the connections between the following components: 1) technology (both hardware and software), 2) process of teaching and learning to accommodate different settings (educational context), 3) and users (both lecturers and students) [25].

B. Benefits of PL in Higher Institutions of Learning

The aim of PL is to provide a positive learner experience that is based upon information about the learner. Students have the opportunity to access services that are most relevant to their learning context which suit their interests saving them time to filter out from the vast amount of information available. PL's main objective is to address the intended 'one-size-fits-all' approach, provide support that is dependent on the student's engagement with the course material, and peer interactions [26].

Verdu et al. [27] alludes to some of the benefits that PL brings. These include increased motivation, learner empowerment, and improved attitudes to learning. PL further contributes towards sharing and developing expertise, through collaboration and networking. It produces better results through a student's personal development of better learning strategies, skills, and technological capacities. It caters for differences in learning contexts and cultures in terms of sociocultural practices in urban versus developing areas. More so, PL enable students to have the agency when making choices of what, when, how and where to learn, where control over setting their learning goals is within their reach. Learning is made flexible enough to allow students to take their learning outside the confines of the traditional classroom.

C. Challenges of Personalizing Learning

While the idea of personalization might be appealing, the reality of its implementation is much more complex. As Ross et al. [25] indicated many universities are faced with the dilemma of same content presentation in different sequence

for different students thus not serving the purpose of filtering it to cater for a diverse set of students. Hostler [14] postulates the difficulties of implementing PL especially for larger groups. This is because not only does it require training but also time to accommodate the approach in the lecturer's teaching practices. In addition, it requires restructuring of curriculum and change of teacher classroom practices. The introduction of new technologies calls for support and on-going training to address specific challenges that may arise while using PL tools and spaces. More so, with large lecture environments it is difficult to individualize the learning to ensure all students' misconceptions are addressed. Therefore, careful thought and consideration should be put forth in terms of structuring learning when applying this PL strategy to have an effective lecture session.

D. Related Work

Laohajaratsang [17] explored the use of technology to personalize learning in a study for personalized, flexible blended learning features of the Moodle Learning Management System (LMS) through mobile platforms. The study factored the following as key to the implementation of PL, change in teaching practices including instructors skills, need to develop the learning content, support staff needed to manage, inspire and support both student and lecturers, and training particularly in areas of mobile content creation and pedagogical skills.

On the other hand Callaghan et al. [8] looked at using web-based technologies as pedagogy to enhance learning. In in their findings they indicated that students' academic performance increased by 67%. They emphasized the universities' need to explore other innovative ways beyond web-based technologies that could be used to ensure seamless learning environments. Furthermore, the study identified 8 factors that can enhance learning through use of technology. These included high-performance network infrastructure, choice of digital devices and software to support the pedagogical model underlying the course, content presentation to facilitate ease of use, social interaction and human touch, flexibility and adaptability of systems to cater for learner diversity, stimulating interaction, facilitating student's learning processes, and fostering an effective learning climate, specifically in the context of African higher institutions of learning.

Pimmer et al. [23] highlighted the works of Casany et al. [9], which presented a Protus system that was built on the foundations of an intelligent tutoring system. The system recognized different patterns of learning styles and learner habits through testing their learning styles and mining their server logs as key to ensure system flexibility. By so doing the requests done by students would then be customized to suit their learning preferences thus creating a learning space that is flexible and personalized to their needs.

More so, Pimmer et al. [23] emphasized on use of gaming for computing education as another means of personalizing learning for students. Its ability to teach specific concepts and strengthen particular competencies helps students to stay focused on the learning activity while stimulating their will to achieve. However, majority of

evaluations on gaming education were ran with small samples and they lacked scientific rigor. Therefore, there is a need for further research on how to improve scientific rigor of their evaluations for teaching computing.

Studies by Verdú et al. [27] were carried out in the spheres of PL which highlighted the need for incorporating mobile technologies to extend learning flexibility. The study identified among other factors, the need for stimulating interaction, facilitating student's learning processes, and fostering affective learning climate.

E. Theoretical Foundations and Conceptual Model

Several theories have been adopted to underpin learning with technologies, particularly using mobile devices to support or extend teaching and learning, which came with their shortfalls [22] ;[6]. These theories lacked the inclusion of curriculum that is more tailored to student needs as an important aspect that would strengthen their personalized experiences. Instead, their focus was more on mobile technologies embedded in their current LMS. Studies of Bachman and Gannod [5] have used FRAME by Koole [16] aiming to explain mobile learning dynamics. They added additional characteristics that affected the device, learner, and social aspects in M-learning and referred to their conceptual model as augmented FRAME. Lai et al. [18] also used FRAME as a reference model to design tablet-based activities for pre-service teachers, which addressed aspects of collaboration, engagement, motivation and independent learning. Other studies by Juvova et al. [15] for example used and explained FRAME as an evaluation framework and showed through demonstrations how it could be applied in M-learning studies.

However, there is still some limitations in these theories in terms of the learner side when creating learning experiences that support individualized learning [23]. Moreover, various proportions need to be taken into consideration to help in making recommendations that could help in facilitating PL materials that can be administered via mobile devices. In addition, there is still lack of evaluation methods that are multi-attributed to help in modeling student needs for the creation of PL environments that more learner-centered [3].

The proposed study aims to reference two existing theoretical frameworks, FRAME by Koole [16] and a framework of Mobile Learning Preference by Lai et al. [18] to combine its variables to develop a pedagogical model for PL via MC for institutions of higher learning in South Africa. It is believed that no current framework can address the needs and interests of users in a holistic manner. The intent is to get insights based on the identified elements for PL through qualitative methods, which will help in determining whether they should be considered as key elements for effective design and implementation of a mobile computing model for PL. Graphical depictions of a conceptual framework for the proposed study are given in Figure 1.
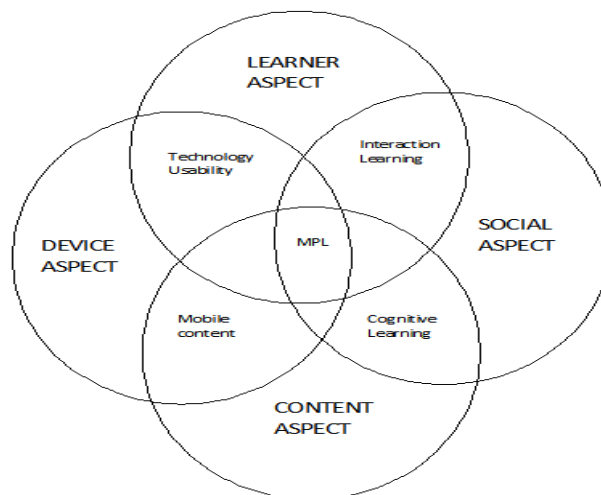

Figure 1.   Conceptual Framework.

The intersection between learner and device aspect (technology use) describes the complexity and usability of the technology in terms of accessibility, portability and ergonomics.   Whilst the intersection of the device and content (Mobile content) addresses the type of content suitable to run on portable devices and how they need to be customized. The intersection between content and social aspects (Cognitive learning) describes how the learner engages with the content based on their social interactions with their peers and instructors, which may affect how they interpret and construct meaning of their own learning. Lastly, the interaction between learner and social aspects (interaction learning) addresses the collaboration issues and interactive learning that promotes learning pertaining to their unique cultural contexts that may influence how they learn individually and from each other. The study proposes that when all these identified aspects are met and their four dimensions are well balanced, a conducive mobile personalized learning environment can be created.

V.   METHODOLOGY

This study used content analysis to search for factors that influence the effective implementations of PL in higher education. Relevant keywords such as "personalization", "learning with technologies", "pedagogical tools for learning", "education", "enhanced learning", "collaboration", "student-centered learning", "ubiquitous learning", "adaptive learning" were used to direct all searches on journal and conferences in the three well know databases JSTOR, Web of Science, and Science Direct. Furthermore, thorough searches were conducted on the following scientific journals which were considered key journals for the field due to their focus on educational use of technology. These include Education and Information Technologies, Journal of Research and Practice in Information Technology, Interactive Technology and Smart Education, British Journal of Educational Technology Computers & Education, Journal of Research on Technology in Education, International Journal of Engineering & Technology, Computers in Human Behavior, International Journal of Education and

Development using Information and Communication Technology, Universal Journal of Educational Research, Journal of Educational Computing Research, Educational Technology Research and Development.

The total searches were limited to the period from 2014 to 2018 due to this pedagogy being at its infant and gaining popularity in the education domain. The results documented in a search protocol were then cleared of any articles that are identified to fall outside the research area of interest-i.e. PL in formal education. 30 articles were read and categorized as relevant based on the preliminary criteria with the intention to identify more themes in the literature. The criterion was inclusive of the following: the novelty of the research, empirical data presence, learning theories applied, model design, technological prototyping, implementation, evaluation and recommendation, and applied educational practices. The criterion was chosen with the intent to help identify literature that deals with different aspects on learning with technology, specifically in PL environments to enhance student performances, and pedagogy. The identification of themes and key factors contributing to the effectiveness of mobile computing PL model were identified following the reading of the articles.

Ms excel was used to tabulate the results and to count the frequency of the appearance of each factor. Factors that were similar in concepts were placed in the same category whereas those with the same meaning were renamed and given a common name. By so doing, many factors were eliminated and the remaining factors were placed into five categories. Table 1 demonstrates the factors tallied with their frequency of appearance in the review literature.

TABLE I.   FACTORS INFLUENCING PL

Factors influencing PL effectiveness					
Pedagogy	**Freq**	**Device/Technology**	**Freq**	**Leaner**	**Freq**
Pedagogical skills	21	Compatibility	23	Experience	11
		Complexity	18	Education & Training	7
Learning theories	16	Flexibility	18	Learner diversity	16
		System quality	16	Learning styles	17
		Internet connectivity	22	Use of technology	16
Content		**Freq**	**Social**		**Freq**
Content presentation		9	Collaboration		15
Content development		8	Interactive learning		14
Information quality		14			

VI. FUTURE WORK AND CONCLUSION

Mobile technologies are considered a new form of social and cultural artifact that mediates teaching and learning in education. Emerging personalized learning spaces along with mobile technologies in the African context aims to better understand how these technologies can enhance quality of learning while promoting accessibility to learning resources. Therefore, it is imperative to look into a holistic approach to education that must be studied in its natural surrounding where personal, situational, cultural and socio-economic factors play a role. PL along with mobile technologies in the African context aims to look into how use of technology can enhance the quality of learning. More so, by extending educational resources to ensure they are readily available to learners anytime and anywhere with no geographical boundaries. This therefore calls for longitudinal studies to be conducted, not just pilot projects that investigate these PL spaces with an attempt to transform pedagogical approaches with authentic contexts that are linked to developing high order thinking.

Mobile computing and technologies have promoted a new vision for learning, particularly in higher education. However, there still exist challenges in education as learning should be fundamentally personal, flexible, social, ubiquitous, complex and dynamic in nature [12]. Therefore, there is a need for a shift in pedagogy towards a more personalized learning environment as opposed to a one-size fits all and passive learning solutions. This requires learning designs that are based on use of mobile technologies that are capable of supporting individual learners to produce desirable learning outcomes. Literature indicates that use of mobile phones have gone beyond making calls and texting due to internet and the Web, which has led web browsing, social media as top uses [11]. The concept of mobile personalized learning aims to put emphasis on the use of mobile technologies and personalization to make learning better in terms of accessibility, portability and mobility, thus eliminating any geographical boundaries. This paper aims to extend flexibility of PL through enhancements of existing models of teaching, and learning with technologies as studies indicates that they are currently minimal [2].

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