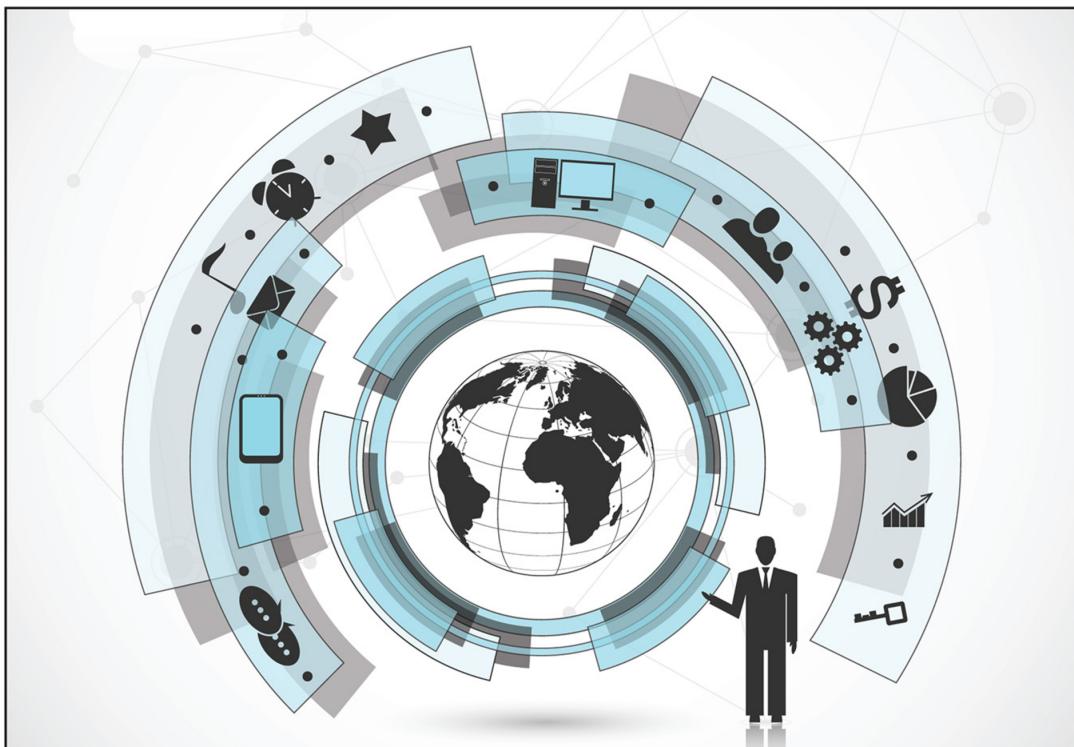


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Table of Contents

International Journal of Information and Communication Technology Education

Volume 16 • Issue 4 • October-December-2020 • ISSN: 1550-1876 • eISSN: 1550-1337

RESEARCH ARTICLES

- 1 Using Learner Group Profiles for Content Recommendation in Ubiquitous Environments
Luis Gustavo Ferreira, University of Vale do Rio dos Sinos, Brazil
Jorge Luis Victória Barbosa, University of Vale do Rio dos Sinos, Brazil
João Carlos Gluz, IFRS - Federal Institute of Education, Brazil
Vítor Kehl Matter, University of Vale do Rio dos Sinos, Brazil
Debora Nice Ferrari Barbosa, Feevale University, Brazil
- 20 The Impact of Compulsory Computer Studies on ICT Literacy at Junior Secondary Schools in Livingstone District
Leslie Simulwi, University of Zambia, Lusaka, Zambia
Evaristo Musonda, University of Zambia, Lusaka, Zambia
- 35 Challenges Facing Faculty Members When Using a Learning Management System
Emad Abu-Shanab, Qatar University, Qatar
Jumana Samara, Qatar University, Qatar
Mohamed Arselene Ayari, Qatar University, Qatar
- 48 Factors Affecting Woman's Continuance Intention for Mobile Games
Pinghao Ye, Wuhan Business University, China
Liqiong Liu, Wuhan Business University, China
Linxia Gao, Wuhan Business University, China
Quanjun Mei, Wuhan Business University, China
- 68 Student Performance Measurement on Psychometric Parameters
Iti Burman, Amity University, Noida, India
Subhranil Som, Amity University, Noida, India
Syed Akhter Hossain, Daffodil International University, Bangladesh
Mayank Sharma, Amity University, Noida, India
- 86 Recommendation-Based Meta-Search Engine for Suggesting Relevant Documents Links
A. Salman Ayaz, BSAR Crescent Institute of Science and Technology, Chennai, India
Jaya A Venkat, BSAR Crescent Institute of Science and Technology, Chennai, India
Zameer Gulzar, BSAR Crescent Institute of Science and Technology, Chennai, India
- 100 Incorporating Information Communication Technology Skills in Accounting Education
Mohamad Osmani, Qatar University, Qatar
Nitham Hindi, Qatar University, Qatar
Vishanth Weerakkody, University of Bradford, UK
- 111 Determinants of the Adoption Academic Electronic Books by University Students in a Developing Country
Foluke Okocha, Landmark University, Nigeria
- 122 An E-Portfolio as an Assessment Strategy in an Open Distance Learning Context
Matlala V. Makokotela, University of South Africa, Pretoria, South Africa

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Using Learner Group Profiles for Content Recommendation in Ubiquitous Environments

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ABSTRACT

The application of ubiquitous technologies in the improvement of education strategies is called ubiquitous learning. This strategy amplifies the pedagogical potential of e-learning through a ubiquitous and contextualized perspective. On the other hand, a ubiquitous technological mediation in learning can also increase the isolation of learners and reduce the integration among colleagues. Strategies to encourage the group learning can minimize these possible side effects. In this sense, this article proposes UbiGroup, an agent-based model for ubiquitous recommendation of educational contents for groups of learners. UbiGroup aims to help teachers to search, select and distribute educational materials for groups. The model considers the group profile and the context where learners are. The recommendation for dynamic groups of learners through a consensus profile is the main scientific contribution of this research. The model was evaluated through simulated scenarios. The results were encouraging and show potential for implementing UbiGroup in real learning environments.

KEYWORDS

Context-Aware Computing, Groups, Learning Environment, Learning Objects, Profile Management, Recommendation, Ubiquitous Computing, Ubiquitous Learning

INTRODUCTION

The ever-increasing use of portable devices, such as smartphones and tablet PCs, has stimulated the adoption of mobile computing in different application areas. The user who carries portable devices can explore wireless communication technologies to access resources in anywhere and anytime. In

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addition, the widespread use of location systems (Hightower, LaMarca, & Smith, 2006), such as the GPS, has allowed a contextualized access to information (Dey, 2001). In this scenario, the ubiquitous computing initially introduced by Weiser (1991) and Satyanarayanan (2001) is becoming reality (Barbosa et al., 2015). The ubiquitous computing is a computational model that aims to proactively serve the needs of users, acting in an invisible way. The goal is to provide a continuous integration between technology and the environment, helping users in their daily tasks.

The application of mobile and ubiquitous computing in the improvement of learning strategies has created two research fronts called mobile learning and ubiquitous learning. Mobile learning (m-learning) (Saccol et al., 2011; Tatar, 2003; Klein et al., 2018) is fundamentally about increasing learners' capability to carry their own learning environment along with them. M-learning is the natural evolution of e-learning. The mobile computing has the potential to make learning even more accessible. In m-learning model, mobile computers are still not embedded in the learners' surrounding environment, and as they cannot seamlessly obtain information about contexts (Dey, 2001).

On the other hand, ubiquitous learning (Barbosa et al., 2011; Wagner et al., 2014; Rosa et al., 2015; Abech et al., 2016; Pimmer, Mateescu, & Gröhbierl, 2016; Guabassi et al., 2018) refers to learning supported by the use of mobile and wireless communication technologies, sensors and location/tracking mechanisms (Barbosa et al., 2018), which work together to integrate learners with their environments. In addition, ubiquitous learning systems can involve the collaborative development of learning contents and learning processes, as well as, the use of social media for informal learning, communication and encouragement of participation (Marinagi, Skourlas, & Belsis, 2013).

Ubiquitous learning systems connect virtual and real objects, people and events, in order to support a continuous, contextual and meaningful learning. While the learner is moving with mobile device, the system dynamically supports learning process by communicating with embedded computers in the environment. The essence of Ubiquitous Learning is to realize which information can be presented throughout the learners' daily tasks, in different forms and places, and to link this data with the learners' educational process. Technologies that support Ubiquitous Learning should provide these aspects through mechanisms that allow knowing learners' profiles, contexts involving them, and how learners relate to contexts.

Nowadays there are works about recommendation of educational material, which are becoming increasingly important due to the dissemination of ubiquitous learning. The web already provides a huge quantity of materials that can be useful for educational purposes. In this scenario, teachers not only need to examine whether this vast quantity of materials available falls in line with the syllabus but, ideally, also check if they comply to the learning profiles of students (Akbulut & Cardak, 2012; Felder & Silverman, 1988; Peterson, Rayner, & Armstrong 2009) and to the teaching context where the learning is occurring (Barbosa et al., 2011; Rosa et al., 2015; Abech et al., 2016, Guabassi et al., 2018).

However, the management of student digital profiles and ubiquitous pedagogical contexts could make the already complex tasks of planning the educational activities and the organization of lessons, even more difficult to the teachers. They already devote considerable time to accomplish these tasks, seeking appropriate learning materials for the teaching plan. In addition, due to the wide range of available digital content, the teacher may require significant effort to find appropriate educational materials. This problem becomes more complex when one considers not only individual aspects of a profile, but collaborative aspects in learning groups. This motivates the development of computational tools to help teachers (and students) to explore the potential of Ubiquitous Learning and, mainly to support the selection and recommendation of content for groups.

This work assumes that educational contents are already catalogued as Learning Objects (LO) (IEEE-LTSC, 2002; Wiley, 2001). Of course, with this assumption we are not allowing the search and selection of any material from the web. However, this is not very restrictive because the systems need only the metadata to catalog LO for recommendation purposes. There is a crescent trend to use metadata standards like DublinCore (Kunze & Baker, 2007), IEEE-LOM (IEEE-LTSC, 2002)

and OBAA (Gluz & Vicari, 2012) to catalogue information about materials available in the web, allowing more productive and effective searches. Other LO standardization issues that could be more restrictive, like packaging or accessibility, are not of concern of this work.

Making an integrated use of the information provided by LO metadata, the ubiquitous learning could become instrumental for the recommendation process, not only because it allows the easy distribution of customized materials directly to the learners on time and at the appropriate place, but because it allows the precise content distribution based on the context information.

With these considerations as the background, we propose UbiGroup as an agent-based model to provide ubiquitous content recommendation for groups of learners. The main contribution of this research is the strategy to recommend for groups. UbiGroup uses the learners' profiles to determine a consensus group profile, which is used to recommend learning objects. In addition, UbiGroup considers the dynamicity of groups and the context where learners are.

This article is organized in five sections. The next section discusses related work in the area of recommendation for groups. Third section describes the UbiGroup. The fourth presents a scenario used to evaluate the model. Finally, in the last section, we draw some conclusions and plans for future work.

RELATED STUDIES

We considered as related works only models that contain mechanisms to recommend content for groups of users. The search was not restricted to works that recommend learning content because few articles were found with this focus. Table 1 presents a comparison among related works considering five aspects considered strategic in this research.

Boratto et al. (2010) proposed a model for automatic identification of user groups. The work created the ImprovedGRA recommendation algorithm for groups using the technique of collaborative filtering. For group identification, the model uses individual recommendations, combined with users' preferences and uses them as input to the clustering algorithm. The recommendation algorithm generates predictions from the classification matrix used to identify the groups and, then, adds the predictions of the items not rated by users.

Kim et al. (2010) proposed a recommendation procedure for groups in on-line communities, which is called GRec_OC. The procedure works by initially generating a set of recommendations for the group using the method of collaborative filtering. Soon after, the similarity between the profiles of the group is calculated and the determination of neighboring groups with greatest similarity is made. For each neighbor group a set of recommendations based on items most frequently purchased is selected. The final step consists of a filtering method to reduce the dissatisfaction of individual group members.

Christensen and Schiaffino (2011) described the development of two recommender systems for groups of people: jMusicGroupRecommender and jMoviesGroupRecommender. These systems recommend, respectively, music and movies. They were developed based on the framework GroupRecommendation. This work proposes two approaches for generating recommendations for groups: merging the individual recommendations made by aggregating the individual ratings of each item evaluated and developing a model of group preferences.

Webber and Lima (2012) considered that group work is an important resource for teachers to promote collaborative learning. So, they empirically studied one of the most important issues of this research field, namely, if automatic mechanisms for group formations can actually be able to form consistent and successful groups for education purposes. The experiment presented in the article shows that automatic techniques can produce results consistent with regard to the formation of groups.

Kardan and Ebrahimi (2013) proposed a hybrid recommender system. The similarity of users is identified based on implicit information about their interactions and web navigation. After, association rules are used to improve the collaborative filtering process. The content-based filtering process uses semantic techniques to identify relevant posts and automatically infers the formation of groups, uses

rules to select the recommended collaborative material, and applies semantic techniques to filter the returned content.

Zapata et al. (2015) proposed a collaborative methodology focused on learners' groups for searching, selecting and rating learning objects. This methodology is an extension of DELPHOS which is a framework to assist users in the individual personalized search for learning objects in repositories. To group support, the authors included the creation and management of groups of users, the realization of collaborative activities, and the recommendation of the most interesting learning objects to these groups. A meta-learning approach is also proposed in order to help the mediator of a group to select the best rating aggregation method depending on the rating of previous similar groups.

Table 1. Related works comparison

Aspects/Works	Boratto et al. (2010)	Kim et al (2010)	Christensen and Schiaffino (2011)	Webber and Lima (2012)	Kardan and Ebrahimi (2013)	Zapata et al. (2015)
1. It uses a multiagent system	No	No	No	No	No	Yes
2. It focus on learning	No	No	No	Yes	No	Yes
3. It automatically infers the formation of groups	No	No	No	No	No	Yes
4. It uses rules to select the recommended content	Yes	Yes	Yes	Yes	Yes	Yes
5. It applies semantic techniques to filter the content	No	No	Yes	Yes	Yes	Yes

Boratto et al. (2010) and Kim et al. (2010) proposed similar techniques to create groups and to content recommendation. The proposed systems do not focus on learning recommendation, as well as they do not use ubiquitous information to recommend content.

The works of Webber and Lima (2012), Kardan and Ebrahimi (2013) and Zapata et al. (2015) are the works most similar to UbiGroup. They automatically infer the formation of groups and use association rules to improve the collaborative filtering process. In addition, these proposals apply semantic techniques to identify relevant content.

UbiGroup also automatically infers the formation of groups, uses rules to select the recommended collaborative material, and applies semantic techniques to filter the returned content. However, there are two main differences, which are the contributions of UbiGroup. First, the techniques used to dynamically form groups and select materials are generalized to work with ubiquitous information of learners. The second difference relates to the semantic approach to filter results. Unlike the dictionary techniques used by Kardan and Ebrahimi (2013), and the framework elements explored by Zapata et al. (2015), UbiGroup uses a full ontological approach to handle the semantics of the filtered contents (learning objects). UbiGroup focuses on learning such as Webber and Lima (2012) and Zapata et al. (2015). In addition, UbiGroup and Zapata et al. (2015) use multiagent systems, but Zapata et al. (2015) does not consider ubiquitous information for reasoning.

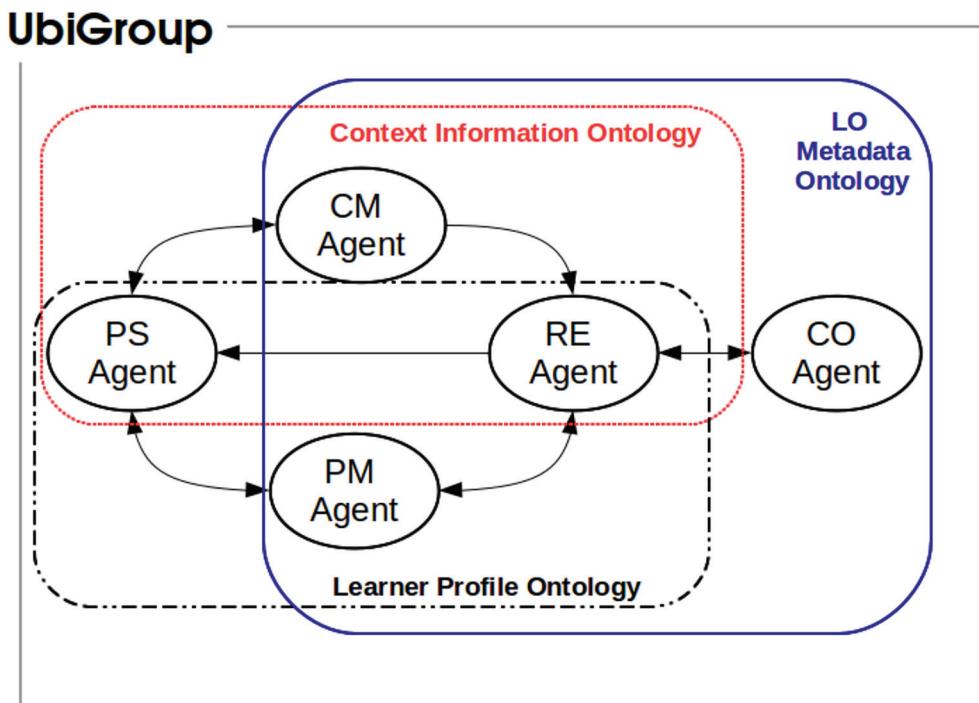
UbiGroup was designed to work based on contexts and portable devices. The model uses context information to dynamically create groups of learners, and then use this information to select appropriate educational material. UbiGroup is dedicated to support educational environments using ontology to

recommendation support. All information management focuses on learning support, including the profiles, contexts and learning objects.

THE ARCHITECTURE OF UBIGROUP

Figure 1 shows the architecture of the proposed model. UbiGroup is a multiagent system (Wooldridge, 2009) composed by five pedagogical agents (Giraffa & Vicari, 1998; Vicari et al., 2008). These agents work autonomously and cooperatively in a distributed environment formed by mobile devices and computer servers. The overall architecture and all of its individual agents were designed using software engineering methods focused on developing pedagogical agents for tutoring systems (Vicari & Gluz, 2007).

Figure 1. Agent-based architecture of UbiGroup model



The Pedagogical Support agent (PS) obtains information from learners and informs them about new recommendations. The Profile Management agent (PM) keeps learner profiles updated and generates the similarity degree between these profiles. The Context Management agent (CM) manages the contexts in the ubiquitous environment. The Recommender agent (RE) maintains the base of recommendation rules. Finally, the Communicator agent (CO) performs communication with the repository of LO. Besides the requirements of ubiquitous computing and recommendation systems, there are other important requirements that impacted on the design of the model: a) groups of learners can be formed dynamically, namely, they can be created and dissolved at any time; b) information about learning materials are represented in the form of LO metadata; c) information about learner profiles and contexts are also provided in the form of metadata.

All metadata about learner profiles, teaching contexts and learning materials were represented in ontologies specified in OWL language (W3C, 2012). In this sense, UbiGroup followed the principles established in previous works (Gluz & Vicari, 2012; Gluz, Vicari & Passerino, 2012). OWL data properties (W3C, 2012) were used to represent these metadata, allowing us to use a previously developed OWL/RDF semantic base. This base can be used to solve SPARQL (W3C, 2013) queries over inferred ontologies (Gluz & Silva, 2014) to store, locate and retrieve the metadata necessary for the recommendation process. The specific operational knowledge about how to identify and recommend materials was represented in the form of recommendation rules, which are analogous to the production rules used in expert systems (Russel & Norvig, 2010). In UbiGroup, these rules map profiles, contexts and LO metadata information to recommendation filters. The following subsections detail the UbiGroup architecture.

Pedagogical Support (PS) Agent

The PS agent is the interface of UbiGroup with learners, being the only agent that runs on the mobile device. While executing, this agent sends the updated information of profiles to PM agent and sends the updated location to CM agent. The PS also calls the PM agent for the validation of the learner's access credentials.

The main role of the PS agent is to monitor the movements of the learner and send this information to the CM agent. If the CM identifies that the learner is in a learning context, it informs the PM agent, which in turn, notifies the learner that he or she has entered a particular context.

During the recommendation process, the responsibility of the PS is to notify learners about recommendations for them. The agent also presents the recommended materials to learners. After viewing a material, the learner is asked to rate the recommendation indicating whether it was satisfactory or not.

Profile Management (PM) Agent

The PM agent keeps updated the profiles of learners. This agent also works with the CM agent to monitor the access of learners to contexts. The PM retrieves the credentials from the learner profile and sends these credentials to the CM, which in turn keeps track of which context the learner is.

The learner profile is represented by an ontological model specified in OWL (W3C, 2012). The classes and properties of this ontology were defined based on the PAPI standard for learner metadata (PAPI, 2002) (see Figure 2).

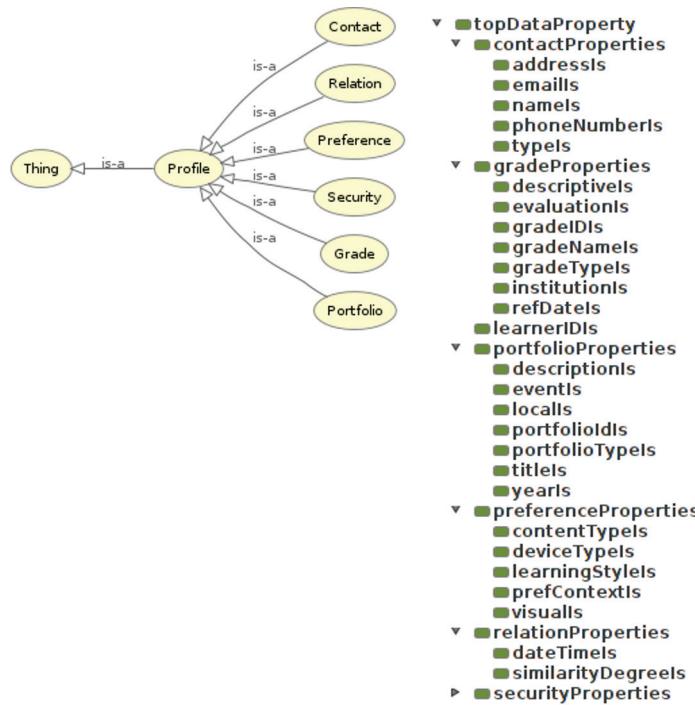
Profile information has six categories: contact, portfolio, grade, relation, preference and security. Personal information about the learner was collected in contact category. The portfolio category groups information about the works produced by the learner. The relation category collects information about the relationships with other learners. The grade category contains the grade evaluations of the learner. Preference category groups the preferences of the learner and security category indicates the access credentials.

The profile metadata were represented by OWL data properties directly associated with the individual (instance) representing the profile of a learner in the ontology. Thus, assuming that *p1* represents the profile of learner A, the identification and name of the learner would be represented by the following RDF triples:

p1 learnerIDIs "1"
p1 nameIs "Student A"

The PM agent also calculates the similarity degree between profiles of learners. The estimation of the similarity is based on values of Preference, Grade and Portfolio properties (see Figure 2). Before calculating the similarity between two profiles, all preference, grade and portfolio properties

Figure 2. High-level classes and properties of learner profile ontology



that coincide in both profiles (learners have the same property, but not necessarily the same value for the property) are selected to form a set of n item values, which is used in the comparison. Equation 1 shows how the degree of similarity is calculated based on this set of values:

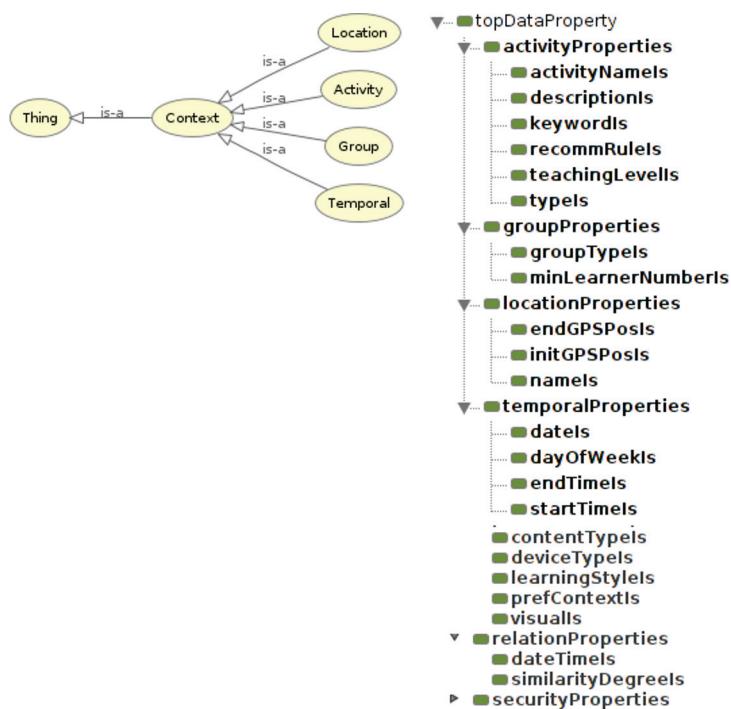
$$S(SP_1, SP_2) = \frac{\sum_{i=1}^n (SP_1.itemValue_i, SPA_2.itemValue_i)}{n} \quad (1)$$

The similarity (S) between the profiles of two learners (SP1, SP2) is equal to the sum of the Value of Equivalence (VE) for each preference, grade and portfolio item stored on profiles of both learners, divided by the total number of items evaluated (n). The individual VE between each two items is estimated by the editDistance algorithm (Levenshtein, 1966). This algorithm compares two strings and determines the editing distance, which is the minimum number of operations needed to transform one string into another. With this distance is possible to calculate the similarity degree, dividing the number of operations (obtained by the algorithm) by the maximum number of possible operations. Note that to use the editDistance algorithm, we needed to set the range of all OWL data properties used in the learner profile ontology to the string data-type.

Context Management (CM) Agent

The CM agent maintains the base of contexts used for teaching purposes and informs the RE agent about changes regarding the entry or exit of learners in some context registered in the base. The context information used by CM is represented in an OWL ontology. The classes and properties of this ontology were based on the definitions proposed by Dey (2001). Figure 3 shows the main classes and data properties of the context ontology.

Figure 3. High-level classes and properties of context ontology



The context information is organized in four categories: location, activity, temporal and group. Location category collects geographical information about the context. The activity category collects information about activities that can occur in some context. Temporal category indicates the temporal limits for the context. The group category collects information related to the formation of groups of learners in the context. Following the same structure used in the profile ontology (Figure 2) and in the LO metadata ontology, specific metadata information about the context are represented by data properties associated with the ontology individual (instance), which uniquely identifies the context.

The CM maintains all contexts that are active, which are those having at least one learner. This, however, does not imply that the context is already able to receive content recommendations. This will occur only when this particular context meets the requirements in temporal and group categories. It is the CM agent that checks if these requirements were satisfied. Whenever a learner enters or leaves a context, the CM informs the RE agent about this movement, because this is one of the triggers to start the recommendation process.

Recommender (RE) Agent

The RE agent manages the recommendation process. It keeps the rules to select new recommendations, and performs the steps necessary to prepare, execute and forward the recommendation to learners.

A recommendation rule is formed by a set of mappings between profiles, learning contexts and LO metadata. From these mappings, it is possible to extract production rules to generate a set of filters that will select LO through metadata. The mappings on the recommendation rule correlate information contained in the profile, or learning context, with information appearing in LO metadata. All information that may appear in these rules is represented according with the corresponding OWL ontology. Learner profile and context information are represented by classes and properties of

ontologies shown, respectively, in Figure 2, and Figure 3. The LO metadata used the ontology defined by Gluz and Vicari (2012), which covers all IEEE-LOM metadata (IEEE-LTSC, 2002).

Each mapping is formed by three items: the learner profile/context information, the corresponding LO metadata, and the value that should appear as the content of previous items. In all ontologies used by UbiGroup, the information is organized in the same way: (a) the class, which defines the LO metadata group, or the category of learner profile/context information; (b) the OWL object/data property, which defines the LO metadata or learner profile/context attribute. Table 2 shows an example of a mapping from learner profile information to LO metadata. In this example, the type of the profile is mapped to the intended type of end user of the LO. Preferential content formats and digital devices are also mapped to specific technical LO metadata that can be used to select materials with these characteristics.

Table 2. Example of mappings between learner profile information and LO metadata

Learner Profile		LO Metadata		Value
Class	Property	Class	Property	
Contact	typeIs	Educational	intendedEndUserRoleIs	“learner”
Preference	contentFormatIs	Technical	formatIs	“video”
Preference	deviceTypeIs	Technical	supportedPlatformIs	“mobile”

Table 3 shows an example of mappings from context information to LO metadata. This example shows how to use keywords about activities that will occur in the context, to select appropriate educational materials, looking in the title, description or keyword in the LO metadata.

Table 3. Example of mappings between context information and LO metadata

Context Information		LO Metadata		Value
Class	Property	Class	Property	
Activity	keywordIs	General	TitleIs	“java” or “programming language”
Activity	keywordIs	General	descriptionIn	“java” or “programming language”
Activity	keywordIs	General	KeywordIs	“java” or “programming language”

The mappings of recommendation rules provide the information that the *RE agent* needs to generate metadata filters that will be used to select LO to a context and profile. These filters are sent to the *CO agent*, which in turn will select the LO corresponding to the filters informed in the message. The recommendation rules used by the *RE agent* can be managed through a web interface (see Figure 4, the interfaces are in Portuguese).

The recommendation process is initiated when a context is ready to receive a recommendation. For this, it is necessary that the temporal and group conditions for this context are fully satisfied. When this occurs, the selection of material to be recommended starts. The process is conducted by RE agent in three steps: (1) identification of the most representative profile for the group (consensus profile), (2) the selection of recommendations for this profile, and (3) classification of selected items based on reviews from group members.

Figure 4. Web interface to manage recommendation rules (in Portuguese)

ID	Tipo	Classe	Campo	Classe OA	Campo Classe OA	Tipo Associação	
1	Contexto	Atividade	PalavrasChave	General	Title	Direta	<input type="checkbox"/>
2	Contexto	Atividade	PalavrasChave	General	Description	Direta	<input type="checkbox"/>
3	Contexto	Atividade	PalavrasChave	General	Keyword	Direta	<input type="checkbox"/>
4	Perfil	Contato	Tipo	Educational	IntendedEndUserRoleIs	De-para	<input checked="" type="checkbox"/> <input type="checkbox"/>
5	Perfil	Preferencia	FormatoOA	Educational	LearningResourceTypes	De-para	<input checked="" type="checkbox"/> <input type="checkbox"/>
6	Perfil	Preferencia	FormatoOA	Segmentation	SegmentMediaTypeIs	De-para	<input checked="" type="checkbox"/> <input type="checkbox"/>
7	Perfil	Preferencia	TipoDispositivo	Technical	SupportedPlatformsIs	De-para	<input checked="" type="checkbox"/> <input type="checkbox"/>
8	Perfil	Preferencia	EstiloAprendizagem	Educational	InteractivityType	De-para	<input checked="" type="checkbox"/> <input type="checkbox"/>
9	Perfil	Preferencia	EstiloAprendizagem	Educational	InteractivityLevel	De-para	<input checked="" type="checkbox"/> <input type="checkbox"/>
10	Perfil	Preferencia	EstiloAprendizagem	Educational	Perception	De-para	<input checked="" type="checkbox"/> <input type="checkbox"/>
11	Perfil	Preferencia	EstiloAprendizagem	Educational	Synchronism	De-para	<input checked="" type="checkbox"/> <input type="checkbox"/>

The first step starts with the analysis of the profiles of the learners in the context. This analysis identifies which is the most representative profile for the group using the degree of similarity between the profiles (see Equation (1)). This profile is used as the basis to select the LO. The profile that has the highest average similarity among the group members will be chosen as the representative profile. To identify this profile, firstly the RE agent requests the PM agent for calculating the similarity of each profile in the context with all other profiles in the same context. This analysis results in a similarity matrix (see Table 6 in advance, as an example). Thereafter, the RE searches profiles that have similarity greater than 90% with all other profiles. If no profile is found, the RE follows successively reducing in 10% the similarity threshold until be found at least one profile that meets to a minimum average value.

The second step begins with generating recommendations for the representative profile. Based on the profile, context and recommendation rules contained in the context, the *RE agent* builds a set of LO filters, each one specified as a relational and logical expression over LO metadata. Then, these filters are sent to the CO agent. This agent transforms the filters in appropriate queries for the LO repositories registered in the system and returns to the RE, the lists of LO that satisfy the queries. After determining the recommendations to the representative profile, these recommendations are unified into a single list with the LO to be recommended for learners.

In the final step, the RE agent classifies the list, considering the assessments made by the group members. So, the best evaluated items will be the first to be recommended to the group. The RE agent selects and sends the learnings objects to PS agent.

Communicator (CO) Agent

The CO agent implements communication with LO repositories. This agent receives a request from the RE agent containing a set of search filters and transforms this data into a query compatible

with the LO repositories. Then the CO accesses the repositories to obtain the information of LO. Communication with the repositories occurs through a web services interface. Finally, the list of LO returned by the repository is forwarded to the RE agent.

Currently, the CO agent works only with semantic repositories (Gluz, Silva & Vicari, 2014) which support SPARQL queries over IEEE-LOM/OBAA metadata represented in OWL ontologies (Gluz & Vicari, 2012). Figure 5 shows the SPARQL query corresponding to the rule mappings shown in Table 2.

Figure 5. An example of SPARQL query generated by CO agent

```
PREFIX obaa: <http://obaa.unisinos.br/obaa22.owl#>
SELECT distinct ?lobj ?key ?title ?desc ?loc
WHERE {
    ?lobj a obaa:LearningObject .
    ?lobj obaa:hasMetadata ?mdata.
    ?mdata obaa:keywordIs ?key.
    ?lobj obaa:hasMetadata ?mdtit.
    ?mdtit obaa:titleIs ?title .
    ?lobj obaa:hasMetadata ?mddesc.
    ?mddesc obaa:descriptionIs ?desc .
    ?lobj obaa:hasMetadata ?mdloc.
    ?mdloc obaa:locationIs ?loc .
    {FILTER (regex(?key,'java','i'))} UNION
    {FILTER (regex(?key,'programming language','i'))} UNION
    {FILTER (regex(?title,'java','i'))} UNION
    {FILTER (regex(?title,'programming language','i'))} UNION
    {FILTER (regex(?desc,'java','i'))} UNION
    {FILTER (regex(?desc,'programming language','i'))}
}
```

IMPLEMENTATION ASPECTS

UML was used for specifying the UbiGroup architecture. This modeling language has been considered suitable for the specification of the overall architecture of multiagent systems and their individual agents (Bauer & Odell, 2005; Guedes & Vicari, 2010).

The prototype implements a basic set of features for each agent, which were considered strategic to conduct the evaluation. The PS agent was developed for Android devices with the Android SDK support. Server-side agents (PM, CM, RE and CO) were developed in Java with support of Tomcat server for the web interface, REST/Jersey framework for web services interface, Jena library for handling OWL ontologies and SPARQL queries. The prototype used a semantic LO repository that is capable of dealing with SPARQL queries to search LO metadata. The metadata information retrieved is represented in XML.

EVALUATION ASPECTS

The evaluation methodology was based on a strategy of validation by scenarios. This approach was used in classical works to evaluate context-aware systems (Dey, 2001) and ubiquitous systems (Satyanarayanan, 2001). Most recently, this strategy has been applied to evaluate the use of ubiquitous computing in various application areas such as Health (Vianna & Barbosa, 2014), Commerce (Barbosa et al., 2016), Accessibility (Barbosa et al., 2018), Competences Management (Rosa et al., 2015) and Learning (Barbosa et al., 2011; Wagner et al., 2014).

Several scenarios were created to evaluate the UbiGroup. In this article, we discuss a specific scenario that evaluates the most significant features of the model. The scenario assumes a teacher in an undergraduate course in “Algorithms and Programming”. He would like that students in the classroom received a recommendation of educational material on their smartphones during the class, in video format. The context information registered about this scenario is presented in Table 4.

Table 4 defines the context A which will be located in classroom A and where there will be the course of “Algorithms and Programming,” on Monday from 19:30 to 22:00. This information is previously registered in UbiGroup by the teacher using the web interface of CM agent. An example of this interface is shown in Figure 6.

Table 4. Example of context information

Context A		
Localization Properties	NameIs	“classroom A”
	initGPSPosIs	-29.792702, -51.152301
	endGPSPosIs	0.00132,0.002642
Activity Properties	TypeIs	“Class”
	activityNameIs	“Alg. and Prog.”
	descriptionIs	“Course of algorithms and programming – Prog. language Java”
	recommRuleIs	Class Standard Rule
	KeywordIs	“Programming Language”
	keywordIs	“Java”
Temporal Properties	dayOfWeekIs	Monday
	DateIs	-
	startTimeIs	19:30
	endTimeIs	22:00
Group Properties	groupTypeIs	Mix
	minLearnerNumberIs	3

Near the time of the beginning of class, students begin to arrive and are identified in context. To simplify the understanding of the scenario, we consider only profiles of the teacher and three students. Table 5 presents the information contained in the profiles. Profiles of students are maintained by the web interface of the *PM agent* as exemplified in Figure 7.

The *CM agent* checks if the minimum number of learners was satisfied at each time a student enters the context. When the minimum is reached, the *RE agent* receives the learning context of the group of students, selects their profiles and identifies the most representative profile for the group with the assistance of *PM agent*. In this scenario, student A was selected as the consensus profile (see Table 6).

Based on the recommendation rule contained in context (see Tables 2 and 3), the *RE agent* defines the filter parameters for LO metadata and sends this information to the *CO agent*. The *CO* receives the search filters, creates a SPARQL query and sends the query to the LO repository. The *CO agent* receives the results and forwards them to the *RE agent*. This agent sends the recommendation of content to the *PS agent*. This agent puts a notification on the top bar of the mobile device (see

Figure 6. Web interface of CM agent

ID	Local	Tipo Atividade	Nome	Descrição	Regra	Palavra-chave	Grau Ensino	Dia Semana	Data	Hr Inicio	Hr Fim	Tipo Grupo	Qtde Grupo	
1	Sala de Aula	MS Aula	Aula 3 sobre...	Regra Modelos de Ens. Simulação	01	Superior		20/04/13	21:00	22:00	Alunos	5		

Figure. 8.a). When students select “View”, the recommended materials are shown (see Figure 8.b). After viewing the LO, the students are invited to assess the recommendation, indicating whether they liked the material. These reviews are stored for use by the *RE agent*.

CONCLUSION

This article proposed UbiGroup, a model for ubiquitous recommendation of educational contents for groups of learners. UbiGroup recommends materials for dynamically managed groups which share a context. Furthermore, the model allows teachers to create their recommendation rules giving them freedom to align the search for materials to the teaching plan. Through the use of recommendation rules, it is possible to model the degree of refinement most appropriate for the pedagogical plan being implemented by the teacher.

The implementation of a prototype allowed the evaluation of the model by means of a scenario in a controlled environment. The results indicate that UbiGroup can recommend LO considering the context information and the most representative profile of the group. This is the case in the scenario presented in the article. The scenario also showed that the technology used by UbiGroup works and is ready for use in learning environments, except for a few details about the user interface, which will be discussed below.

The main contribution of UbiGroup is the recommendation for learner groups based on a consensus profile. Furthermore, the model detects the formation of dynamic groups and uses context information to guide the recommendation. In technological terms, the main differential of UbiGroup is the use of semantics in all phases of the recommendation process, including the detection of groups, handling of profiles and selection of LO contents. The semantics treatment is done by combining ontologies, metadata and agents’ technologies.

Table 5. Profiles used in the scenario

Learning Profiles					
Contact Properties	learnerIDIs	1	2	3	4
	nameIs	“Student A”	“Student B”	“Student C”	“Teacher D”
	typeIs	“student”	“student”	“student”	“student”
Portfolio Properties	portfolioTypeIs	“paper”	“short-paper”	-	“paper”
	titleIs	“A multiagent model for content recommendation”	“Recommendation of educational contents for groups”	-	“A multiagent model for content recommendation”
	descriptionIs	-	-	-	-
	eventIs	“SBYY”	“ERYY”	-	“SBYY”
	localIs	“City A”	“City B”	-	“City A”
	yearIs	2012	2012	-	2012
Grade Properties	gradeTypeIs	“discipline”	“discipline”	“discipline”	-
	gradeNameIs	“Alg. and Prog. I”	“Alg. and Prog. I”	“Alg and Prog. I”	-
	descriptiveIs	-	-	-	-
	institutionIs	“Inst. A”	“Inst. A”	“Inst. A”	-
	evaluationIs	7	8	8.3	-
	refDatIs	2012-1	2012-1	2012-2	-
Preference Properties	contentTypeIs	“video”	“video”, “audio”	“video”	“video”
	deviceTypeIs	“mobile”	“mobile”	“notebook”	“mobile”
	visualIs	“visual”	“visual”	“visual”	-
	prefContextIs	“classroom A”	“classroom A”	“classroom A”	“classroom A”

Figure 7. Web interface for the management of students' profiles

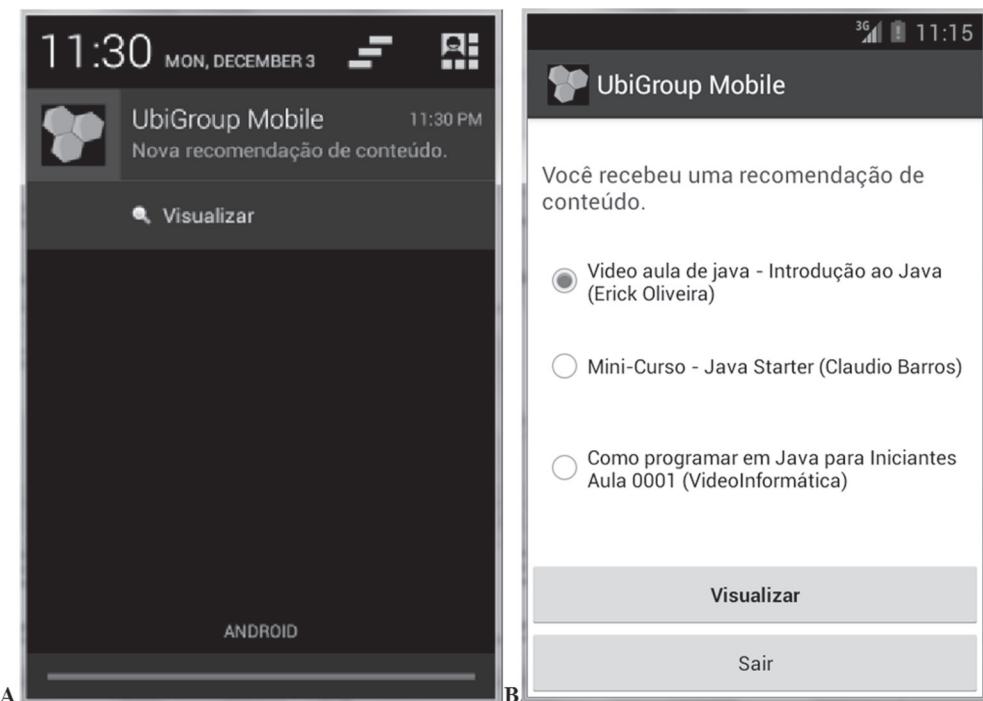
ID	Nome	Tipo	E-mail
1	Aluno A	Aluno	alunoa@gmail.com
2	Aluno B	Aluno	aluno_b@hotmail.com
3	Aluno C	Aluno	alunoc@gmail.com
4	Aluno D	Aluno	alunodd@gmail.com
5	Aluno E	Aluno	alunod.E@gmail.com

Logos at the bottom include UNISINOS, OBAA, and MILOS.

Table 6. Similarity of the profiles contained in the context

	Student A	Student B	Student C	Teacher D
Student A	-	67%	47%	53%
Student B	67%	-	43%	27%
Student C	47%	47%	-	7%
Teacher D	53%	27%	7%	-
Avg.	56%	47%	32%	29%

Figure 8. Example of the mobile user interface



Currently, the main limiting factor of UbiGroup is the interface used by the teacher. This interface requires extensive and tedious specification of contexts and recommendation rules for the teaching plan used in the course. Future research will focus on the automation of these activities, based on ontological knowledge of the curriculum, learning domains, pedagogical strategies and teaching methods. This information can be combined with the physical (geographical) and social information about the institutions. We hope that with the use of these technologies, it will be possible to create a simple and useful interface for the teacher, automating the main activities of the generation of contexts and recommendation rules. In this sense, UbiGroup does not address the relationship between individual lessons. Teachers do not have the possibility to create dependencies between lessons or combinations to organize lessons sharing. We believe this is a relevant feature that can be added to UbiGroup, perhaps by including learnings objects chains and objects group recommendations following the chain.

In addition, although the main focus of UbiGroup is in educational contexts, this is not a limiting factor of this model, because the technologies employed (ontologies, agents and metadata) can be applied to other domains related to information management. In future research, we intend to integrate UbiGroup with systems dedicated to competence management (Rosa et al., 2015), u-commerce (Barbosa et al., 2016), u-health (Pittoli et al., 2018) and u-accessibility (Barbosa et al., 2018). Currently, UbiGroup does not address data security aspects, mainly no treatment is done to separate public data (lessons) and private data (students' personal information). In this regard, future efforts will be directed to include security standards in the system. This feature will improve the educational application and allow better infrastructure to other applications.

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The Impact of Compulsory Computer Studies on ICT Literacy at Junior Secondary Schools in Livingstone District

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ABSTRACT

The study investigates the impact of compulsory computer studies (CS) on information and communication technology (ICT) literacy in secondary schools in the Livingstone District, Zambia. The objectives were to investigate the availability of specialised ICT teachers, to find out the availability of ICT equipment and infrastructure, and to establish the impacts of compulsory ICT. The study was mainly qualitative using primary data, however, had a component of quantitative research using secondary data in form of Examination Council of Zambia (ECZ), ICT examinations results for grade nine. The study established that the introduction of ICT as a compulsory subject had an impact on teacher and pupil literacy in ICT, and due to insufficient ICT equipment, may have negatively affected the performance of the pupils in the ICT final examination.

KEYWORDS

Examination Results, ICT Equipment, ICT Literacy, Specialized ICT Teachers, Zambia

INTRODUCTION

In 2014, the Zambian Government through the Ministry of Education (MOE) introduced ICT Subjects in Schools and made the subject compulsory at Junior Secondary (Ministry of Education Science Vocational Training and Early Education, 2013a), with the ICT subject at Junior Secondary being called Computer Studies (CS). This development was a source of concern to many due to the fact that most rural areas of the country were not electrified (Banda, 2016; Mulenga, 2016; Lusaka Times, 2015). Junior Secondary in Zambia runs from Grade 8 to Grade 9. It was also reported that, the MOE had made the Subject compulsory at Junior Secondary despite schools having inadequate facilities (Banda, 2016). Furthermore, it was reported that, most stakeholders were of the view that the introduction of the Subject was rushed (Mwambazi, 2015). This study was aimed at establishing the impact of making ICT Subject compulsory on ICT literacy in Secondary Schools. The Specific Objectives were to investigate the availability of specialised ICT Teachers, to find out the availability of ICT Equipment and Infrastructure in Secondary Schools of Livingstone District, and to establish the impact of making ICT Subject compulsory at Junior Secondary on ICT Literacy in Secondary

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Schools in Livingstone District. The rest of the Article is arranged under the following Sections, Background, Results, Discussion of Results and then the Conclusion.

BACKGROUND

For quite some time now, Information and communication technologies (ICTs) have been considered as a necessity to education as they are seen to have the potential to transform education and student learning, especially in developing countries (Behar & Mishra, 2015). In Zambia, many efforts have been made to integrate ICT in the education sector. In 2006 a project called iSchool was established for the purpose of delivering the National curriculum online, this project aimed at changing the pedagogies used in schools and deliver exciting, hands-on learning to students of all ages, or ability across the country (Habler et al., 2011). This is a good program which encourages the use of ICTs to customise learning and teaching but does not emphasise on integrating ICT as a subject. However, the iSchool Project would help to successfully integrate ICT Subjects in Schools and further promote ICT literacy among Teachers and Learners.

By 2010, sixty percent of the country's population was still leaving in rural areas (Central Statistical Office Lusaka Zambia, 2015), this may be an indication that most people in the country were not accessing ICT efficiently due to lack of electricity, therefore most of them remained ICT illiterate since most ICT equipment require the use of power. The integration of ICTs in learning and teaching practice was very limited in the beginning, but after the introduction of computer studies (SC) as a compulsory subject, the situation started changing (Shafika, 2007).

The Government of the Republic of Zambia has made significant reforms to improve the ICT sector in the country, this is partly demonstrated by the adoption of ICT as the priority sector in the Fifth National Development Plan (FNDP) (2006-2010), the introduction of teacher education in ICT at all teacher training institutions (TTIs) in the country, developing a national ICT curriculum, implementing special schemes and policies to facilitate easy acquisition of ICT equipment for both learners and teachers and promoting internet access at all levels of the education system (Ministry of Communications and Transport, 2006).

In view of the above stated adoptions and approval of the 2006 National ICT policy, the Zambian government through the Ministry of Education (MOE) introduced ICT subjects in the schools in 2014 and made the subject compulsory at junior secondary (Ministry of Education Science Vocational Training and Early Education, 2013b).

Related Literature

Banda (2016) conducted a study in Chipata District of Eastern Province, Zambia, and investigated whether or not the teachers and pupils were using ICTs in their teaching and learning of other curricula subjects, what materials were available in the implementation of ICTs in primary schools and what challenges teachers were experiencing in the implementation and interventions to improve the delivery of ICTs. The study established that there was low availability of ICT teaching and learning materials including poor infrastructure in schools. Findings of the study also indicated that some teachers resorted to using some personal ICT materials to help in teaching and that some schools were not electrified. Findings further indicate that the teachers were lacking knowledge and skills in ICT but had much interest in teaching the subject. The study however did not state the whether the implementation was a success and what impact it had on the ICT literacy in the school.

On the other hand, Mulenga (2016) tried to investigate whether the implementation of computer studies curriculum was a failure or a success, the study was conducted in Ndola District of Zambia and indicate that the implementation of the curriculum faced a number of challenges which included: inadequate funds to purchase ICT equipment, lack of infrastructure such as computer laboratories, lack of trained teachers to teach the subject and inadequate books and other materials. The study concluded that the implementation of CS curriculum was a failure in Ndola District (Mulenga, 2016).

Furthermore, a study which was conducted in the Mwansabombwe District to investigate barriers to effective implementation of CS curriculum in selected Junior Secondary Schools, established that there was lack of ICT equipment and basic infrastructure in schools to support the implementation process and further highlighted on the effects of teacher training and exposure to ICT by teachers. The study employed descriptive statistics to analyse the data collected and it was reviewed that only about 10% of the schools investigated had successively implemented the curriculum. Major challenges outlined in the study include inadequate funds to procure ICT equipment, lack of computer laboratories, lack of trained computer teachers and lack of revision materials (Mambwe, 2016). The study did not indicate whether transfer of ICT literacy skills was taking place effectively.

Pelekole (2017) investigated experiences of teachers and learners in the teaching and learning of computer studies at junior secondary school level in three selected secondary schools of Luanshya District. Findings indicate that the teaching and learning of computer studies had positively empowered teachers and learners with various long-life technological skills such as browsing, typing and researching via internet. The study further indicates challenges that were experienced by teachers and learners which include: lack of teaching and learning materials and other ICT facilities, incidences of power outages, lack of modern school computer laboratories, inadequate trained personnel, negative attitudes from parents toward the teaching and learning of computer studies, lack of funding from government, limited time, overcrowding of classes, and high rate of theft of computers in schools among others challenges (Pelekole, 2017). Findings of the study review the benefits of computer studies on both teachers and the learners but do not clearly state whether skills development in ICT was demonstrated by the performance of the pupils in the ICT final examinations.

Another study conducted in Mazabuka district investigated teachers' and pupils' perceptions of information communication technology (ICT) as an examinable curriculum subject in secondary schools, the study utilised descriptive research design. Findings of Moono (2017) indicate that both the teachers and pupils had positive perceptions towards ICT as an examinable curriculum Subject as most of participants were of the view that current times demanded for ICT knowledge and skill in order for one to be effective and contribute positively in the world of work. The study also established that: lack of trained ICT teachers, inadequate computer hardware and software and irregular power supply were some of the challenges secondary schools faced in the management of ICT Subject. However, the study did not state whether positive perception by both teachers and pupils translated into effective ICT literacy skills transfer of which this study was looking at.

From related literature, it can be noted that lack of specialised ICT teachers and insufficient ICT equipment and infrastructure has been a common challenged faced by most schools in the country. However, other studies did not categorically state in detail the impact of ICT Subject on ICT literacy and how these challenges impacted the performance of the pupils in the final ICT examinations. However, this study like other studies also established the lack of both specialised human and material resources but went further and established the impact of compulsory CS at junior secondary grades on ICT literacy in schools and how the stated challenges had were likely to affect ICT literacy skills transfer and thereby affect performance of the pupils in the ICT final examinations.

METHODOLOGY

The purpose of the study was to establish the impact of making ICT Subject compulsory at junior secondary on ICT literacy in secondary schools of the Livingstone District. In order to fulfill this purpose, the study was guided by the following specific objectives:

1. To investigate the availability of specialised ICT Teachers in secondary schools of the Livingstone District;
2. To find out the availability of ICT equipment and infrastructure in secondary schools of the Livingstone District;

3. To establish the impact of making ICT subject compulsory at junior secondary grade level on ICT literacy in secondary schools of Livingstone District.

Research Site

The study was conducted in Livingstone District of Zambia. The district covers an area of about 695 square kilometers (District Education Board Secretary, 2017) sharing boundaries with Kazungula and Zimba Districts and shares its border with Zimbabwe in the south. Conducting the study in this area enabled the researcher to compare the findings of this study to the findings of other studies which were conducted in other districts of Zambia thereby giving a picture of what was obtaining at national level regarding teaching and learning of ICT subject in the schools.

Population and Sampling Techniques

The Livingstone District has 44 public schools with a junior secondary section, of these 15 are secondary schools running up to grade 12, and 29 are basic schools running only up to grade 9. The study targeted all 15 public secondary schools to avoid the problem of outliers which was the case with some basic schools. The surveyed schools were coded from 1 to 15. The study population covered officials at the District Education Board Secretary (DEBS), head teachers, teachers and pupils in secondary schools of Livingstone District. The study employed non-probability purposive sampling (Kombo & Tromp, 2014) to select the examination standards officer (ESO) and the statistician at DEBS, 15 head teachers of all public secondary schools and 26 teachers who teach ICT subject at junior secondary in the Livingstone District. Furthermore, forty pupils in groups of 10 were randomly selected in four different schools for group discussions, making a sample size of 83 respondents.

Research Instruments

The study utilised interview guide, questionnaires, classroom observation guide and focus group discussion guide (Phellas, Bloch, & Seale, 2011). For head teachers, interviews were used for the sake of clarification where necessary. Low response rate on the questionnaire was not expected since the study was not a country wide or over a very large area. For site visits to the computer lab or classroom observations, observation guide was used.

Validity and Reliability

A pilot study was conducted in two secondary schools in the Mumbwa District to check the validity of the instruments. Weaknesses in the instruments were identified and necessary adjustments made so that the instruments would be used to collect data necessary to this study. Also, triangulation of information from different sources within the same School was used to make the study more robust and reliable.

Data Analysis

The study utilised various data analysis techniques, using notes from interviews with head teachers, documents were generated and thereafter thematic analysis was used, for data gathered from questionnaires and notes made from classroom observations, a quick impressionist summary in the form of narrative reports were used (Kombo & Tromp, 2014). In addition, direct interpretation was employed where necessary (Thompson, 2010). For secondary data, descriptive statistics (Banda, 2016) using Microsoft Excel.

FINDINGS

For primary data (PD), findings were presented under emergent themes and then information tabulated for clarity. For secondary data (SD), descriptive statistics was used then charts, tables and graphs were drawn for easier understanding.

Availability of Specialised ICT Teachers

To determine the availability of specialised ICT Teachers in public secondary schools in Livingstone District, head teachers were asked on the number of teachers they had at their schools that were trained to teach ICT subject. Responses from head teachers were analysed under the following emergent themes: Trained to teach ICT, trained to teach other subjects, employed on parent teachers associations (PTA) basis and teacher background and competences in ICTs:

1. **Trained to Teach ICT:** Head teachers from two secondary schools indicated that they had one teacher trained to teach ICT who were employed by the MOE. The other head teachers indicated that she had two specialised ICT teachers, bringing the total number of schools with specialised ICT teachers to three;
2. **Trained to Teach Other Subjects:** Eight secondary schools representing 53% of the surveyed schools indicated that, they had no teachers who were trained to teach ICT so they had engaged teachers trained in other fields to handle the subject;
3. **Employed on PTA Basis:** Four secondary schools representing 27% of the surveyed schools indicated that they had one ICT teacher each who were employed on PT basis to cushion the lack of trained ICT Teachers at their school;
4. **Teachers' Background and Competences in ICTs:** To find the teachers' background in ICT, teachers were asked whether they had done any form of training in ICT or at least did ICT during their initial teachers training, of the 26 consulted, 12 (46%) teachers indicated yes, the other 14 (54%) indicated that they had no training in ICT and were teaching the Subject out of interest.

Table 2 shows teacher training and background in ICT.

When the teachers were asked how they would rate themselves in terms of skills and competences in ICT, eight (30%) indicated "above average," 18 (70%) indicated "average" and none indicated "below average." Table 3 shows teacher competences and skills as rated by the teachers themselves.

Table 1. Availability and distribution of teachers teaching ICT in public secondary schools

Status of Teachers	Teachers		Schools	
	No.	Percent	No.	Percent
Trained to Teach ICT	04	14%	03	20%
Trained to Teach other Subjects	21	72%	08	53%
Employed on PTA Basis	04	14%	04	27%
Total	29	100%	15	100%

(Source: Data from the field, June 2016)

Table 2. Teachers' background in ICT

Teachers' Background in ICT	Teachers	
	No.	Percent
ICT Trained/ Did ICT during initial training	12	46%
No training in ICT	14	54%
TOTAL	26	100%

(Source: Data from the field, June 2016)

Table 3. Competences and skills of teachers in ICT

Rating	Teachers	
	No.	Percent
Above Average	08	30%
Average	18	70%
Below Average	00	00%
Total	26	100%

(Source: Data from the field, June 2018)

Availability of ICT Equipment and Infrastructure

When head teachers were asked the number of computers and classes the school had and what infrastructure was available to facilitate the teaching of ICT subject at junior secondary grades. Findings were analysed under the following emergent themes: computers are not sufficient, internet is a challenge, specialised computer laboratory and additional ICT equipment and infrastructure:

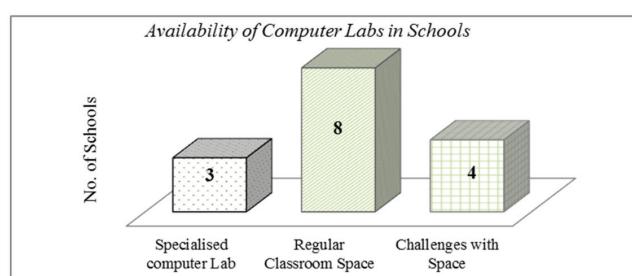
1. **Computers are Not Sufficient:** Head teachers from two secondary schools indicated that they had enough computers. One head teacher said the school had a whole block dedicated to ICT with three computer laboratories and over 40 computers in total, however, the exact number of computers was verified using field notes. The school had 4 streams of classes at junior secondary excluding APU. Head teachers of 13 (87%) secondary schools indicated that the schools had computers but were not enough. One head teacher stated that the school was using refurbished computers and they did not have enough to go around a class. The other head teachers said that the school had 25 computers against 2 streams of classes with an average of 45 pupils per class. Table 4 shows availability of computers in public secondary schools of the Livingstone District;
2. **Internet is a Challenge:** Six head teachers representing 40% of the surveyed schools indicated that it was very costly for the schools to meet internet subscription charges; therefore, internet connectivity was not available most of the times at the school. One head teacher said the school was connected by ZAMLINK and the school was paying K6000 (\$600) plus per month. Head teachers from nine (60%) secondary schools indicated that they had no internet connectivity at the school;
3. **Specialised Computer Laboratory:** Three secondary schools indicated that they had specialised computer labs, eight secondary schools representing 53% of the public secondary schools had converted regular classroom space to be used as computer labs, and four secondary schools indicated that they had serious challenges with space to be used as a computer lab even infrastructure such as computer desks was a problem. Figure 1 shows availability of computer laboratories in schools and Figures 2 and 3 show pictures of computer labs in two secondary schools;
4. **Back-Up Power Supply:** Two secondary schools indicated that they had back up power supply to power the computer lab during Zambia Electricity Supply Company (ZESCO) power outages. The other 13 representing 87% public secondary schools had no back-up power sources. One Head teacher informed the interviewer that one of the challenges they had was with back-up power supply, he further told the interviewer that in 2017 during practical exams power went and was only restored around 11:00 hours. Table 5 shows availability of back-up power sources in public schools;
5. **Additional ICT Equipment and Infrastructure:** Teachers were asked what other equipment and infrastructure was available at the School to facilitate the teaching of the ICT subject. Most (80%) teachers indicated that the schools had a wide range of ICT equipment but the quantities

Table 4. Availability of computers in the secondary schools of Livingstone

School	Number of Classes		No. of Pupils in a Class	Number of Computers		Computer to Pupil Ratio in a Lesson Class	Computer to Pupil Ratio in at Grade 9 Examinations
	G8	G9		2014	2018		
1	3	3	46	32	32	1:2	1:4
2	4	4	40	48	48	1:1	1:2
3	2	2	47	13	25	1:2	1:4
4	4	4	43	6	15	1:3	1:11
5	3	3	40	4	10	1:4	1:6
6	3	3	45	30	42	1:1	1:3
7	1	1	45	20	20	1:2	1:3
8	3	3	45	0	20	1:2	1:7
9	2	2	40	0	24	1:2	1:3
10	3	3	45	20	20	1:2	1:7
11	1	1	40	0	9	1:4	1:4
12	4	4	42	42	42	1:1	1:4
13	3	3	43	20	42	1:1	1:3
14	3	3	40	0	28	1:2	1:5
15	1	1	28	N/A	16	1:2	1:2
TOTAL				235	377		

(Source: Filed data June 2018)

Figure 1. Specialised Computer laboratory in public secondary schools (Source: Data from the field, June 2018)



were not sufficient. Below is a table showing additional ICT equipment and infrastructure available in public secondary schools of the Livingstone District.

The Impact of Making ICT Subject Compulsory at Junior Secondary

Using findings of objectives 1 and 2, the impacts of compulsory CS on ICT literacy in secondary schools in the Livingstone District were established and analysed under the following themes: impact on teachers literacy and competences in ICT, impact on pupils' literacy in ICTs, impact on ICT equipment availability in schools and impact on pupils' performance in the ICT final examinations:

Figure 2. Computer laboratory at secondary school 2 (Source: Captured in the Field, 14/06/2018)



Figure 3. Used as a computer laboratory at secondary school 11 (Captured in the field on 27/06/18)

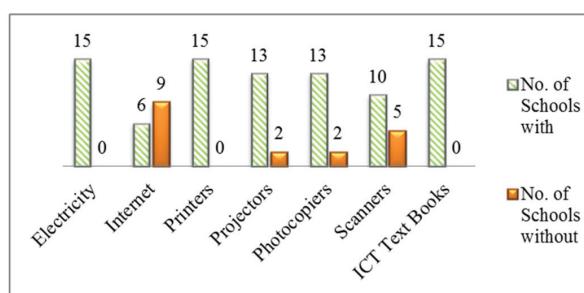


Table 5. Availability of backup power supply in public secondary schools

Backup Power Sources	Schools	
	Number	Percent
With	02	13%
Without	13	87%
TOTAL	15	100%

(Source: Data from the field, June 2018)

Figure 4. Additional ICT equipment and infrastructure available in public secondary schools (Source: Data from the field, June 2016)



1. **Impact on Teacher's Literacy and Competences in ICT:** Findings reviewed that in 2014 when the ICT subject was introduced, one secondary school had two trained ICT teachers while 14 (93%) secondary schools had none, the number had risen to a total of four trained ICT teachers in three secondary schools by June 2018. Findings further reviewed that in 2014, teachers who had no training in ICT were teaching out of interest, however, by June 2018, seven teachers had done short courses in ICT and four teachers were pursuing bachelor's degree courses in ICT with various institutions by distance education. Table 6 shows the training and professional development of teachers in ICT;
2. **Impact on Pupils' Literacy in ICT:** Before the introduction of ICT as a compulsory subject at junior secondary, most (75%) pupils had no access to a computer, therefore, acquiring ICT literacy skills was not easy. This was reviewed when forty pupils were consulted whether they had a personal computer (PC) or if they had access to a computer while at home, two pupils said they had PCs, 8 (20%) said there was at least one at home and 30 (75%) said they had no access to a computer while at home. Table 7 shows pupil access to computers at home;
3. **Impact on ICT Equipment Availability in Schools:** Findings indicated that following the introduction of ICT Subject, there has been an increase in number of computers in the schools. At inception the total number of computers in the 15 public secondary schools surveyed was 235, but this number increased to a total 372 computers by 2018, an increase of 137 computers. Table 8 illustrates the increase in number of computers in Schools;
4. **Impact on Pupils' Performance in the ICT Final Examinations:** The introduction of compulsory ICT Subject at junior secondary when most schools did not have specialised ICT teachers and equipment may had a negative effect on pupil performance in the ICT final examinations, where performance can be used as a measure of ICT literacy levels among pupils. To appreciate the impact of availability of specialised ICT teachers and equipment on the performance of the pupils in the ICT final examinations, results analysis of the grade nine ECZ ICT examinations for public secondary schools in the Livingstone District was done using Microsoft Excel, and the performance of the pupils was as shown in the Figure 6.

Table 6. Summary of teachers' training and professional development in ICT

Training of Teachers in ICT	Year	
	2014	2018
Trained to Teach ICT	02	04
Short Courses in ICT	00	07
On Study in ICT	00	04

(Source: Data from the field, June 2018)

Table 7. Pupils access to computers at home

Access to Computer at Home	Pupils	
	No.	Percent
YES	Own Computer	02
	Others' computer	08
No	30	75%
TOTAL	40	100%

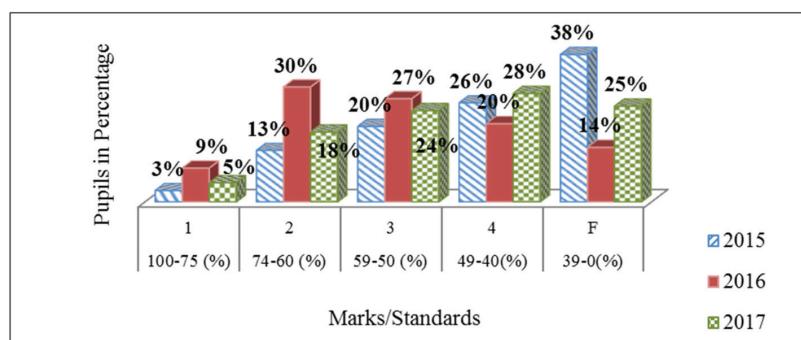
(Source: Data from the field, June 2018)

Table 8. Increase in number of computers accessible to pupils

Number of Computers Accessible to Pupils	Number of Schools	
	2014	2018
Above 20	4	8
11-20	4	5
1- 10	2	2
0	5	0
TOTAL	15	15

(Source: Data from the field, June 2018)

Figure 5. Overall performance of pupils in the Grade 9 ICT ECZ examinations in public schools of Livingstone District (Source: Grade 9 ECZ Examinations Results)



The outcome of the analysis showed that in 2015, some schools were more affected than others, which could be attributed to insufficient or lack of ICT equipment. Mostly affected were the upgraded primary and secondary schools. To further appreciate the correlation of availability of competent ICT teachers and ICT equipment to pupil performance in the final ICT examinations, pupil failure rate in four selected schools, Schools 1, 3, 8 and 9 was plotted. Table 9 shows the number of computers accessible to pupils in the selected school and Figure 6 shows the failure rate of the pupils in the ICT final examinations in these selected schools.

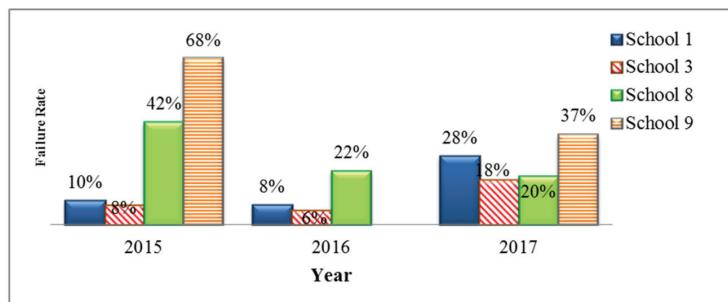
The outcome shows that in 2015 schools 8 and 9 had higher failure rate compared to the other two schools. High failure rate in these schools could be attributed to lack of computers as indicated

Table 9. Availability of computers accessible to pupils in four selected secondary schools

School	No. of Computers		
	2014	2018	
1	3	2	3
3	1	3	2
8	0	2	0
9	0	2	4

(Source: Data from the field, June 2018)

Figure 6. Failure rate in the Grade Nine ECZ ICT examination for four selected secondary schools (Source: Grade 9 ECZ Examinations Results)



in Table 9. In 2016 pupils at school no. 9 did not seat for the ICT examinations due to lack of ICT equipment at the school.

DISCUSSION OF FINDINGS

The discussion of findings was guided and presented under specific objectives.

Availability of Specialised ICT Teachers in Public Secondary Schools

Findings revealed that 3 (20%) public secondary schools in the Livingstone District had trained teachers employed by the MOE to handle the ICT subject, while 12 (80%) public secondary schools did not. Furthermore, findings indicated that not only were the schools with few trained ICT teachers, but that these specialised ICT teachers were not sufficient in that only one secondary school had two well-trained teachers to teach ICT subjects, the other two schools had one ICT trained teacher each against at least three streams of classes at junior secondary.

Even though these findings may not be generalised to other districts, this result is consistent with the findings of other studies such as Mambwe (2016) and Mulenga (2016) that were conducted in other districts, giving an impression that the lack of specialised ICT teachers in secondary schools could be a national challenge and this could negatively impact the teaching and learning of ICT literacy skill in schools. This is because teachers who are not trained to teach ICT subjects could possibly be incompetent to handle the subject (Enochsson, 2010). This is likely to compromise the quality of service delivery.

Findings further reviewed that some teachers had done short courses in ICT which had helped the teachers to have general knowledge in the subject. As much as this strategy may be helpful, systematic and organised training for teachers is required to fully equip them with necessary skills in ICT (Shafika, 2007) and Khvilon & Patru (2002) also confirms that, a well-organised training programme is necessary for teachers in any subject area.

This finding does not agree with findings of Çapuk (2015) which highlights that the US government puts much emphasis on the availability of specialised teachers to teach ICT in secondary schools. In addition, Abuhmaid (2017) argues that technology alone cannot have much effect in the implementation of ICTs, this is a clear demonstration that availability of well-trained Teachers in ICT cannot be overlooked if we are to have a positive impact on ICT literacy in the schools. Also, time spent during short course may not be sufficient to fully equip a teacher with necessary ICT skills.

Findings further indicated that in terms of skills and competences in ICTs, eight (30%) Teachers rated themselves as “above average,” 18 (70%) teachers indicated “average” and none indicated “below average.” It was noted that most of those who indicated “above average” had degrees and diplomas in computer studies and a few had degrees in business studies while most of those who had indicated

“average” had no formal training in ICT. This may mean that teachers who have formal training in ICT exhibit confidence in their teaching of ICT subject while those who are not trained to teach the subject may have low confidence levels to handle the subject which may disadvantage pupils under such a scenario, since confidence is as important as competence (Anderson & Weert, 2002).

Availability of ICT Equipment and Infrastructure

Findings indicated that 12 (80%) public secondary schools in the district had challenges with computers. This is likely to affect the exposure of pupils to computers and many schools may not be able to achieve the minimum requirement of four 40 minutes periods per week broken down as a single double period for practical and 2 single periods for theory lessons per week as stipulated in the computer studies syllabus for grade 8 and 9 (Ministry of Education Science Vocational Training and Early Education, 2013a).

These findings agree with findings of studies which were conducted in other parts of the country and also are consistent with results of other studies which were conducted in other Developing Nations such as findings of Mavellas, Wellington, and Samuel (2016) conducted in Kwekwe, Zimbabwe, and findings of Ngajie and Ngo (2016) conducted in Cameroon. However, this finding is not consistent with findings of Haydn (2009) and Enochsson (2010) which were conducted in the United Kingdom (UK) and Sweden, respectively. Therefore, it appears the problem of insufficient ICT Equipment in secondary schools could be common to most developing nations but not developed ones, this may be an indication that developing nations like Zambia still need to invest more in ICT in education if their ICT sector is to contribute significantly to socio-economic growth.

Findings also highlighted that most (80%) public secondary schools did not have specialised computer laboratories. This finding is in line with findings of Mulenga (2016), Mambwe (2016), and Nyanja (2018), this could be an indication that most schools may not have been ready at the time the subject was introduced and some were still facing challenges to conduct ICT practical lessons and examinations. This could be confirmation that pupils in different schools and Districts were potentially not equally advantaged which could be a barrier to the achievement of fairness in education as stated in the Zambia Education Curriculum Framework 2013 (Ministry of Education Science Vocational Training and Early Education, 2013b).

The Impact of Making ICT Subject Compulsory at Junior Secondary

Objective 3 sought to establish the impact of making ICT Subject compulsory at junior secondary on ICT literacy in secondary schools. Using findings of objective 1 and 2 of the study, the impacts were established and discussed under the themes: impact on teachers’ literacy and competences in ICTs, impact on pupils’ literacy in ICTs, impact on ICT equipment availability in school and impact on pupils’ performance in the final ICT examinations:

1. **Impact on Teacher’s literacy and competences in ICT:** Findings reviewed that the number of specialised ICT teachers had risen from a total of two in 2014 to a total of four by June 2018 in all public secondary schools in the district. Findings further reviewed that by June 2018 seven (07) (24%) Teachers had done short courses in ICT and four teachers were at the time pursuing bachelor’s degree courses in ICT with various institutions on distance basis. Findings demonstrate that after the introduction of ICT as a compulsory subject, teachers developed interest in ICT and were acquiring skills, knowledge and becoming more literate and competent in ICTs. Training in ICT has the capacity to increase awareness among teachers of the benefits ICT brings to education thereby encouraging the use of ICTs in the teaching and learning of other subjects. This is in line with the findings of Abuhmaid (2017) who indicates that 110 teachers in Sweden became aware of the benefits of ICT after being trained in ICT;
2. **Impact on Pupils’ Literacy in ICT:** Findings indicated that 10 (25%) pupils had access to computers at home while 30 (75%) pupils had no access to computers while at home. Introduction

of ICT as a compulsory subject at junior secondary provided most pupils with an opportunity to be exposed to computers, thereby likely to become ICT literate. This means that before the introduction of ICT as a compulsory subject at junior secondary, few pupils had access to computers, therefore had no much opportunity to learn ICT literacy skills. It was also observed that two 13% public secondary schools indicated that they were offering ICT Subject to their pupils even before it was introduced in the curriculum. 13 (87%) said they started offering the subject after it was introduced in the curriculum in 2014 and later. This finding further confirmed that before the subject was introduced in the curriculum few pupils had access to ICTs especially computers but after the introduction of ICT subject more pupils have an opportunity to be exposed to a computer thereby have an opportunity of learning ICT literacy skills. This will help to build a well informed and ICT competent society which is the case with many developed nations (Maryland School, 2015);

3. **Impact on Availability of ICT Equipment in Schools:** Findings indicated that at inception 47% public secondary schools in the Livingstone District had 20 computers or more, but this number had increased to 73% secondary schools with 20 computers or more by June 2018, an increase of 26% schools. Findings also showed that at inception total number of computers in public secondary schools was 235, but this number increased to 372 computers by June 2018, an increase of 137 (58%) computers. Findings demonstrate that the introduction of ICT as a compulsory subject at junior secondary had a positive impact on equipment availability in public secondary schools;
4. **Impact on the Pupils' Performance in the ECZ ICT Examinations:** Findings reviewed that making ICT subject compulsory at junior secondary when schools did not have specialised ICT teachers and sufficient ICT equipment may have strongly contributed to the poor performance of the pupils in the national ICT examinations especially in Schools which had serious challenges or had no computers as was further demonstrated by the outcome of the results analysis for selected public secondary schools in the district. This may mean that the transfer of ICT literacy skills may not be effective.

Results further showed that in 2017 the failure rate had gone up which could be attributed mainly to the manner in which ECZ ICT Practical Examinations were conducted. ICT practical examinations were written over a period of three days and each day, pupils wrote a different paper.

CONCLUSION

The study outlined that most (80%) public secondary schools in the Livingstone District had no specialised teachers in ICT employed by the MOE to teach the subject at Junior Secondary. It was further outlined that some teachers who were trained to teach other subjects had done short courses in ICT. However, it was noted that, as much as this may be a good initiative, organised formal training for teachers in ICT cannot be overlooked.

The study further established that public secondary schools had necessary ICT equipment to support the teaching of the ICT subject, however, computers were not sufficient, in some cases with a ratio of 1 computer to 4 pupils in a lesson class and 1 computer to 11 pupils at final examinations. Therefore, the teaching of the subject and imparting of ICT literacy skills may not have been effective in most cases.

It was also established that the introduction of compulsory ICT subject at junior secondary in schools had an impact on teachers' literacy and competences in ICT, also provided pupils with an opportunity to be exposed to ICTs mainly computers thereby likely to learn ICT literacy skills. Furthermore, it was established that compulsory computer studies at junior secondary amidst lack of specialised human and material resources in the schools may have strongly affected the performance of the pupils in the ICT ECZ Examinations, which may be used as a measure of ICT literacy skill transfer to learners.

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Challenges Facing Faculty Members When Using a Learning Management System

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ABSTRACT

Universities use learning management systems (LMS) to support teaching practices and add value to the educational system. A leading university in the gulf region (XYZ) provides support for faculty members (FMs) through its Center of Excellence in Teaching and Learning (CETL), where experts respond to their enquiries on how to use the LMS features. This study analyzed data available from such interactions and concluded that FMs preferred office (face-to-face) contacting method, assessment is the major generator of FMs enquiries, and also the majority of enquiries were clustered into five major dimensions. Full details and analyses are available in this study.

KEYWORDS

Challenges, Faculty Members, Gulf Region, Higher Education, Learning Management System

1. INTRODUCTION

Using learning management systems (LMSs) is becoming an integral part of educational systems and higher education infrastructure. The contribution of technology toward a better and more efficient system is undisputable. Universities are using LMSs for many objectives. Examples of such objectives are the reduction of teaching/learning cost, the opening of communication channels with students, the facilitation of the learning/teaching process and its eminent tasks, and the management and control of various processes for the purpose of analysis and decision-making. Using such systems will improve universities' performance and improve their image.

Universities try their best to make the adoption and implementation of such systems successful. The main stakeholders involved and interfacing with LMSs are students, instructors, and administrative staff in universities. Faculty members and students are the main users of the system. The success of such system in attaining universities' objectives is dependent on many factors among which users' acceptance is a major one. The adoption and use of LMSs by faculty members will open doors for their utilization and help in reducing costs, opening communication, and better control.

Faculty members face many challenges when using such systems and thus might avoid using them and lean towards traditional methods and channels. The use of LMSs by faculty members can

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be enhanced if universities identified such issues and challenges and addressed them properly. This study will try to explore the challenges facing faculty members, which prevent them from using LMSs or certain parts or functionalities.

The following section will review the literature, followed by a description of our research method. Section 4 will describe the data collection process, the analysis of data, and discuss the results and findings. Finally, our conclusions are stated in Section 5.

2. LITERATURE REVIEW

Information and communication technology (ICT) use in universities is not limited to LMSs; many studies are exploring the use of other channels and applications. Recent research focused on utilizing social media in conducting many educational activities (Aljasir, Bajnaid, Elyas, & Alnawasrah, 2017; Madge et al., 2009; Moran et al., 2011), where such applications are becoming popular among faculty members and students. Other outlets like the Internet, e-mail, and other Web 1.0 or Web 2.0 tools are also utilized by universities in an attempt by faculty members and students to improve the learning process. This study will explore the use of a LMS as a major tool for educational activities. The following sections will try to summarize what the literature reported in this regard.

2.1. Learning Management Systems

Research reported that more than 90% of American universities use LMSs to offer academic programs (Al-Alak & Alnawas, 2011). Learning management systems (LMSs) are portals that help instructors conduct various types of educational activities and reach students through a controlled domain. Universities use more than one system to facilitate the educational process like Learning Management System (LMS), Instructional Management System (IMS), Content Management System (CMS), and Student Information System (SIS) (Abu-Shanab et al., 2012).

LMSs help manage the practices and activities related to teaching and learning. Activities like registration, scheduling, facilitating and augmenting the communication between instructors and students, examination of available content, tracking students' performance, reporting performance to targeted stakeholders and students are examples of such cases (Yung-Ming, 2011). Recent versions of such systems are equipped with chat rooms, discussion forums, e-mail, and blogs. Furthermore, instructors can conduct detailed and rich assessments, perform surveys, and check attendance.

LMSs enable faculty to develop and deliver learning content, communicate with students, and enable open discussion (Kalinga, Bagile, & Trojer, 2007). Some LMS applications are difficult for instructors to administer and use like organizing virtual office hours, automatically reminding students of their deadlines, and using group functionalities (Yueh & Hsu, 2008).

Universities can benefit from open source portals like Moodle or Dokeos or many other available commercial and proprietary types if they pay their licensing and support costs. Examples of famous LMSs available in the market are Blackboard, WebCT, or Atutor (Abu-Shanab & Ababneh, 2015). Other examples of e-learning systems used in higher education are the following: TopClass, LearningSpace, Virtual-U, and FirstClass Classrooms.

XYZ is using one of the major LMSs in the market. It is mandatory for its faculty members to use the LMS to post content and grades. Faculty members are also encouraged to use other features such as announcements, assignments, discussion boards, online exams, attendance, etc. The university has recently grown to have nine colleges. It has around 20,000 students and above a thousand Faculty members. All new faculty members who join XYZ attend, as part of their orientation program, a mandatory training on how to use the different features of the LMS. The university offers ongoing workshops through the academic year to all faculty members on how to use intermediate and advanced features of the LMS. Tutorial videos and documents are available on the university website for their reference. They can also seek support by phone, email or office appointments with the LMS experts when they need help or have certain enquiries.

2.2. Benefits of LMS

The major claimed purpose of using LMSs is to apply pedagogical policies and strategies in a more effective and efficient manner (Abu-Shanab & Harb, 2011). As described earlier, LMSs can help universities, faculty members, and students in many activities. The list of activities provided by LMSs is endless. LMSs support most educational activities and the list is growing (Yung-Ming, 2011). The recent improvements on LMSs enable them to interact and interface with many applications to facilitate the learning process. Another study concluded that planning and building technological changes and integration into an organizational strategic planning process would ensure continuing and effective integration of technology in teaching (Yang & Spear, 2017).

LMSs help faculty members manage their time to reach better efficiency and chances for innovation and creativity. Using administrative and educational tools available within LMSs, instructors can design, author, and develop instructional material and components to support the learning/teaching process (Abu-Shanab et al., 2012). The authors also emphasize the role of LMSs in facilitating an effective guidance and support, where instructors can interact with students and other associates using the available communication tools available through the system.

A study in the School of Education at the University of Alabama conducted few interviews with faculty members regarding the use of Blackboard, a popular LMS, and concluded to positive perceptions regarding the use of such systems. The author concluded that Blackboard might improve communications, nurture community sensation, and escalate productivity and expectations of students and faculty (Anderson, 2003).

Research also reported conflicting perceptions regarding their benefits. A study compared students and teachers perceptions and concluded that Eduwave, a Learning Management System, can attain university objectives, support teacher's role, support educational activities, influence students' learning process, and facilitate and improve communication and collaboration (Abu-Shanab, 2014). The author compared teachers and students perceptions and found that teachers perceive LMS as useful and trustworthy. On the other hand, students reported favorable perceptions towards the ease of use of Eduwave and their future intention to use the system.

2.3. Challenges Facing Faculty Members

Research related to technology adoption theories reported many factors that cause resistance or hinder organizational efforts to adopt such applications (Al-Alak & Alnawas, 2011). LMSs are not an exception. Examples reported by the authors included perceived usefulness, perceived ease of use, knowledge, trust, social influence, and others. Research investigated many factors in an assumption that they might cause a challenge for faculty members. Similar results supported similar constructs proposed in the UTAUT model (Social influence, performance expectancy and effort expectancy) in predicting the intention to use technology in higher education institutions (Rosaline & Wesley, 2017).

In a study in Newzealand, the researchers concluded that the major challenge facing faculty members is their ICT literacy (Nanayakkara, & Whiddett, 2005). The study assumed that faculty members, with better knowledge and more experience, would demonstrate higher acceptance rates. The second contribution of the study is their conclusion that people are different in their adoption in early vs. late stages of system implementation. Another study proclaimed that using traditional face-to-face methods are more effective than using LMSs or electronic channels (James, 2008). The author conducted the study in Thailand and utilized a sample of faculty members in a process of investigating the challenges facing faculty members in adopting e-learning systems. Based on faculty members competencies, the author stressed the importance of training faculty members to better equip them with needed skills and bridge their resistance.

In alignment with the previously mentioned study, self-confidence was a major predictor of instructor's adoption of LMS. Another study indicated that age and job satisfaction are not influencing the adoption of e-learning systems (Tarthini et al., 2013). Furthermore, a study of 212 responses of faculty members in the USA concluded that ICT background is not a major determinant of technology

adoption (Kamali, 2012). Finally, a study proclaimed that the nature of online learning requires faculty members to be more attentive and be prompt communicators, which rest heavier loads on their shoulders (Li & Irby, 2008).

LMSs can cause substantial challenges with respect to technical issues, where major efforts by universities target faculty members to help them manage all types of activities. Still, some studies reported that faculty members need material that can be easily and semantically managed on LMSs (Davidson, 2005). In such situations, universities need to devote more effort and resources to support faculty members in accommodating their material and content requirements.

On the same line of argument, faculty members embracing such systems (using LMSs) require more advanced training if they need to implement certain activities. A study conducted in Poland concluded that teachers in general adopt LMSs but resist the use of activities that require an advanced skill (reported by less-experienced teachers). The study reported that (66%) of teachers used LMSs for teaching, but less than (10%) use LMS tools to support testing and assessment (Moscinska & Rutkowski, 2010). Faculty members also reported that some LMSs require that they train students so they effectively and efficiently use the system (Coyner & McCann, 2004). Faculty members reported that during online assessment, any deficiency in the process might cause a dilemma for faculty members. Taking the previous challenges into a higher level, the seamless integration of technology and pedagogy would become a big challenge for faculty members (Karsenti, 2001).

In the Middle East, a study in Saudi Arabia concluded that LMSs are popular and fully supported by faculty members, but reported low implementation and use. Such contradictory result might indicate some challenges facing universities and faculty members in using such systems (Hussein, 2011). The study also reported insignificant influence of gender and academic background in adopting such systems.

Another study, aiming to explore students' attitudes toward online assessment using Blackboard (BB) grade center and assessment tools, proclaimed that faculty members' attitudes toward BB is influencing students' motivation for embracing the system. The author of the article used the word "intricacies of the system" to describe BB assessment tools (Fageeh, 2015). The author recommended that more training be provided for instructors and students on the system. In addition, more language options are useful to facilitate certain types of courses. Finally, another study in Jordan revealed that the quality and involvement of users in implementing LMSs are the major obstacles facing universities. Faculty members reported that the two reasons are the major ones that hinder their adoption efforts (Altarawneh, 2011).

In conclusion, we can summarize that faculty face significant challenges when using a LMS. Reported reasons were conflicting, but can be summarized in the following: technical skills needed by faculty, training required for faculty and students, infrastructure adequacy and system efficiency, compatibility of system, and the integration of pedagogical objectives and technical characteristics of the LMS.

3. RESEARCH METHOD

This study explored the literature to better understand the challenges facing faculty members (FMs) in using the LMS. The majority of previous research focused more on the adoption of LMSs from a behavioral direction (refer to the previous sections), neglecting the functionalities of a specific LMS and how FMs use them. The use of an LMS improves the efficiency and effectiveness of the teaching/learning process, makes it convenient, and reduces the university cost. The use of any LMS by faculty members is accompanied by many challenges. Such challenges will hinder the use of such important systems by faculty.

This study tried to investigate the different functionalities of a specific LMS and the challenges facing FMs when using them. The view of data is reversed, where we utilized available data collected for the purpose of reporting the performance of the Center of Excellence in teaching and Learning

(CTEL) in XYZ university. In XYZ, faculty are encouraged to use the adopted LMS, where many resources are available for them like online courses and help files. In addition, The University offers training courses and one to one consultation through its CTEL.

Center of Excellence in teaching and Learning (CTEL) is responsible of supporting academic staff at XYZ through different types of activities. One of these major activities is to organize workshops for FMs to help them be acquainted with available systems and improve their teaching and administrative performance. A set of these training workshops will focus on the use of the LMS at the university. Faculty members can also refer to the CTEL staff for some help by office appointments, phone or e-mail. Such support help faculty members when using the LMS and facilitate the adoption of such system.

The CTEL team keeps a record of such consultations and their proceedings. The data collected reveals many challenges facing faculty members when using such a tool for the purpose of managing the teaching process. The data used in this study was collected during the academic years 2014-2017 (Three academic years; 2014/2015, 2015/2016 & 2016/2017). As mentioned, the purpose of collecting such data was for reporting and performance purposes. The data collected is tabulated using a spreadsheet application to make it easy for analysis and exploration. The following are the column headings of the available data: Date of contact, trainer, month, FM name, FM e-mail, FM College, contact method, Enquiry details, and comments. A manual clustering and summarization technique is implemented to conclude to the major challenges facing FM when using the LMS. The study analyzes other issues related to the consultation preferences, the college of FM, and other related issues.

This study is a descriptive one, where we tried to use the existing data to describe the challenges that FMs face when using the LMS. It is still imperative to keep in mind the other side of the coin when investigating the adoption of technology, i.e. behavioral and contextual factors. The technology adoption theories explored many factors like the system's usefulness and ease of use, the social influence, the infrastructure and environment, the risk and security issues, trust in technology, and other important factors. This study will take the functional view and see FMs challenges when using the LMS based on its functionalities and actual use. Such perspective is important as it exposes new perspectives and enrich our knowledge in this domain.

4. DATA ANALYSIS AND DISCUSSION

The first step in our analysis to organize and clean data to prepare for our use. The names and e-mails of FMs were removed from the file for privacy reasons. The college column was kept for further analysis. The second step was to clean data from mistakes and redundant terms. Examples of such redundancy and errors are the following: the names of colleges were used in different forms (acronyms vs. full names), the enquiry names were also misspelled or written differently (SafeAssign vs. Safe Assignment), or errors in some terms (quickly vs. qwickly). The data was also cleaned for missing values within the data records and for any type of contradiction with the set of known activities and tasks in this specific LMS.

After cleaning the data and merging the three files into one consolidated file. The resulting file included 424 enquiries. The analyses utilized pivot tables to classify the frequencies of data and summarize and cluster data into its final form. The list of unique enquiries distilled from the data set included 26 categories ranging from communication to assessment. Table 1 lists the enquiries categories and the method of contact. As mentioned, the CTEL trainers supported FM through multi-channel communication. They responded to enquiries through phone, e-mail, office visits, and after the training workshop. It lists the frequencies of enquiries per each category and per contact method. The grand total of columns and rows represents the total enquiries for each enquiry type of contact method.

We notice that the top five frequencies were all related to an assessment related category except one related to communication. The highest numbers of enquiries are related to grade center (119

enquiries), test (97 enquiries), SafeAssign (48 enquiries), create assignment (26 enquiries), and the last is related to discussion boards/forums (22 enquiries).

Table 1 shows the data classified into five major dimensions based on the LMS major functionalities and our perspective of the topic. We listed the dimension names in the last column, where we summarized all enquiries' frequencies into these five dimensions. Such classification is limited by our data set, even though the LMS vendor reported their own classification of the overall functionalities into three: building courses, enhancing communication, and assessing learners. Our classification concluded to five categories: general and management, building courses, communication, assessment, and other tools. Once we had our categories in place, we classified all enquiries into the five dimensions. Then numbered them as shown in Table 1.

Table 1. Enquiry frequencies based on type and contact method

#	Enquiry Name	Contact Method			Grand Total	# (freq)	Dimension	
		After session	Email	office				
1	Access & Permissions		3	2	4	9	1 (58)	General and Management
2	BB Introductory		3	8	4	15		
3	Course Availability		3	3	1	7		
4	Course Customization/Style		1	1		2		
5	Groups/Users	1	1	4	6	12		
6	Qwickly Attendance		1	8	4	13		
7	Camtasia Recording		1	5	1	7		
8	Content				1	1		
9	Content Area		2	3	4	9		
10	Uploading Content		2			2		
11	Announcements		1		3	4	2 (19)	Building Courses
12	Collaboration (Lecture Hall & Office Hours/chat)		2		1	3		
13	Discussion Board/Forums		1	19	2	22		
14	Email	1		1	2	4		
15	Notifications Dashboard		1	1	2	4		
16	Assignment			3	3	6	3 (37)	Communication
17	Create Assignment	1	3	11	11	26		
18	Generating Reports		1		1	2		
19	Grade center	2	8	69	40	119		
20	SafeAssign		3	27	18	48		
21	Surveys		1		1	2		
22	Tests	1	14	50	31	97		
23	Echo on BB		1	1		2	4 (300)	Assessment
24	Online Books			1	1	2		
25	Packages & Utilities		3		1	4		
26	Tools area			1		1		
Grand Total		6	56	218	142	423		

Extending our inspection to the dimension level, we can see that assessment was the highest enquired dimension (300 enquiries). Table 1 shows the grand total enquiries of each category and to what dimension it belongs. In addition, the # (Freq.) column indicates the dimension number and the total number of enquiries reported. Less enquiries were reported in relation to building courses and other tools. To have a better understanding of this issue, the data should have included the time spent on each category. The number of enquiries might indicate a measure for the difficulty of dimension (and its categories) or the degree of use.

The second direction related to Table 1 is the contact method used. It seems that FMs prefer face-to-face interaction as the enquiries done through after session and office visits are 224 cases compared to 142 and 56 for phone and e-mails respectively (based on data in Table 1). Considering the preferred means of communication, phone channel has also a commonality with the face-to-face channels as it includes a synchronous nature. It seems that FMs are appreciating a fast and direct response from CTEL staff, where the direct channels dominated the channels available.

The second analysis done included the list of enquiries and the FM's college. Taking such analysis further will reveal the credentials of FM. In addition, the data used did not include the department of FM. The Blank column indicates a non-reported college for the FM, taking into consideration the diversity of contact method. The list of Colleges and their appreciations are listed in Table 2, Followed by Table 3, which includes the enquiries.

Table 2. Colleges appreciations used

Acronym	College or Program Name
CAS	College of Arts and Sciences
CBE	College of Business and Economics
CCP	Core Curriculum Program
CED	College of Education
CENG	College of Engineering
CHS	College of Health Sciences
CLAW	College of Law
CSIS	College of Sharia and Islamic Studies
FP	Foundation Program
CCP	Core Curriculum Program
Other	Other centers and departments

The data included no enquiries from the College of Medicine, and the College of Pharmacy. In addition, we can see two columns that include other and blank. The blank column includes enquiries with no college or program reported. The other category includes other departments and centers not included or distinct from the lists colleges.

Table 3 shows that the highest numbers of enquiries are associated with CAS (242 enquiries) and the CBE (60 enquiries). On the other hand, we should report here that the largest colleges in XYZ based on student and FM numbers are the CAS and CBE. Such issue explains why we have such large number of enquiries.

Our investigation could not reveal any reasoning (other than size) for such frequency distribution as the type of college is not a well-defined criteria in this context. XYZ had jointly merged arts and sciences in one college. Also, some scientific college had less presence in the list even though they

Table 3. Enquiry frequencies based on FM's College

Enquiry Name	College or Program										Grand Total	
	CAS	CBE	CCP	CED	CENG	CHS	CLAW	CSIS	FP	Other		
Access & Permissions	3	1		1					2	1	1	9
BB Introductory	11	2		1							1	15
Course Availability	4	2			1							7
Course Customization/Style	1								1			2
Groups/Users	3	3		1	3					2		12
Qwickly Attendance	8				2		2		1			13
Camtasia Recording	3	3			1							7
Content								1				1
Content Area	5			1						1	2	9
Uploading Content		2										2
Announcements	2	1			1							4
Collaboration (Lecture Hall & Office Hours /chat)	1	1						1				3
Discussion Board/Forums	16	1		3						1	1	22
Email	2	1									1	4
Notifications Dashboard		1		2						1		4
Assignment	2				1						3	6
Create Assignment	17	4		2		1		1			1	26
Generating Reports		1		1								2
Gradecenter	77	15	4	6	6		2	1			8	119
SafeAssign	31	5	2	4	4			2				48
Surveys		1		1								2
Tests	53	13		4	2	2	2	8		6	7	97
Echo on BB		1					1					2
Online Books		1									1	2
Packages & Utilities	3	1										4
Tools area					1							1
Grand Total	242	60	6	27	22	3	7	14	4	12	26	423

might be perceived as similar (like CHS vs. College of Medicine or Pharmacy). Future research might try to cluster the enquiries into colleges and see what categories are more associated with a certain college or a certain contact method.

The last analysis done is related to the date of enquires. The data was labeled according to the month of enquiry and then the semester. The data was represented visually using a column chart to show the trend of frequencies change. Figure 1 depicts such results. The months are not sequential as the data did not include any enquiries in the month of July, and few were reported for the month of August (in all three years). Based on that the columns are 31 columns only. An increase in enquiries is witnessed in the third month of each semester. This can be explained by the start of assessment and midterm exam and the serious use of assessment activities.

Another column chart depicted the data according to semesters and is shown in Figure 2 and Table 4. The data indicates a rise in enquiries in Fall semester each year based on new recruitment and the extensive scheduled training for new faculty members. It is also visible that enquiries increase with time as more use of the LMS is expected. Finally, XYZ policies require that new faculty members attend some LMS workshops and use the LMS in their management of the teaching process.

Figure 1. Enquiries related to month (ranked from August 2014 to June 2017)

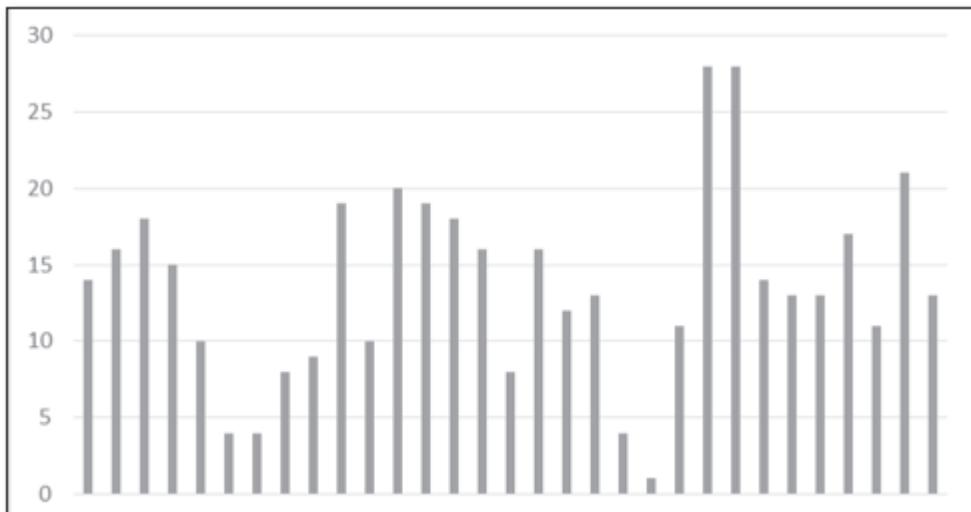


Figure 2. Column chart representing semester related data

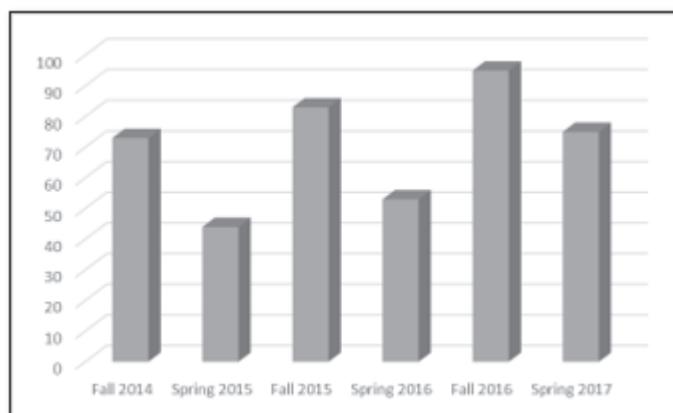


Table 4. Semester related data

Semester	Enquiries
Fall 2014	73
Spring 2015	44
Fall 2015	83
Spring 2016	53
Fall 2016	95
Spring 2017	75

5. CONCLUSION

Research on LMS is challenging, as it requires some type of accessibility to university data, which can be difficult in many cases. This study utilized previously collected data by a CTEL (Center of Excellence in Teaching and Learning at XYZ University). The data included the FMs enquiries during their use of the university LMS. The data spanned for three years and included 424 enquiries. The analysis of data focused on three main directions: First, the distribution of enquiries according to colleges. Second, the distribution of data according to contact method. Finally, the distribution of enquiries according to time. Results indicated that the majority of enquiries were from FMs from College of Arts and Sciences, and College of Business and Economics. Results also indicated that FMs preferred office (face-to-face) contacting method rather than other open channels of communication.

Finally, more enquiries were triggered during the Fall semester when compared to the Spring semester. The 26 categories reported in the data file were clustered into five major dimensions. The dimensions were general management of the learning/teaching process, building courses, communication, assessment, and other tools used. All previous results are summarized in Tables 5 and 6.

Table 5. Enquiries related to colleges clustered into the major five dimensions

Dimension	CAS	CBE	CCP	CED	CENG	CHS	CLAW	CSIS	FP	Other	(blank)
General and Management	30	8	0	3	6	0	2	0	4	3	2
Building Courses	8	5	0	1	1	0	0	1	0	1	2
Communication	21	5	0	5	1	0	0	1	0	2	2
Assessment	180	39	6	18	13	3	4	12	0	6	19
Other Tools	3	3	0	0	1	0	1	0	0	0	1
Grand Total	242	60	6	27	22	3	7	14	4	12	26

Table 6. Enquiries related to contact method clustered into the major five dimensions

Enquiry Name	After Session	Email	Office	Phone	Total
General and Management	1	12	26	19	58
Building Courses	0	5	8	6	19
Communication	1	5	21	10	37
Assessment	4	30	160	105	300
Other Tools	0	4	3	2	9
Grand Total	6	56	218	142	423

Based on the previous results, this study concluded that assessment is the major generator of FMs enquiries. In addition, CTEL can conduct focused sessions for the two major colleges to support FMs in their locations and encourage them to use the LMS. The research team, and based on the examination of the communication channels open for FMs to contact the CTEL trainers, recommends opening a discussion board (or a forum) that make available all enquiries to all members and open a direct synchronous channel. Even though the major contact methods are related to face-to-face medium, still, a discussion forum open for FMs will reduce the number of enquiries and help reduce

common categories. CTEL trainers need to understand that the limitation associated with forums is that FMs might not accept revealing their identity. Such a limitation might hinder such channel. A “Frequently Asked Questions” page (FAQ) is another recommendation that can solve the issue of identity and can include answers to many common questions.

5.1. Contribution of Research

As we mentioned earlier, research on actual data related to faculty members' use of LMS is challenging. Many universities are keen on providing access to such data for the purpose of research. This study is the first to examine the adoption challenges of a specific LMS based on data related to its functionalities. Results revealed important insights around the frequencies of enquiries among colleges and contact methods. We also gained important insights of FM preferences on their preferred contact channel. Finally, this study utilized real data based on a long period of time that mapped and revealed important conclusions on the topic of interest.

One of the major contributions of this study is its longitudinal perspective, where data was collected during the years 2014-2017. Such perspective is rich, where a collective image of the issues discussed in the conclusions and the previous paragraph of this subsection is formulated. One of the major initiatives of the university is to open all needed material for faculty members online, which neglects the F2F interaction requested by substantial portion of FMs. This result supports the findings of (Budu, 2018), where their qualitative analysis concluded that subjects might be keen on opening their mind in an online environment and prefer F2F settings for convenience. They also stressed the anonymity aspect, which might be at risk if we use the formal e-mails/channels of university.

5.2. Limitations and Future Work

This study suffered from its small sample size and simple data set collected. The richness of behavioral studies is lacking, but was compensated by the data type and its originality. This study utilized secondary data that was collected for the purpose of reporting and performance. Future work can add more dimensions to the existing data, where clustering techniques can be utilized to come up with certain categories related to certain colleges or contact methods. One of the approaches to explore such direction of research is to design a different research instrument to capture such proposed dimensions.

The other direction of research is to control for the role of the training office and directly contact faculty and explore their perceptions regarding the research questions. Future work can also utilize scale related data that can depict the interactions of diverse constructs in this domain.

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Factors Affecting Woman's Continuance Intention for Mobile Games

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ABSTRACT

The article finds the main factors affecting women's continuance intention for mobile games, and analyze how and to what extent these factors affect women's continuance intention for mobile games in a research model. In this study, a Model of Factors Affecting Women's continued interest in mobile gaming is comprised of eight variables and relevant hypotheses has been created based on a technology acceptance model (TAM), and three theories of flow theory, the theory of scenarios, and customer satisfaction theory. Also, a questionnaire survey involving 319 female mobile gamers was conducted, and all hypotheses have been verified using a structural equation model. Research results show that the perceived challenges, novelty, and cost of mobile games had significant positive effects on the perceived enjoyment of female mobile gamers; the mobility of mobile games had significant positive effects on the perceived ease-of-use of female mobile gamers; perceived enjoyment and ease-of-use had significant positive effects on female gamers' continuance intention for mobile games; while the security of mobile games had no significant effect on the perceived ease-of-use of female mobile gamers.

KEYWORDS

Continue to Use, Influence Factors, Mobile Game, Women

INTRODUCTION

Thanks to the rapid popularization of smartphones which provides us much easier access to internet technologies and interactive design, the burgeoning mobile games industry has experienced explosive growth in consumers, who, showing gradual acceptance of mobile games and gaming services, have turned from passive consumers to active consumers (Merikivi, Tuunainen, & Nguyen, 2017). According to I-research, in 2016, China created a 102.28 billion yuan mobile games market with 521 million consumers, up 81.9% and 14.5% respectively over the previous year (Iresearch, 2017). A surprising fact is that today, most mobile gamers are female not male as thought by many. Mobile analytics company Flurry recently released a report, claiming that based on a sample of games that

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reached a total of 1.1 million devices on its platform, they have found that women make 31% more in-app-purchases than men, spend 35% more time in gaming apps than men, and have 42% higher 7-day retention on average versus males. The constantly growing number of female gamers has increased their position and importance, and of course, their value in the eyes of game developers. A consumer segmentation now, existing and potential female gamers have become an important force driving the development of the mobile games industry (Wang, Lee, & Hsu, 2017). Women tend to spend more money on in-app-purchases. Compared to men, they also spend more time in gaming and social apps during break and travel times, and before sleep, obtaining aesthetic experiences in this process. Even though, factors affecting women's continuance intention for mobile games have seldom been studied at present.

In previous studies, models and theories for using mobile games were mostly based on a specific model, and less introduction was provided to other theories; thus, a more comprehensive analysis of influencing factors was lacking. Moreover, limited research was conducted on the continuous usage intention of females. Hence, focusing on the continuous usage intention of female mobile game users and combining the scenarios and satisfaction theories, this study comprehensively investigates the influencing factors of the effective and continuous usage intention of female mobile game users, determines manners to engage users and increase user loyalty, thereby attracting and retaining more users and promoting the development of the mobile game industry.

In this study on the mobile games usage intention, the factors affecting the mobile games usage intention are summarized into three major factors—personal, technical, and social. Besides, based on the consumer acceptance theory, studies have also summarized the key factors for the success of mobile games—content innovation, game time, social network experience, and convenience of operation. Mobile games are associated with flow, and girls reported higher flow experience scores than boys ($d = 0.30$) (Bressler, 2019).

A summary of previous reports concluded that in the measurement indicators covered by the technology acceptance theory, perceived entertainment and perceived usefulness are two determinants of the mobile games usage intention. Perceived efficiency and perceived interest exert a direct and positive impact on the adoption of mobile games. In addition, perceived entertainment plays a key role in the attitude of users, and age is a key factor in the adoption of mobile games. Furthermore, studies have suggested that performance expectation, expectation effort, social impact, and promotion conditions affect usage intention of users by determining the attitude of users to play games on mobile phones.

As the development of mobile games is yet to be improved in technical ability, scholars' research on mobile games tend to focus on the technical level; while the related research on user behavior is less, especially on the behavior of female users. In the available research, the following problems remain to be effectively resolved: how to effectively acquire more new female users? What factors affect the continuous usage intention of female users? How does the experience quality of female users of mobile games affect user stickiness?

The traditional theoretical model has a certain explanatory power for the related applications in the mobile Internet field, but the self-particularity of the mobile game declines the interpretation ability of a single model. Thus, it is essential to establish a specific model to enhance the predictive ability of the receptive behavior of mobile game users by combining relevant theories for specific applications. Thus, this study constructed an influence factor model of female continuous usage of mobile games based on the available research models and the characteristics of mobile games.

This study integrated flow theory and technology acceptance model to identify factors that influenced Women's intention to use mobile game. The rest of this paper is structured as follows.

Section 1 introduces the research background, research status and research problems. Section 2 shows the technical background of mobile games and the research status of user behavior. Section 3 discusses the research model and hypothesis. Section 4 presents the research methodology. Section 5 introduces the data analysis and results. Section 6 puts forward the conclusions. Section 7 Discussion

the theoretical and managerial implications of the study. Section 8 Provides limitations and directions for future research.

LITERATURE REVIEW

Previous academic studies primarily focused on the design and development of mobile games, ignoring customer loyalty which has actually become a key factor affecting the market share of mobile games. During the study, we've noticed the lack of research on such factors as consumers' intention to play mobile games, consumer behavior in playing mobile games, and channels through which consumers introduce mobile games to other. Although there is little literature directly connected with our research, we've found a lot of indirectly connected literature studying SNS games and other mobile games for the elderly, students and the disabled.

Profile of Mobile Game Development

Such studies mainly focus on the status quo, history, development strategies and reshaping of the mobile games industry. Okazaki, Radoslav, and Ildefonso (2015) summarized the development of mobile games industry in Japan, Korea and the U.S., and analyzed factors affecting young people's choosing mobile games from a cross-cultural perspective. They divided online games into web games, network games and pure online games. Web games are online multi-player interactive games played through a web browser, requiring no downloading of apps, or high-performance computing configurations. Network games are network-based sustainable individual multiplayer online games, which, using operators' servers and gamers' computers as terminals, and apps for information interaction, provide entertainment, leisure, communication, and virtual experiences to players (Alzahrani, Mahmud, Ramayah, Alfarraj, & Alalwan, 2017). Pure online games, with the largest number of players, comprise diverse genres, such as role-playing games, gladiatorial games, shooting games, puzzle games, and strategy games. Gamers may play different roles with the help of VR technology. Different roles, things and events, and surprising experiences are designed to help gamers gain a sense of achievement (Lee, Hsu, & Chang, 2013; Lin, Hung, Fang, & Tu, 2015; Lu & Wang, 2008; Pan & Fu, 2013).

Chang, Liu, and Chen (2014) conducted a questionnaire survey and built a structural equation model to verify the effects of hedonism and social factors on player continuance intention for mobile games. Results show that utilitarian motivations (good reputation, position, and effective value) can enhance the intention of gamers to constantly play games, and interactivity and multimedia enjoyment have become key factors determining game design. The study suggests that all factors of long-lasting enjoyment were equally important.

J. Hamari and Sjöblom (2017) studied factors affecting the appeal of eSport games. A pilot survey was conducted before a questionnaire survey involving 888 respondents. Results show that knowledge acquisition, escapism, and innovation had positive effects on gamers' frequency of playing online games. In the same year, (Vashish & Sreejesh) verified the effects of nature of advergame and moderating roles of game-product congruence and need for cognition on gamers' ad-persuasion from the perspectives of attention and elaboration. The results indicate that slow-paced advergames are more persuasive than fast-paced advergames.

The mobile games industry has shifted its focus from traffic acquisition and rapid realization to content innovation, industrial innovation and customer value maximization, including digging into the core value of female mobile gamers to develop their loyalty.

Research on Mobile Game Implementation Technology

Such studies mainly focus on the selection and design of mobile game development platforms. Thanks to advances in technology, mobile games have experienced the transition from black and white screens to color screens, and from 2D to 3D. At present, the most widely used mobile game engines are Cocos2d-X for 2D games and Unity 3D for 3D games. The former, supporting cross-platform

compiling, features a low technological threshold and a much shorter development cycle. Based on advanced game development models, Cocos2d-X describes all objects in game development through integrated application of third-party databases, SDK components, and other resources and tools, avoiding chaotic processes (Ahreum, Kibrum, Hokyoung, Jieun, & Gyuhyun, 2015; Chuang-Chun & I-Cheng, 2016) during game development. Given the characteristics of Cocos2d-X, many researchers have studied the R&D of Cocos2d-X-based mobile games (Yang Liu, Daniel, & Dongping, 2016). Compared with Cocos2d-X, Unity3D, which also supports cross-platform compiling, additionally incorporates other functions such as DirectX and OpenGL graphics Libraries, and various components and scripts. Besides, game developers may purchase Unity3D development codes and models from Unity (Yang & Sik, 2014). Boasting enormous advantages in the development of 3D games, Unity3D has been widely studied by foreign researchers for game design and development (Bae & Kim, 2014). De Kervenoael, Palmer, and Hallsworth (2013) analyzed factors affecting consumer choice from industrial and technological perspectives, and found that consumer choice was affected by regulating the self-regulated, understanding anti-choice, boundary-setting and including the self-excluded.

User experience, especially product availability, has been widely studied. In comparison, there are only a few studies analyzing the affective reception and aesthetic experiences of gamers from very limited perspectives. In a word, current studies have only noticed the importance of customers' acceptance of games, but ignored the importance of customer loyalty.

Empirical Research on Mobile Game User Behavior

Previous studies on the behavior of mobile gamers mainly focus on factors affecting the willingness of gamers to play games, and some methods to increase the loyalty of gamers have been developed in the process of research (Park, Baek, & Ohm, 2014). Most studies first built research models based on the TAM (Okazaki et al., 2015) and collected information, trying to find new factors affecting the behavior of gamers. Then, empirical studies were conducted to verify the research models. Okazaki et al. (2015) discovered that perceived ease-of-use directly affected perceived efficiency and perceived enjoyment in a positive manner.

There is a gradually growing number of studies on the behavior of old people and children as mobile gamers, but studies on female gamers are still rare. Schmitz, Klemke, Walhout, and Specht (2015) reported a mobile game application where children played an active role in the simulation of a dynamic process and provided principles and process for the interactive design of children's mobile games. Based on mobile games, they built an online environment encouraging the ubiquitous learning of children. Wang et al. (2017) noticed that loss of jobs, broken relationships, and failure in interpersonal relationships were reasons behind women's participation in mobile gaming. Merilampi et al. (2014) evaluated the effects of mobile games on older people with memory impairment. Findings indicate that mobile games can enhance the recreation and self-managed activity level of old people with memory impairment, and can potentially assist them in self-rehabilitation and extending independent living. With the growth of the older population, more mobile game apps will be designed for old people, helping them reduce cognitive decline. There are also studies reporting that mobile games can improve the quality of life and mental health of old people (Cota, Ishitani, & Vieira, 2015), and help children with hearing impairment in overcoming hearing problems (Neves, Vanessa, & Tania, 2017).

Values, consumer experience, lifestyle, safety, perceived risk, and subjective norms exert a more significant impact on users' intention to purchase mobile games. Online mobile game addiction significantly positively correlates with online mobile game loyalty and positively correlates with purchasing online mobile game applications. User online mobile game loyalty increases the intention to buy mobile games (Balakrishnan & Griffiths, 2018). In addition, usability, perceived ease of use, and flow experience can promote the continuous use behavior of mobile game users. As a crucial scenario variable, diversion not only indirectly affects the continuous usage intention through the flow experience but also directly affects the continuous usage intention of the situation mobile game

(Yanni Liu, Liu, Yuan, & Archer, 2018). Students lack enthusiasm because they consider remembering English words and vocabulary are boring learning activities. The vocabulary learning system based on mobile games could effectively attract students' attention and interest, thereby producing better learning effects and providing positive feedback on learning motivation (Wu, 2018). Mobile games can effectively enhance users' creativity. Teenagers with a higher artistic sense of self-efficacy prefer playing situation mobile games than teenagers with lower self-efficacy; situation mobile games focusing on creative activities can effectively enhance participants' innovative sense of self-efficacy (Atwood-Blaine et al., 2019). Besides, mobile games can effectively encourage learners to participate in various educational activities and can increase the user's flow experience. In the process of playing mobile games, females get more flow experience than males (Bressler, Bodzin, & Tutwiler, 2019). Of note, learning research based on mobile games has shown positive effects, and students' degree of empathy for characters in mobile games negatively correlates with their interest and knowledge of the game. In addition, the perception of the authenticity of content negatively correlated with the students' consumption rationality, which is conducive to enhancing students' ability to participate in teamwork (Huizenga, Admiraal, Dam, & Voogt, 2019).

Research on the Continuous Adoption Behavior of Mobile Game Users

SNS games, as a new genre of games and one of the many functions of SNS, have become a concern of researchers who are interested in studying factors affecting the intention of gamers to play games. Shen (2013) measured how social and cultural factors affect SNS games. The study involved 11 interviewees and 321 questionnaire respondents. Findings indicate that social and cultural factors had significant effects on the appeal of SNS games. That's why many game developers have started to incorporate the social and cultural factors of different countries into the design of SNS games. P. S. Wei and H. P. Lu (2014) tried to find out the reasons behind gamers' affection for SNS games. Based on 237 valid questionnaires collected online and a structural equation, they discovered that network externalities had considerable effects on the willingness to play and satisfaction of gamers, and were associated with personal schedule flexibility. Avatar identification improves virtual community participation and social presence, these factors positively related to online gamer loyalty (Ching-I, 2017). Social influence is positively associated with purchase intentions for virtual goods, intention to continue playing is positively associated with purchase intentions (Hamari, 2015).

Hsiao and Chen (2016) studied factors driving the in-app purchase intention of mobile games. Baek and Touati (2017) investigated individual traits as predictors of game enjoyment by including learning style, intrinsic motivation, collaboration skills, and computer game attitude as key parts of a model that also included achievement. Results of correlation and regression analyses reveal that intrinsic motivation was the only variable to predict game enjoyment. Rauschnabel, Rossmann, and tom Dieck (2017) conducted a survey among 642 AR game players to explain drivers of their attitudinal and intentional reactions through a research framework built based on the gratification theory and flow theory. Results show that hedonic, emotional, and social benefits and social norms drove consumer reactions while physical risks (but not data privacy risks) hindered consumer reactions. However, the importance of these drivers differed depending on the form of user behavior. Chen and Leung (2016) conducted a survey among 409 Chinese mobile gamers to study their use of, especially addiction to mobile games. 7.3% of the respondents were considered addicts who were characterized as lonely, leisurely bored, and motivated by the mobile nature of the game. As expected, frequent players had a higher tendency to become addicts. In particular, loneliness and self-control were significant predictors of mobile social game addiction, whereas leisure boredom was linked to the intensity of game use. Researcher found that there are two types of motivations driving gamers, including ceremonial motivations such as passing time, escapism and hobby, hedonic motivations such as happiness, enjoyment and entertainment (Asta, Nikou, & Gatautis, 2017; Hussain, Williams, & Griffiths, 2015; Li, Liu, Xu, Heikkila, & Heijden, 2015).

Most mobile games are already available for free download. In the initial stage, mobile game developers primarily obtain revenue through product placement. However, developers using throughput agreements to charge become a trend (Rutz, Aravindakshan, & Rubel, 2019). Learning letters is crucial in language learning, which is conducive to improving reading and writing skills. Nowadays, students prefer to learn through mobile games. Mobile games could improve teachers' ability to classify teaching content and students' ability to learn classified content, and decrease the interference of external environment on learning (Samur, 2019). The rapid advancement of mobile technology has made mobile games a leader in the global game market, and the mobile game market has grown in size and competition. Besides, the scale of the mobile game market has increased dramatically, with more intense competition. Furthermore, the market share of mobile games will monotonously decrease with time and continue increasing after the decline reaches the peak, and then begin to decline again, which presents a certain life cycle (Yi, Lee, & Kim, 2019).

As more studies on mobile games are conducted, new theories will be constantly proposed, but gamers as objects of study will always be the core. Mobile gamer attrition, which is a type of gamer behavior, has also been studied. Most studies focus on building a customer attrition model, mainly in the communication industry, but overlook reasons causing mobile gamer attrition. Actually, reasons behind gamer attrition can explain gamers' willingness to play games to some extent. The paper creates a Model of Factors Affecting Women's Continuance intention for mobile games based on a technology acceptance model, and the validity of the created model has been verified.

Totally 21 papers including frequently used references and some latest studies discussing mobile games and the technology acceptance model have been included in the paper. Please see Table 1 for details.

RESEARCH MODEL AND HYPOTHESES

Affective Factors and Perceived Enjoyment

Economic motives and results were the focuses of information system adoption study, and cost was a key factor affecting people's information system adoption behavior. Hsiao and Chen (2016) argued that price greatly drove in-app purchase intention for mobile games. Kai-Shuan (2013) reported based on a statistical analysis that innovation and uniqueness were the main characterizations of popular games. The study contributed to human-computer interaction in cyberspace. Kim and Lee (2017) studied how switching costs and epistemic curiosity affect gamers' continuance intention for mobile games. Results show that the continuity cost and the sunk cost positively affected the retention intent, but there was no significant effect from learning cost. Focusing the gamer into as the male gamer, the learning cost was significant but negatively to the intent.

T. Huang, Bao, and Li (2017) found that satisfaction in enjoyment and social contact had significant positive effects on mobile gamers' willingness to buy, and vigor, players' dedication and absorption also significantly affected mobile gamers' willingness to buy. Xu et al. (2017) found that network density and the number of core gamers had positive effects on the price of massively multiplayer online role-playing games. Su, Chiang, James Lee, and Chang (2016) analyzed the effects of flow experience on the loyalty of mobile gamers. Results reveal that human-computer interaction, social interaction, challenge and skills all positively affected flow experience, and challenges had positive effects on the loyalty of mobile gamers. Personality traits are related to interdependence and network convergence, which fuel continuance intention of online gamers (Huang, Cheng, Wei-Fan, & Ching-I, 2018). Thus, we propose the following hypotheses:

H1: Perceived challenges have significant positive effects on perceived enjoyment.

H2: Perceived novelty has significant positive effects on perceived enjoyment.

H3: Perceived cost has significant positive effects on perceived enjoyment.

Table 1. A summary of previous studies about Mobile Game

Author(s)	Key Variables	Study	Theoretical Basis
Schmit et al. (2015)	Design	Design in mobile games for school children	Flow and Context
Hsiao and Chen (2016)	Perceived value: Loyalty	Factors of motivating game players to make purchases	Value
Su and Chen (2013)	Environment; design	The mobile game-based insect learning system for improving the learning achievements	TAM
Su et al. (2016)	Flow experience: Skill: Human-computer Interaction: Challenge: Social interaction	The effect of flow experience on player loyalty in mobile game	Flow
Cota et al. (2015)	Motivation; Age; Digital games	Mobile game design for the elderly	Flow
Madeira et al. (2017)	User experience: Design	The design and user experience of mobile game for phonological disorders in children	Metaphor methodology
Baek and Touati (2017)	Motivation: Skills: Attitude	Study the influence of individual traits for enjoyment in a mobile learning game	TAM
Merikiv et al. (2017)	Challenge: Variety: Novelty: Design Playability	The factors of making continued mobile gaming enjoyable	TAM
Rauschnabel et al. (2017)	Hedonic: Emotional: Social factor Social norm: Risk	Investigate the mechanisms that explain the popularity of mobile AR games	U&G
Kim and Lee (2017)	Epistemic curiosity: Gamer attributes; Switching costs	Gamer's attributes affecting continuous play intention.	Flow
Chen and Leung (2016)	Mobility: Relaxation Sociability Achievement: Entertainment	Explore the relation of psychological factors to mobile game use and addiction	U&G
Zhu et al. (2011)	Service: Sound: Game view	Development of mobile games	UML
Bai et al. (2012)	Main class: Main program Background class	Mobile game's design and implementation	TAM
Lee et al. (2015)	Mirroring service; Finger movements	Finger stroke time estimates for touchscreen-based mobile gaming interaction	TAM
Liu et al. (2016)	Augmented reality: Interaction Experience	Analyzing students' language learning experience in an augmented reality mobile game	U&G
Feijoo et al. (2012)	Policy: Usable: Mobile Platform Affordable: Content	The industry challenges and policy implications of Mobile gaming	TAM
Okazaki et al. (2017)	Inherent novelty social norms seeking	Factors influencing mobile gaming adoption among the youth	TAM
Shen et al. (2013)	Practicable & realizable; Innovative & unique	Explore the sociocultural appeal of SNS games	U&G
Wei and Lu (2014)	Network externality; Gratifications	Identify the factors that influence people to play socially interactive mobile games	U&G
Xu et al. (2017)	Network externality Density: Closure	Network externalities, density, and closure, would exert impacts on the in-game currency price	Value
Huang et al. (2017)	Vigor: Flexibility Dedication: Absorption Entertainment Self-presentation	Explore the purchase intention in mobile social network games	CE and U&G

Characteristics and Perceived Ease-of-Use of Mobile Games

Mobile games can be played using smartphones, tablets and other portable computing devices. Compared to traditional computing devices, these devices feature easier access to the Internet, high mobility, and lighter weight, allowing gamers to play games anytime, anywhere. This explains the huge number of people playing games on smartphones. (Wei & Lu, 2014) found that flexible play hours had positive effects on mobile gamer willingness to play games. Based on previous research which has proved the effects of system quality, information quality and service quality on gamers' willingness to play, (Wei & Lu, 2014) reported that enjoyment and interaction were main factors

deciding gamers' choosing mobile games, and the sense of satisfaction had positive effects on gamers' willingness to play mobile games. Jeon, Ahn, and Yu (2016) found that the user interface design of mobile games had positive effects on gamers' intention to play; and extensive information, active interaction, and content-related feedback had significant positive effects on the response of gamers. Mobile games are interactive products, which means their ease-of-use is a key factor affecting user interface design. Thus, the following hypotheses are proposed:

H4: Perceived mobility has significant positive effects on perceived ease-of-use.

H5: Perceived security has significant positive effects on perceived ease-of-use.

Personal Perception and Willingness to Use

Al-omoush and Shaqrah (2010) empirically studied the home network in Jordan based on the TAM and the theory of social consciousness, and found that perceived ease-of-use significantly affected gamers' willingness to play through perceived usefulness. Ismail, Razak, and Zakariah (2012) studied the e-learning system based on a TAM integrating such factors as information quality, service quality, system quality, perceived usefulness, and perceived ease-of-use. Results indicate that perceived usefulness significantly affected the students' willingness to continuously use in-apps. Byoungsoo (2010) performed an empirical study based on the ECM-ISC, finding that perceived usefulness, perceived playfulness, perceived cost, and satisfaction were main factors affecting mobile gamers' continuance in gaming. Enjoyment and usefulness are equally important determinants for using them (Hamari & Keronen, 2017). Thus, we propose the following hypotheses:

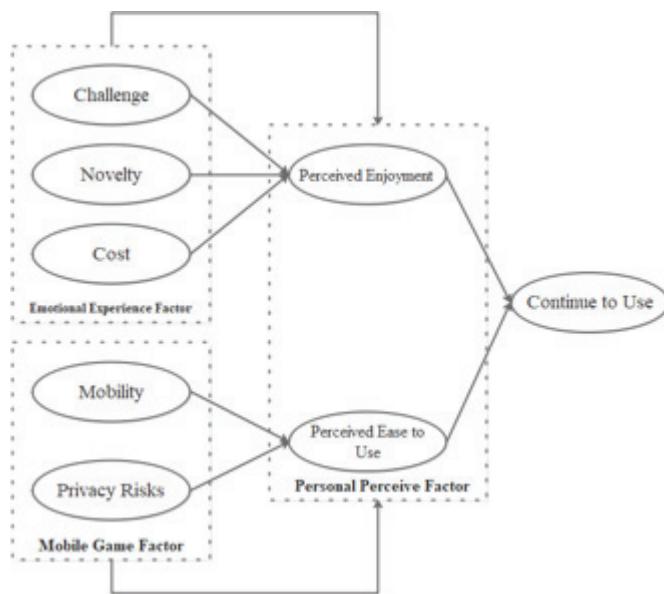
H6: Perceived enjoyment has significant positive effects on continue to use.

H7: Perceived ease-of-use has significant positive effects on continue to use.

The paper builds a TAM in which factors affecting women's continuance intention for mobile games are divided into affective factors and game factors. The former was measured through challenge, novelty and cost, while the latter through mobility and privacy risks. Personal perceived factors were measured through perceived playfulness and perceived ease-of-use, and female gamers' willingness to play was measured through personal perceived factors. A hypothesis model shown in Figure 1 was created based on the above hypotheses.

This study primarily constructs and measures the variables, such as challenge, novelty, cost, perceived mobility, security, perceived ease of use, perceived enjoyment, and usage intention, when users play mobile games. All the measurement items of these variables are referenced to the existing mature scale and modified and improved in combination with the mobile game application scenario. The details are as follows: (1) Challenge. Based on Koufaris (2002), five measurement items, such as user thinking ability improvement, user ability expansion, and game skill improvement, were measured for female users during the usage of mobile games. (2) Novelty. Based on Huang (2003), five measurement items, such as innovation, imagination, and freshness of mobile games, were measured. (3) Cost. Referring to the study by Amberg et al. (2004) and Tang (2008), four measurement items, such as various expenses, time, and energy of users when playing mobile games, were measured. (4) Mobility. Based on Amberg et al. (2004) and Tang (2008), the degree to which a user can acquire a mobile game anytime and anywhere was measured, including three measurement items. (5) Privacy Risks. Based on Featherman et al. (2010), four measurement items, such as mobile games legality, personal privacy protection, and newcomers, were measured. (6) Perceived Enjoyment. Based on Koufaris (2002), the extent to which users feel happy, fun, and curious when using mobile games were measured, including four measurements items. (7) Perceived Ease of Use. Based on Davis (1989), the user's perception of the ease to use a mobile game was measured, including four measurements.

Figure 1. Hypothesis model



(8) Continue Using. Referring to Davis (1989), the possibility that consumers think they will use mobile games in the future was measured, including four measurements items.

RESEARCH METHODOLOGY

Sampling and Data Collection

A questionnaire survey has been carried out for the research. The questionnaire comprised three parts: basic information (e.g. the age, gender and income of the respondents), participation of respondents in mobile gaming (including frequency of playing mobile games and genres of games), and items regarding variables in the model built, a seven-point Likert scale was adopted. Due to limited research on female mobile gamers, perceived factors used herein were obtained by improving previous research. Through perfecting relevant scales, adjusting questions according to female mobile gamers' opinions, and feeding back questions evaluated by experts to the respondents, seven questions were finally determined to measure various factors. A pilot survey involving 20 female postgraduates at Wuhan University E-Commerce Lab was executed, and the structure and way of expression of the questionnaire were adjusted according to the results.

Through online survey platform and social commerce communities, totally 350 questionnaires have been collected, including 319 valid ones which accounted for 91% of the total. As shown in Table 2, 73.98% of the respondents were under 35, indicating that young women form the majority of female mobile gamers. 93.42% of the respondents had a bachelor's degree or above, indicating a high level of education. 80.56% of the respondents had serious careers at enterprises or schools. 80.25% of the respondents had an income above the average. Role-playing games, board games, music games, adventure games, casual games and puzzle games, which feature relaxing rhythm, were popular among female mobile gamers who were willing to spend more on in-app purchases. The results agree with the conclusions made by Flurry (2016).

Table 2. Demographic information of the respondents

Variable	Categories	Frequency	Percept
Age	Under 18	2	0.63
	19-25	52	16.3
	26-35	182	57.05
	36-45	57	17.87
	Over 45	26	8.15
Education	Middle school or less	1	0.31
	Senior school/Vocational school	20	6.27
	Junior college/ Undergraduate	269	84.33
	Master	28	8.78
	Doctor	1	0.31
Occupation	Institution staff and civil servant	113	35.42
	Enterprise technical staff and management	122	38.24
	Teacher	22	6.9
	Student	22	6.9
	Housewife	5	1.57
	Freelancer	17	5.33
	Others	18	5.64
Time of play the game	Under half of time	74	23.2
	Half of time to an hour	134	42.01
	1 hour-2 hours	94	29.47
	Over 2 hours	17	5.33
Kind of game people like	Sports competition (Running racing, Skiing)	64	20.06
	Action (Fruit ninja, Shadow of the blade)	75	23.51
	Simulated business (Sims, Simulated city)	77	24.14
	Leisure puzzle (Looking for your sister)	106	33.23
	Adventure (Plant zombies)	117	36.68
	Role play (Paladin, Dragon 8)	134	42.01
	Music (Rhythm master, Big Musician)	143	44.83
	Chess (Landlord, Chess)	238	74.61

Tests of Reliability and Validity

In this study, we used SPSS v.23 software to test the reliability and validity of the collected sample data. The coefficient of reliability of the questionnaire was 0.947, and those of variables all exceeded 0.7 (see Table 3). The internal consistency of the questionnaire has been verified. Questions were designed by reference to mature scales and have been confirmed by experts, which ensured their content validity. The construct validity was obtained through KMO and Bartlett's Test. KMO was 0.923 and Bartlett P was less than 0.001. According to (J. Lu, Liu, & Yu, 2008), when KMO is greater than 0.5, it's ideal for factor analysis. Extracted main factors cumulatively explained 68.237% of the total variance. The validity of the questionnaire has been verified.

Table 3. Results of confirmatory factor analysis

Construct	Items	Factor Loading ^a	Cronbach's α	AVE	CR
Challenge	CH1	0.717	0.831	0.597	0.881
	CH2	0.764			
	CH3	0.817			
	CH4	0.780			
	CH5	0.783			
Novelty	NO1	0.817	0.875	0.667	0.909
	NO2	0.757			
	NO3	0.829			
	NO4	0.841			
	NO5	0.835			
Cost	CO1	0.791	0.811	0.639	0.876
	CO2	0.778			
	CO3	0.841			
	CO4	0.786			
Mobility	MO1	0.908	0.837	0.756	0.903
	MO2	0.894			
	MO3	0.803			
Privacy Risks	PR1	0.864	0.888	0.749	0.923
	PR2	0.875			
	PR3	0.890			
	PR4	0.831			
Perceived Enjoyment	PE1	0.757	0.778	0.601	0.858
	PE2	0.759			
	PE3	0.819			
	PE4	0.764			
Perceived Ease to Use	PEU1	0.866	0.843	0.681	0.895
	PEU2	0.806			
	PEU3	0.772			
	PEU4	0.854			
Continue to Use	CTU1	0.861	0.901	0.772	0.931
	CTU2	0.896			
	CTU3	0.892			
	CTU4	0.864			

Note: ^a All standardized factor loadings were significant at $p < 0.001$

The observations of convergence validity include factor load, combination reliability (CR), and average extracted variance value (AVE). Notably, the three observation indexes have fulfilled the basic requirements of the test, suggesting that the survey scale has good convergence validity.

Reliability reflects the stability and reliability of the observation scale, which is generally verified by Cronbach's α coefficient.

Table 3 shows that the factor loadings of observed variables all fall between 0.7 and 0.9, greater than 0.50 and less than 0.95, indicating that the basic fit indices of the scales are fairly ideal. The composite reliability values of latent variables are in the range of 0.800-0.930, greater than the evaluation standard of 0.60. The average variances extracted (AVE) of latent variables fall between 0.50 and 0.70, greater than the evaluation standard of 0.50. The reliability of the scales is high.

The validity test comprises content validity, convergence validity, and differential validity. Regarding the content validity, when selecting the initial scale, the relevant literature on the influencing factors of the continuous usage of mobile game users is organized and summarized, and the classical effective scale is combined to determine the measurement items of this study. In the formation process of the scale, the author conducted comprehensive research with the experts in related fields and performed frequent revisions of the questionnaire. Finally, the content and items of the questionnaire were determined, which ensured that the questionnaire had good content validity to the greatest extent.

The discriminant validity of latent variables indicates the low correlation or significant difference between observed variables and latent variables. In the paper, discriminant validity was tested based on the AVE of each latent variable, and the squared value of the correlation coefficient quantifying the statistical relationship between the latent variable and other latent variables. The discriminant validity values of latent variables are listed in Table 4.

Table 4. Results of discriminant validity analysis

Construct	CH	NO	CO	MO	PR	PE	PEU	CTU
CH	0.773							
NO	0.487	0.817						
CO	0.001	0.011	0.799					
MO	0.563	0.666	0.101	0.869				
PR	0.187	0.214	0.105	0.306	0.865			
PE	0.584	0.620	0.060	0.578	0.189	0.775		
PEU	0.449	0.531	0.108	0.599	0.249	0.461	0.825	
CTU	0.421	0.463	0.030	0.460	0.165	0.421	0.442	0.879

Notes: CH: Challenge; NO: Novelty; CO: Cost; MO: Mobility; PR: Privacy Risks; PE: Perceived Enjoyment; PEU: Perceived Ease to Use; CTU: Continue to Use

Figures in diagonal are square root of the AVEs, and off-diagonal elements are corrections of constructs

The values on the diagonal in Table 4 are the square roots of the AVE of latent variables, and those off the diagonal are the squares of correlation coefficients reflecting the correlations among latent variables. To sum up, the survey scales are satisfactory in reliability and discriminant validity, which lay a solid foundation for further analyses.

DATA ANALYSIS AND RESULTS

Amos23 software was used to analyze collected data based on a structural equation model, and maximum likelihood estimation was adopted to verify the hypotheses raised in the theoretical model.

Parameter Estimation Reasonability Test

Before estimating the overall fit of the model, it is necessary to test whether the model violates the estimation and verify the rationality of parameter estimation. In the model designed, the estimated values of standardized parameters all stayed below 0.95; the variances of measurement errors were between 0.123 and 8.007 (no negative variance); and the correlation coefficients reflecting the correlations among estimated covariances of latent variables all fell between 0.056 and 0.099 (less than 1). The reasonability of parameter estimation indicates that the covariance matrix or related matrix was positive define. The estimation results of the model show that there was no violation of the estimation, which allowed the overall fit test.

Overall Fit Test of the Model

In this paper, the overall fit evaluation indices of the model were divided into absolute fit indices, incremental fit indices and parsimonious fit index (Hair, Anderson, Tatham, & Black, 1998). See Table 5 for overall model fit test statistic. The chi square (χ^2)/degree of freedom ratio (CMIN / DF) was 1.973, less than 3, indicating that the model was compatible with the actual sample data. However, since the chi-square and chi square/degree of freedom ratio are susceptible to the size of the sample, it is necessary to determine model fit by referring to other fit indices (Wheaton, 1987). Table 5 shows that the model has a RMSEA of 0.055 (less than 0.07), and a GFI value of 0.900, a CFI of 0.98, a TLI of 0.924, and an IFI of 0.939 which are all greater than 0.9, indicating that the overall model fit indices have reached the fit standard. Generally, the hypothetical model proposed herein was in good agreement with the actual observation data, and the structural equation model presented good external quality.

Table 5. Measures of the model fit

Fit Index	X ² /df	RMSEA	GFI	CFI	TLI	IFI
Recommended value	< 3	< 0.07	> 0.9	> 0.9	> 0.9	> 0.9
Model value	1.973	0.055	0.900	0.938	0.924	0.939

Source: According to Bentler and Bonett (1980)

Research Hypothesis Test

As shown in Table 6, the estimates obtained based on the structural equation model indicate that all hypotheses have been verified by the significance test, and are in agreement with theoretical analysis results and expectations. Test results indicate that perceived mobility had the greatest effects on perceived ease-of-use, while perceived risks had no obvious effects on perceived ease-of-use. Perceived cost had the least effects on perceived enjoyment, while perceived challenges had the greatest effects on perceived enjoyment.

In this study, we used Amos23. When the absolute value of CR was >1.96 , and the P-value was <0.05 , the correlation between the two potential variable paths was significant. The establishment of the hypothesis relationship between the latent variables in the theoretical model was confirmed by whether the path coefficients were significant or not.

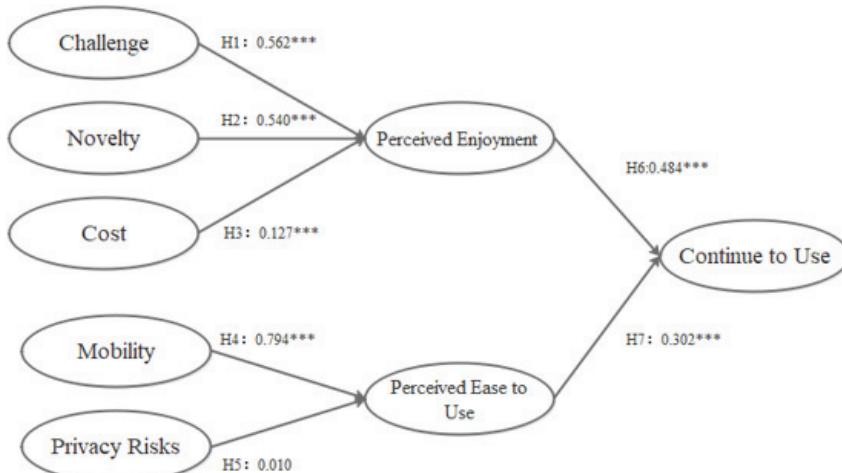
Estimates obtained based on the structural equation model (see Figure 2) show that the path coefficient from perceived challenges to perceived enjoyment is 0.562, greater than the significant value of 0.001. Hypothesis H1 ($\beta = 0.562, p < 0.001$) has been verified, indicating that stimulation and challenges raised by mobile games have positive effects on the perceived enjoyment of female gamers. The path coefficient from perceived novelty to perceived enjoyment is 0.540, greater than the significant value of 0.540. Hypothesis H2 ($\beta = 0.540, p < 0.001$) has been verified, indicating that

Table 6. Summary of hypothesis tests

Hypotheses	Standardized Coefficient	S.E.	C.R.	Supported
<i>H1: CH→PE</i>	0.562***	0.081	6.179	Yes
<i>H2: NO→PE</i>	0.540***	0.072	6.229	Yes
<i>H3: CO→PE</i>	0.127***	0.056	2.806	Yes
<i>H4: MO→PEU</i>	0.794***	0.099	8.007	Yes
<i>H5: PR→PEU</i>	0.010	0.090	0.123	No
<i>H6: PE→CTU</i>	0.484***	0.086	5.911	Yes
<i>H7: PEOU→CTU</i>	0.302***	0.070	3.949	Yes

Note: *** $p < 0.001$

Figure 2. Results of the proposed model



the novelty of mobile games had positive effects on the perceived enjoyment of female gamers. The path coefficient from price to perceived enjoyment is 0.127, a little higher than the significant value of 0.001. Hypothesis H3 ($\beta = 0.127, p < 0.001$) has been verified, indicating that the price of mobile games has minor positive effects on the perceived enjoyment of female gamers. This means female mobile gamers are not very sensitive to the cost of gaming. The path coefficient from the mobility of games to perceived mobility is 0.794, greater than the significant value of 0.001. Hypothesis H4 ($\beta = 0.794, p < 0.001$) has been verified, indicating that the ubiquitous of mobile games had positive effects on the perceived ease-of-use of female gamers. Well-performed networks and mobile terminals jointly create an environment where net female gamers can play mobile games anytime, anywhere. The path coefficient from privacy risks to perceived mobility is 0.010, less than the significant value. Hypothesis 5 hasn't been verified, indicating that privacy risks have no positive effect on the perceived mobility of female mobile gamers. The path coefficient from perceived enjoyment to continuance intention for mobile games is 0.484, greater than the significant value of 0.001. Hypothesis H6 ($\beta = 0.484, p < 0.001$) has been verified, indicating that perceived enjoyment had positive effects on female gamers' continuance intention for mobile games. The path coefficient from perceived ease-of-use to continuance intention for mobile games is 0.302, greater than the significant value of 0.001.

Hypothesis H7 ($\beta = 0.302$, $p < 0.001$) has been verified, indicating that perceived ease-of-use had positive effects on female gamers' continuance intention for mobile games.

CONCLUSION

Based on a theoretical model and previous studies, the authors suggested new factors affecting female gamers' continuance intention for mobile games. Then, an empirical study was conducted based on the results of a questionnaire survey containing the above-suggested factors. Some research conclusions were made at last.

The paper studies factors affecting female gamers' continuance intention for mobile games based on a TAM. Perceived enjoyment and perceived ease-of-use were used as mediating variables. Findings show that perceived enjoyment and perceived ease-of-use had positive effects on female gamers' willingness to play mobile games (similar results were confirmed in studies conducted by (Bao, 2014; Juho Hamari & Koivisto, 2015; Merikivi et al., 2017); the challenge, novelty and price (minor factor) of mobile games had positive effects on the perceived enjoyment of female gamers (similar results were confirmed in studies conducted by(Okazaki et al., 2015)); the ubiquitous of mobile games had positive effects on the perceived ease-of-use of female gamers (similar results were confirmed in studies conducted by(Baek & Touati, 2017; Feijoo, Gómez-Barroso, Aguado, & Ramos, 2012; Schmitz et al., 2015); and the privacy security of mobile games had no positive effect on the perceived mobility of female mobile gamers which means that privacy security was not a concern of female mobile gamers in the process of gaming.

Female mobile gamers have gradually developed mature gaming and payment habits. Fair games with shorter playtime and easier rules, being more stimulating than casual games and less stressful than traditional competitive games, are popular among female gamers. Female gamers tend to prefer social games featuring bright colors and a good gaming atmosphere. Given the characteristics of female mobile gamers, we believe that the traditional profit model depending on traffic acquisition is no longer suitable for the current female mobile games market—game operators need to increase the number of paid gamers and the amount of their payment through improving product quality, making innovations in design, integrating marketing resources, and precise data analysis. In the current context that social platforms have become a new battleground for operators and distributors (Rauschnabel et al., 2017), game developers should focus more on the integration of products with SNS, and recommended personalized games to female gamers.

DISSCUSSION THE THEORETICAL AND MANAGERIAL IMPLICATIONS OF THE STUDY

Managerial Implications

Findings of the study offer helpful guidance to mobile game developers, helping them develop products meeting the real needs of female gamers based on a better understanding of the behavior characteristics of female gamers, thus increasing market share. Challenges raised by mobile games have positive effects on the perceived enjoyment of female gamers. Therefore, developers should design more challenging missions, and create more impressive scenarios and story lines, increasing the sense of challenge for female gamers. The perceived enjoyment of female players is positively affected by the novelty of the game. To improve the novelty of games, developers should to frequently update roles and rewards, and develop new highlights through SNS for meeting the needs of female gamers on product novelty. The ubiquitous of mobile games have positive effects on the perceived ease-of-use of female gamers. In this respect, developers should rely on AR technology (Ma, 2016; Rauschnabel et al., 2017) to provide lightweight apps to female gamers, satisfying their needs of playing mobile games anytime, anywhere. For the design of mobile games, in addition to content,

incorporate social systems may also be incorporated into game design, improving the interactivity among players, increasing customer loyalty.

Theoretical Implications

The paper adds new theories applied to the study of female mobile gamers in the process of studying the behavior characteristics of female mobile gamers in a more detailed manner by stressing the importance of factors such as challenges, novelty and mobility of mobile games in maintaining women's continuance intention for mobile games. In addition, the effects of proposed factors on women's continuance intention for mobile games have been proved, and factors affecting female gamers' perceived enjoyment and perceived ease-of-use have been verified. It's fair to say that the study can effectively enhance researchers' understanding of the information behavior of women. Through original application of the TAM in studying women's continuance intention for mobile games, the study has also proved that price is not a major factor affecting female gamers' willingness to play games. The paper provides a useful reference to researchers, helping them have a better understanding of the needs of female mobile gamers.

LIMITATIONS AND FUTURE DIRECTIONS

The limitations of this study are as follows. First, the survey used online questionnaires, and the number of collected questionnaires was limited. However, as the user groups of mobile games were relatively wide, this survey object was lacking in the universality of the sample. In addition, in the research content, this study combined the situation and satisfaction theory, and inevitably ignored the research focus and factors at other levels, resulting in a lack of extensive research perspective.

The future research plan is as follows. First, a comparative study would be conducted along with the behavioral characteristics of male mobile game users to examine the characteristics of different gender users. The future research plan is as follows. First, a comparative study would be conducted along with the behavioral characteristics of male mobile game users to examine the characteristics of different gender users.

Second, the behavioral characteristics of users of different ages would be further studied, with a focus on influencing factors of children and the elderly when using mobile games.

In future research, it would not only ensure the authenticity of the sample answer but also improve the number of samples. Meanwhile, the impact of regional and cultural factors on the continuous usage intention of mobile game users would be studied.

Technological attributes of mobile games and SNS have considerable effects on female mobile gamers' cognition, affection, and experiences which can actually be controlled by SNS and mobile game developers. However, this field is still not a big concern of researchers yet. In the future, further studies in this field may be conducted to explore how to positively affect female mobile gamers' cognition, affection, and experiences through increasing interactivity and telepresence in games using the power of technology.

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Student Performance Measurement on Psychometric Parameters

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ABSTRACT

Educational data mining provides various advantages to the education systems in many ways. It enhances the teaching process, the learning process, the scholastic performance of students, career selection, employability, and more. The differences in attitude of students' behavior lead to difference in their academic performance. The article covers the non-intellectual parameters of students to enhance their academic performance. The study tests the relationship between psychometric constructs of students and their academic correlate. The models for enhancing intellectual performance which involves various non-intellectual parameters are analyzed using structural equation modeling. It is observed that the values of the models were retrieved near to fit values. The results entail that the models will be beneficial for students in improving their academic performance by revising their psychological parameters.

KEYWORDS

Academic Performance, Educational Data Mining, Multivariate Analysis, Psychometric Measures, Structured Equation Modeling, Student

INTRODUCTION

The differences in students' behavior impact their intellectual performance. Students differ in their learning styles like kinesthetic learners referring to learning by immersing in projects, aural learners, analytical learners and global learners adopting stimulations. Evidences have shown that non-intellectual parameters are highly associated with academic performance of students. The relationship between intelligence, personality, and interests; have been depicted by (Ackerman & Heggestad, 1997), also the impact of personality five factor model on intellectual performance is discussed by (Poropat, 2009). Factors involving self-regulatory learning strategies, motivation and style of learning also impact academic performance of students (Chamorro-Premuzic & Furnham, 2008). (Hamsa, Indiradevi & Kizhakkethottam, 2016) worked on scholastic parameters of undergraduate and graduate students like admission time, submission date of assignment, daily attendance, conduction

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of examination on scheduled time; to predict their academic performance. Self-regulatory learning strategies (SRLS) and motivation accentuate in recent years. In current era SRLS have become core skill (Anderson Koenig, 2011). Also, SRLS and motivation are not ordinarily included in classroom teaching or lecture and henceforth becomes an important aspect in students learning (Cleary, Gubi, & Prescott, 2010; Wehmeyer, Agran, & Hughes, 2000). The data mining in the field of education is useful at all stages of learning. In schools the students often find challenges while transiting from elementary studies as they differ in expectations and demands (Grodnick & Raftery-Helmer, 2015). In (Shahiri & Husain, 2015) the data mining approaches are applied on psychometric parameters comprising of personality, motivation and learning strategies. The contribution of extracurricular activities and soft skills is discussed in addition to psychometric parameters by (Mishra, Kumar & Gupta, 2014) to measure the scholastic performance of students.

Students lacking in motivation, SRLS and cognitive abilities are incapable of facing academic challenges especially during absenteeism in classes or lectures, in completing multiple assignments and preparing for examination (Blackwell, Trzesniewski & Dweck, 2007; Butler, Beckingham & Lauscher, 2005; Dignath & Büettner, 2008). Learners belonging to low socio-economic status ordinarily deficit in motivation constructs and interpretations (Byrnes, 2003; Steele, 1997). This leads to development of a system that incorporates these constructs in order to enhance learning. Learning style of students involves psychometric parameters, cognitive abilities and emotions; this describes the way students comprehend and react to the training environment (Keefe, 1979). Moreover, the way students opt for a learning environment puts an impact on their intellectual performance (Cassidy, 2004). This raises an interest in studying the relationship of students' learning behavior with academics (Debdi, Paredes-Velasco & Velázquez-Iturbide, 2016). Further strategies for self-regulation and analysis of data retrieved from online educational environments can be used to predict intellectual performance of students (Pardo, Han & Ellis, 2016).

The study in previous researches have shown that there exists a significant relationship between intellectual and non-intellectual constructs which raised the need of constructing model which can benefit improving the academic performance of students. The paper proposes models which aim at finding regression weights of student non-intellectual correlates which impact their academic scores. It was found that some parameters have positive weights whereas others have negative weights. The results obtained can be utilized to enhance the performance of the undergraduate students in academics.

Section 2 discusses about various non-intellectual constructs related to scholastic performance of students and describes the research framework. Research methodology is defined in section 3. Validity and reliability of the model is discussed in section 4. Section 5 describes the models, its results and findings; and finally, conclusion and future scope is defined in section 6.

CONSTRUCTS AND RESEARCH FRAMEWORK

The work proposes that psychometric parameters have an impact on academic learning of students. The non-academic constructs are operationalised in previous research (Richardson, Abraham & Bond, 2012). Some constructs positively affect the academic performance whereas some have negative impact on it. Each construct is described along with its sub constructs and their relationship with grade of students is discussed. Based on these variables related hypotheses are then developed.

Psychological Correlates Related to Grades of Student

The relation between the non-intellectual correlates of student with their intellectual correlate can be used to enhance the academic performance (Burman, Som & Hossain, 2018). The study considers six psychometric constructs namely – personality, motivation, self-regulatory learning strategies, students' approach towards learning, psychosocial contextual influences and demographics (Richardson et al., 2012). Few other factors are also considered involving extracurricular activities, high school background, social interaction network; and the facets stated in neo five factor model as shown in

Table 2. The major factors are further divided into sub factors, as shown in Table 1, which can be used to describe the students' learning behavior in detail and analytical way.

Personality Traits

The dimensions (i.e., conscientiousness, openness, agreeableness, neuroticism, and extraversion) included in well-known five factor model represent the extensive and broadly enforced way of assessing personality of an individual (Costa & McCrae, 1992). Conscientiousness is the measure which assesses an individual on the basis of being systematized or coordinated and their desire to succeed. Student having high conscientiousness performs well in academics and is determined in challenging subjects too (Mount & Barrick 1995). Procrastination, the behavior to delay the work to the last minute, has a negative impact and is unrelated to intellectual correlate (Lay, 1986). Students who are highly procrastinated score low. Learners experiencing openness are imaginative, prefer variety and open to new ideas and innovations. They are capable of adopting new learning ideas in order to achieve high in academics. Agreeableness trait of personality is perceived as cooperative, sympathetic,

Table 1. Non-intellectual constructs related to academic performance of students

Personality Traits	Motivational Factors	Self-Regulatory Learning Strategies	Approach Towards Learning	Psychosocial Contextual Factors	Demographics
Conscientiousness	Locus of control	Anxiety	Deep	Social integration	Gender
Procrastination	Pessimistic	Rehearsal	Strategic	Academic integration	Age
Openness	Optimistic	Organization	Surface	Institutional integration	Family background
Neuroticism	Self-efficacy	Elaboration		Goal commitment	Socio economic status
Agreeableness	Self esteem	Critical thinking		Social support	Disability
Extraversion	Intrinsic motivation	Metacognition		Stress	
Need for cognition	Extrinsic motivation	Effort regulation			
Emotional intelligence	Goal orientation	Help seeking			
		Peer learning			
		Time/Study management			
		Concentration			

Table 2. Parameters of neo five factor model

Neuroticism	Extraversion	Openness	Agreeableness	Conscientiousness
Anxiety	Warmth	Fantasy	Trust	Competence
Hostility	Gregariousness	Aesthetics	Straight forwardness	Order
Depression	Assertiveness	Feelings	Altruism	Dutifulness
Self-consciousness	Activity	Actions	Compliance	Achievement striving
Impulsiveness	Excitement seeking	Ideas	Modesty	Self-discipline
Vulnerability to stress	Positive emotion	Values	Tender mindedness	Deliberation

kind, ready to accept others' views. Students with high agreeableness attend classes on regular basis, optimistic in behavior and show cooperation with their instructors resulting in enhanced learning (Vermetten, Lodewijks, & Vermunt, 2001). Neuroticism is another correlate which is negatively related to academic performance. It leads to anxiety, stress (Steel, Brothen, & Wambach, 2001) and reduce motivation (Watson, 2000) which affects learning in students. Students with high neuroticism have poor attendance and are found to be absent from examinations due to health issues (Chamorro-Premuzic & Furnham, 2002). Extrovert students are active socially and involve in activities. These students achieve less as they are distracted more towards social activities and involvement which reduce their learning time; limiting their effort towards intellectual tasks (Bidjerano & Dai, 2007).

Other than factors of five factor model, construct need for cognition (Cacioppo, Petty & Kao, 1984) is found to predict student academic performance. Higher need for cognition will lead to motivation in students and result in high performance. Altogether, seven personality measures have been identified that are associated with academic performance of students.

Other than the constructs explained in big five factor model, our study considered neo five factor model which reported six sub parameters of five personality traits termed as facets as discussed by Costa and McCrae shown in Table 1.

Motivation Factors

Various motivational theories exist (Eccles & Wigfield, 2002) but only few constructs of motivation have been examined for predicting academic performance of students. Some students take their own responsibility for academic failure whereas others identify external causes such as course material, insufficient teaching. This is known as the locus of control (Rotter, 1966), a measure in which individuals consider that they have control over the consequences of acts in their lives. A pessimistic style (Peterson, Vaillant & Seligman, 1988) is associated with negative outcome; defined as internal, unchanged and comprehensive attributions for past failures. Students presume that they are incapable of performing well. In contrast, optimistic students presume that they are well capable, do well in exams and the reason for their past failure may be non-understanding of the examiner. Learning skills and abilities enhance academic performance. Students who are self-efficient perform better than those with lower efficacy expectations (Bandura, 1997). Students may feel that their effort leads to success however they lack the required skills to mobilize such effort; hence the distinction is essential between the two.

Self-determination theory differentiated sources of motivation (Ryan & Deci, 2000). The theory proposes that engagement in a task leads to gratification of psychological needs, namely, competent, relatedness and autonomy. Engaging in a task for personal reward, intrinsic motivation, will lead to optimal learning whereas tasks undertaken for external rewards, extrinsic motivation, may squelch academic achievement. Goal theories propose that setting up and aiming of a goal is related to achievement feedback. Achievement of a student consists of their past results of exams and assignments (Wood & Locke, 1987). The goal a student undergoes during academic tenure serves as a degree of their achievement and motivation. Goal oriented and a self-efficient student performs well and the combination of the two is one of the powerful predictors of grades of learners (Pajares & Miller, 1995).

Self-Regulatory Learning Strategies

As stated in "rubicon" model (Gollwitzer, 1990) the decision about the need to act and where to put efforts are elements of goal setting mechanism that anticipates goal committal. Achieving the set goal can be accomplished with regulation of emotions, cognitions, and environment and motivation behaviors by students. In this aspect, regulatory constructs aim to know how to implement efforts in best possible manner (Boekaerts & Corno, 2005). The differences in adoption of self-regulatory strategies by students contribute to goal achievement more or less effective rendering predicting performance. This implies that evaluation of self-regulatory learning strategies aid greater veracity in envisioning intellectual performance. Cognitive strategies include rehearsal, elaboration, critical

thinking and other generic constructs of self-regulation (Pintrich, 2004). The strategies, rehearsal referring repeating the learning, elaboration referring to summarizing the content in self words and critical thinking referring to assessment of facts to form conclusion; reflect in depth learning strategy which facilitate learning and attainment. Metacognition, part of self-regulatory learning strategies, construe higher order reasoning competencies appropriate for learning (Wolters, Pintrich & Karabenick, 2003). The construct anxiety is related to neuroticism affecting skeptically the learning behavior of students.

Behavioral constructs related to self-regulatory abilities (Pintrich, 2004) includes effort regulation that circumscribe individuals' management of endurance in case of challenging tasks, peer learning related to conversing with rivals about their learning, whereas time/study management involves evaluation of the usage of strategies made for study. Help seeking is also identified as behavioral strategy (Pintrich, 2000) including other regulation as such actions of instructors and peers. Concentration is another feature, included in the learning and study strategy inventory (LASSI) (Weinstein, Palmer & Schulte, 1987), evaluate the ability of learners to focus during study.

Psychosocial Contextual Factors

The retention of students is also impacted by the institution itself (Tinto, 1982). It has been noted that students with substantial institution and academic integration leads to optimal results. Some additional constructs, as such support by family members and finances, also direct the responses of students in university life involving responses of stress and depression, affecting integration and academic performance.

Students' Approach Towards Learning

Approaches towards learning can be categorized into three (Biggs, 1987). The deep learning approach refers to the learning style including critical thinking and exploring the concepts with desire to learn. In contrast, the surface approach is comprised of shallow learning with extrinsic motivation to learn. Students may also follow the strategic approach in place of the above stated which involves both styles of learning deep and surface on the basis of the importance and characteristics of the task.

Demographic Feature

The diversity in population results in the need of exploring the consequence of demographic on academic performance. It has been seen that students belonging to higher socioeconomic backgrounds score high as compared to their counterparts (Dennis, Phinney, & Chuateco, 2005). Literature shows that gender, age, family background and disability is also considered in predicting academic performance other than socio economic background (Shahiri & Husain, 2015).

Few other parameters are also considered, apart from those discussed above, influencing academic performance includes extracurricular activities, high school background, social interaction network and emotional skills (Mishra, Kumar, & Gupta, 2014; Angeline, 2013; Elakia & Aarthi, 2014).

The information retrieved from previous work raises two questions- a) are all non-intellectual constructs essential to the study? and b) is it possible to have a model based on these constructs which can provide insight to enhance the performance of students?

Research Hypotheses

Evidences have shown that educational institutes can enhance their results by analyzing the non-intellectual parameters of students in addition to intellectual constructs. Non-intellectual constructs directly impact the academic performance (Richardson et al., 2012) and institutes should use them to excel. Richardson et al. (2012) uses two stage structural equation modeling (TSSEM) for examining a regression model based on non-intellectual correlates. They found three combinations of personality constructs i.e. models are created for procrastination with conscientiousness, need for cognition with conscientiousness and emotional intelligence with conscientiousness. In (Poropat, 2009) it was found

that student academic performance can be predicted by conscientiousness. This arise the need to test the significance of personality traits on academic performance of students.

Hypotheses 1: Personality traits affect the academic performance of students.

Also, in (Richardson et al., 2012) a model with three constructs of motivational constructs is established, locus of control, academic self-efficacy and grade goal. The study by (Pajares & Miller, 1995) found that self-efficacy and grade goal are the strong predictors for academic performance.

Hypotheses 2: Higher levels of motivation lead to higher performance.

It was stated that evaluation of learning strategies aid greater accuracy for performance prediction by (Wolters et. al., 2003). Effort regulation is one of the predictors of academic performance as concluded by (Robbins, Lauver, Le, Davis, Langley, & Carlstrom, 2004). A regression model with learning strategies constructs including elaboration, critical thinking, meta cognition, effort regulation, help seeking and time/study management is given by (Richardson et al., 2012) for predicting academic performance of students.

Hypotheses 3: Regulating the learning strategies will results in better scores.

The study by (Tinto, 1975) demonstrates that the way an institute demonstrates itself consequent the disengagement of its own students. It considers various characteristics of students like gender, values, past experiences to discover the student engagement with their peers, mentors and university system. This will help in knowing their integration with academic and social. It was found that positive engagement with social and academic results in goal commitment and those having conflicts are not able to perform well. The study of other factors like support by family, financial assistance influence integration and direct the responses of students on stress and discouragement to university life (Levin & Rubin, 1998).

Hypotheses 4: Psychosocial contextual factors have an impact on learning

Diverse population in the university raises the need to study about influence of demographic feature on academic achievement of students. The study by (Robbins et al., 2004) showed that students with higher socioeconomic background tend to score high than their counterparts.

Hypotheses 5: Demographic feature influences academic achievement

The work carried in (Pintrich, 2004) discusses about influence of different learning approaches adopted by students on their academic performance. The study by (Biggs, 1987) identified three broad learning approaches – deep learning, strategic learning and surface learning.

Hypotheses 6: Learning approaches have an impact on academic performance

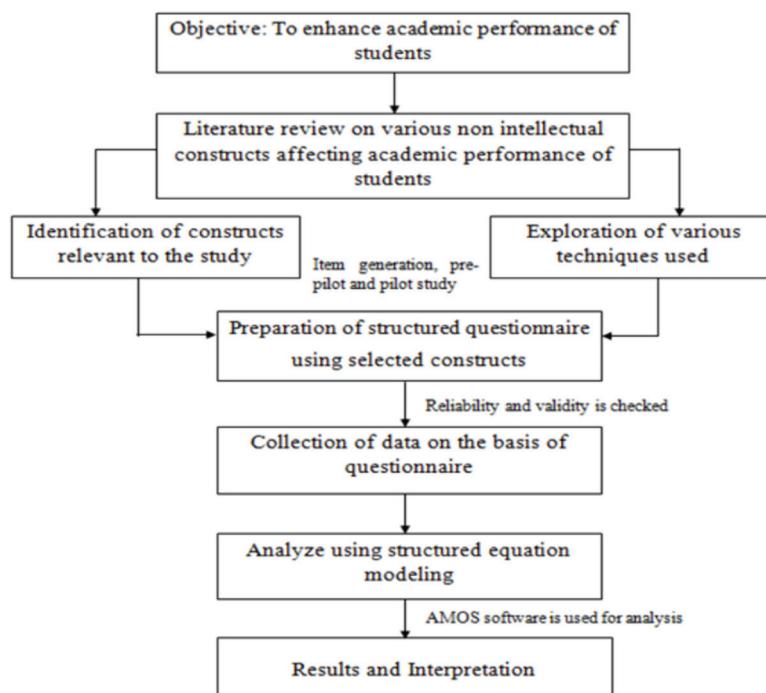
The constructs affecting the academic performance are identified from different studies during the extensive literature and the collective effect of the entire construct on performance is addressed in present study. For personality, the models construct comprising conscientiousness, procrastination, need for cognition and emotional intelligence (Richardson et al., 2012; Poropat, 2009) is included.

The constructs like locus of control, self-efficacy and grade goal (Pajares & Miller, 1995) is tested for motivation. As per SRLS, elaboration, critical thinking, meta cognition, help seeking, effort regulation and time/study management are also taken under account (Wolters et al., 2003; Richardson et al., 2012; Robbins et al., 2004). Also, the review showed that no model exist for psychosocial contextual influences and demographic feature and hence not tested. Current study considers all these as inputs to study the impact on student learning.

Research Methodology

Figure 1 describes the research methodology followed. This section describes the process of development of instrument, data collection and analysis. The instrument development is comprised of generations of items, their pre-pilot and pilot study.

Figure 1. Research methodology



Generating Items, Pre-Pilot and Pilot Study

It is important to cover the domain of the constructs so that the validity can be improved as stated in (Churchill, 1979). Hence, the study considers the statements covering all the items discussed in the literature and the definitions of the constructs which has not been covered yet to answer the questions stated in section 2. In pre-pilot study the items were reviewed by one psychology expert and a doctoral student. Sample data from a hundred students is collected on those statements and pilot study is done. The factor analysis is performed on the statements and it was found that few statements were not significant arose the need to drop those statements. Finally, the significant statements were taken into consideration for preparation of the structured questionnaire to collect the data for analysis. It is comprised of questions related to the psychological behavior of students.

Data Collection

The study focuses on enhancement of academic performance of tertiary students; hence, the target respondents were undergraduate students (of final year). In order to select the respondents' probability sampling is used. First, a list of universities affiliated colleges is prepared running distinct courses. Out of those 11 are selected at random. Students from these colleges are selected randomly for data collection. The responses are recorded on the scale of 1 to 5 (from strongly agree to strongly disagree) by the interviewer. The learning approach feature is recorded in the form of categorical data. Large number of observations, 2,198, are collected from the students out of which 187 are found to be biased in nature. These observations were dropped and the final sample size is of 2,011 which is statistically justified according to the nature of study (Levin & Rubin, 1994). The study is extensive in nature as the observations of students studying heterogeneous courses are taken under the study.

Analysis

The structured equation modeling (SEM) is performed using AMOS software on the dataset to obtain the models. Although various techniques are available for analytics. But the complexity of the model under present study can be well examined using SEM as the study is having dependent, independent and the latent variables. SEM is an efficient tool to deal with these complexities (Karimi & Meyer, 2014). It is a powerful tool for identifying relationships and to uncover their strength and causal nature (Bollen, 1989; Bollen & Long, 1993). This makes it useful in dealing with complex problems in various fields. In e-learning it has been used to enumerate critical success factors anticipated by students (Selim, 2007). Another use of SEM is seen in (Lee & Choi, 2013), to enhance the student retention based on learning strategies, flow experience, internal academic locus of control (ALOC), and student satisfaction. Also, to study the impact of supply chain responsiveness on a firm's competitive advantage SEM is used and it produces decisive results in this convoluted study (Thatte, Rao & Ragu-Nathan, 2013). SEM has developed and improved over the period of time. Early in 1900s it was used for path analysis, factor analysis, reliability, regression; later it was used for nonlinear problems, formative models, bootstrapping; and currently SEM development includes partial least square (PLS), multilevel-mixture models, SEM-based meta-analysis and generalized linear latent and mixed modelling (GLLAMM) (Karimi & Meyer, 2014). Further, the effect of non-academic correlates on student academic performance is examined by (Richardson et al., 2012) using SEM. The present study is enhanced version of the Indian scenario. The results of the models showed that changing the psychometric parameters of student can lead to improvement in their grades. For learning approach construct logistic regression is applied to study the effect of different learning approaches on student academic performance.

Measurement Model

It is important to test the model for validity and reliability of constructs. The discriminant validity, convergent validity and reliability are essential for the validity of constructs. For construct validity structured equation modeling (SEM) is used. "In recent years SEM has gain insight in analyzing psychology data. The current study deals with psychometric factors of students related to their academic performance. The data has been analyzed using regression model also, but the results were found not fit. SEM provides us with beta coefficient that gives the estimated contribution of a specific construct. Also, the relation of construct with academic performance is known. In order to check the internal consistency of operationalization reliability check is implemented.

Construct Validity

Construct validity comprise of convergent validity and discriminant validity. An essential step in testing the model is the evaluation of instrument. Confirmatory factor analysis (CFA) is performed using AMOS software and then SEM is applied to test the relationship of hypothesis. Multiple fit

indices are evaluated to fit the model data. The fit indices include goodness of fit (GFI), adjusted goodness of fit (AGFI) and root mean square (RMSEA). The values ranging from 0.8 to 0.9 is considered as acceptable fit for GFI and AGFI (Joreskog & Sorbom, 1989) and a value between 0.05 and 0.08 is acceptable for RMSEA (Browne, Cudeck, Bollen, & Long, 1993). If the fit indices of the model are not acceptable then the modification in the model is carried out on the basis of the values of modification indices (MI). Multicollinearity, refers to high item correlations among independent variables, is represented by MI i.e. explaining commonality. The final model with fit indices is then constructed. Table 3 shows the model fit indices for the constructs.

The independence of constructs measuring single parameter is referred to as discriminant validity. SEM methodology is used to assess discriminant validity. It was found that very low correlation exists among the constructs illustrating high degree of discriminant validity.

Reliability

In order to check the reliability of the constructs Cronbach alpha value is computed. The accepted value of alpha for internal consistency of operationalization is 0.7 (Hair, Anderson, Tatham, & William, 1998). It was found that reliabilities of the constructs vary from 0.8 to 0.89, which is above the accepted value.

RESULTS AND INTERPRETATION

Different models have been tested to examine the hypothesized relationship of each non-intellectual correlate with academic performance of students. The beta coefficients of each construct and variance explained by model are given in Table 4.

Personality Factors

The relationship among personality constructs and grades, as stated in Hypotheses 1, is tested. It is found that seven constructs are significant out of which conscientiousness ($\beta = 0.592$) is the strongest construct to predict the academic performance of students. Procrastination provides least contribution which is less than 1% approximately null ($\beta = 0.081$) and extraversion ($\beta = 0.286$) also positively affected the performance. On the other hand, openness ($\beta = -0.176$), agreeableness ($\beta = -0.262$), neuroticism ($\beta = -0.085$) and need for cognition ($\beta = -0.116$) negatively affect the performance of students. The model depicted in Figure 2, explains 26.2% of variance with grades of students.

Motivational Factors

This model includes six constructs (locus of control, intrinsic motivation, extrinsic motivation, optimistic, self-efficacy and goal orientation). It explains 1% of variance with grades of students with positive beta coefficients for intrinsic motivation ($\beta = 0.431$), optimistic ($\beta = 0.569$), self-efficacy ($\beta = 0.057$) and negative beta coefficients for locus of control ($\beta = -0.211$), extrinsic motivation ($\beta = -0.391$), goal orientation ($\beta = -0.308$).

Self-Regulatory Learning Strategies

Seven out of ten constructs significantly affect the academic performance of students. Only two of the significant constructs report negative values which are metacognition ($\beta = -0.3.630$) and time/study management ($\beta = -0.561$). Others report positive beta coefficients as for anxiety ($\beta = 0.970$), rehearsals ($\beta = 0.495$), critical thinking ($\beta = 1.704$), effort regulation ($\beta = 1.984$) and peer learning ($\beta = 0.501$). This model accounted for 17% of variance.

Table 3. Model fit indices

Items	Initial Model Fit	Final Model Fit
Personality factors		
Conscientiousness		
Procrastination		
Openness	GFI = 0.804	GFI = 0.933
Neuroticism	AGFI = 0.735	AGFI = 0.888
Agreeableness	RMSEA = 0.114	RMSEA = 0.069
Extraversion		
Need for cognition		
Emotional intelligence		
Motivational factors		
Locus of control		
Pessimistic		
Optimistic	GFI = 0.753	GFI = 0.916
Self-efficacy	AGFI = 0.665	AGFI = 0.870
Self esteem	RMSEA = 0.131	RMSEA = 0.082
Intrinsic motivation		
Extrinsic motivation		
Goal orientation		
Self-regulatory learning strategies		
Anxiety		
Rehearsal		
Organization		
Elaboration		
Critical thinking	GFI = 0.537	GFI = 0.889
Metacognition	AGFI = 0.422	AGFI = 0.824
Effort regulation	RMSEA = 0.155	RMSEA = 0.082
Help seeking		
Peer learning		
Time/Study management		
Concentration		
Psychosocial contextual influences		
Social integration	GFI = 0.928	GFI = 0.985
Academic integration	AGFI = 0.871	AGFI = 0.969
Stress	RMSEA = 0.112	RMSEA = 0.035
	Demographic feature	
Upper socioeconomic status	GFI = 0.882	GFI = 0.928
Middle socioeconomic status	AGFI = 0.825	AGFI = 0.915
Lower socioeconomic status	RMSEA = 0.06	RMSEA = 0.045

Figure 2. Model for personality traits

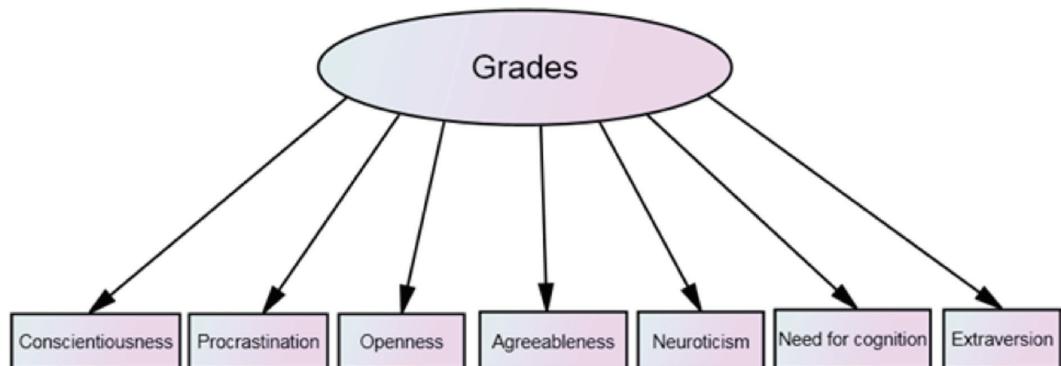


Figure 3. Model for motivational factors

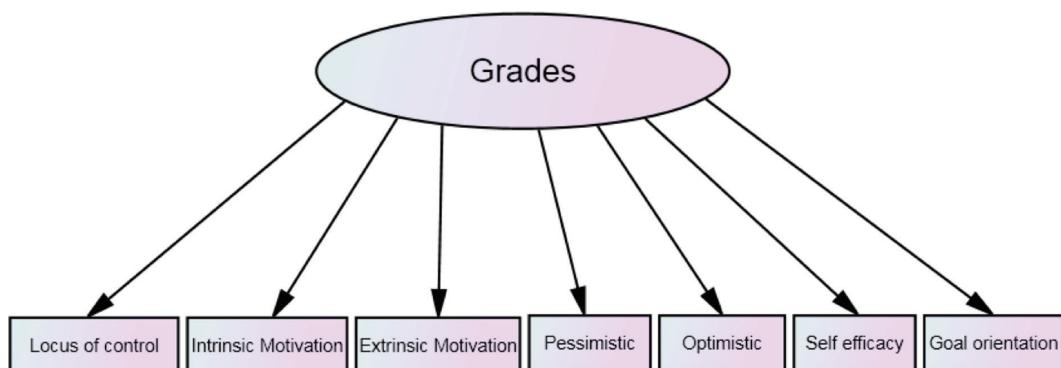


Figure 4. Model for self-regulatory learning strategies

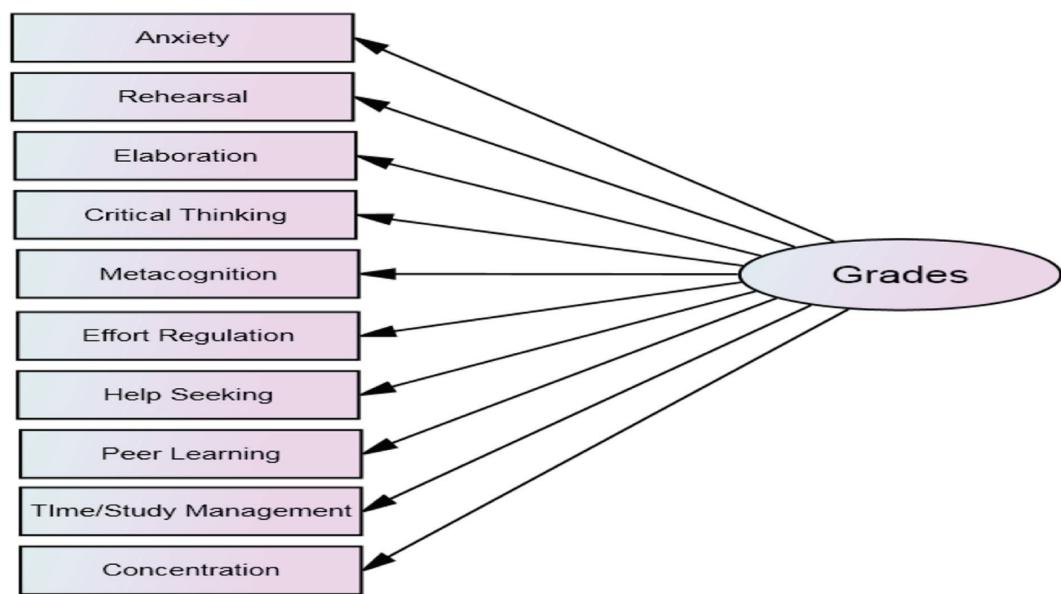
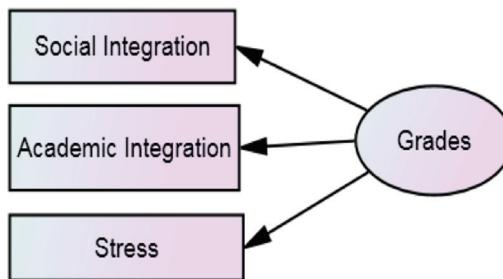


Figure 5. Model for psychosocial contextual factors



Psychosocial Contextual Factors

All the three constructs are found significant. Academic integration is found negatively related with $\beta = -0.520$; and social integration and stress are found positively related with $\beta = 0.0716$ and $\beta = 0.057$ respectively. The model explains 4.6% of variance with grades of students.

Student Approach Towards Learning

Logistic regression is used to obtain the results in order to study the relationship of learning approach with grades of students. The beta coefficients are as, for deep learning ($\beta = 0.823$), for strategic learning ($\beta = 0.648$) and for surface learning ($\beta = 0.353$).

Demographic Feature

It checked the socioeconomic status of the learners. The constructs are found significant with positive beta coefficients for upper socioeconomic status, middle socioeconomic status and lower socioeconomic status ranging between 1.4 and 1.8. This model accounted for 4.9% of variance.

CONCLUSION AND IMPLICATIONS OF RESEARCH

The study highlights various non-intellectual parameters essential for enhancing academic performance of undergraduate students. It aims for finding the constructs which lead to success and those which deviate students from their marks. The models help us to identify the constructs which lead to enhancement in academic achievement of students. Table 5 describes various key findings related to research. It discusses about the significance of constructs on learning of student. This majorly contributes in enhancing intellectual performance of students which inherently improvise employability, retention of students in class and benefit institute, student and society in large.

Figure 6. Model for demographic feature

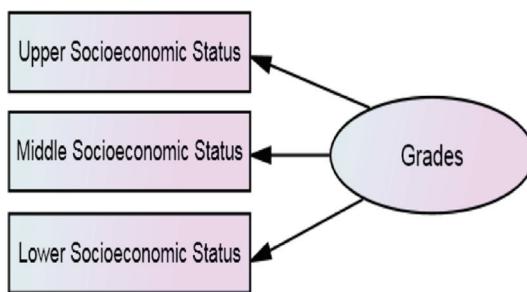


Table 4. Different models for academic performance

	Personality	Motivation	SRLS	PCF	Demographic	LA
	C, P, O, A, E, NFC, N	LOC, IM, EM, OP, SE, GO	Anxiety, R, CT, MC, ER, PL, TSM	SI, AI, Stress	Upper, Middle, Lower	Deep, Surface, Strategic
β	0.592***	-0.211**	0.970***	0.0716***	1.480***	0.823
β	0.081*	0.431***	0.495**	-0.520***	1.726***	0.648
β	-0.176**	-0.391**	1.704***	0.057**	1.543***	0.353
β	-0.262***	0.569***	-3.630***	-	-	-
β	0.286***	0.057*	1.984***	-	-	-
β	-0.116**	-0.308***	0.501**	-	-	-
β	-0.085*	-	-0.561**	-	-	-
R ²	0.262	0.010	0.170	0.046	0.049	-

C-conscientiousness; P-procrastination; O-openness; A-agreeableness; E-extraversion; NFC-need for cognition; N-neuroticism; LOC-locus of control; IM-intrinsic motivation; EM-extrinsic motivation; OP-optimistic; SE-self efficacy; GO-goal orientation; R-rehearsal; CT-critical thinking; MC-meta cognition; ER-effort regulation; PL-peer learning; TSM-time/study management; SI-social integration; AI-academic integration.

***p < .001; ** p < .05; *p < .10

The study has various implications for analysts. Firstly, it is found that personality traits of a student contribute majorly in academic performance. It is seen that students with high degree of conscientiousness may score high marks in comparison to their counterparts. Procrastination defining the delaying behavior depicting delaying the work to the last-minute deviates the student from scoring well. Extraversion i.e. assertive, positive behavior will help in improving performance. Neuroticism, when a student experiences depression, worry about their academic outcomes may lead to lower grades. It is seen that cognitive abilities; defining thinking skills, understanding, memory-based learning; are low in our students. Hence in order to enhance their performance effort is required to improve their cognition. Also, openness and agreeableness lead to lower grades.

Second, for motivational factors it is concluded that students who are self-motivated tend to score high than extrinsically motivated students. Also, students with positive attitude towards their efforts and having confidence on their academic capabilities perform well in academics. Third, as per strategies followed for learning it has been noted that students practicing the contents studied, putting their best efforts towards learning, tries to discuss with peers in order to learn more, and anxious for their future tend to perform well in academics as compared to their counterparts. Critical thinking referring to analytical skills to conclude judgments lead to success. Fourth, it is seen that the deep and strategic approaches towards learning help students in enhancing their academic performance as compared to surface approach followed for passing the examination.

Fifth, for psychosocial contextual factors, it is found that social integration like family support, financial assistance, and interaction with peers will help students to score high marks. Also, students who are concern about their future, take stress for it perform well. Although socio economic status is found significant but the difference in socio economic status of students does not provide much difference in their academic performance.

Sixth, education sector in India is getting weak. As per the report by Aser Center, a survey on level of education of youth in India, it is found that 40% of students are unable to do basic calculation and to read a simple English sentence. Young generation is future of our country which makes this a major societal problem. Further, this results in decreased job rate. By enhancing the academic performance of students this problem can be fully removed and it benefits our education sector. Moreover, this increases employability as education sector is linked to the industry.

Table 5. Summary and key findings

Construct	Key Findings
Personality	Personality constructs puts a positive impact on students' performance. It makes them organized, open to accept new problems and to follow innovative ways to solve them, bring punctuality and build seriousness.
Motivation	These constructs help students in locus of control, motivate them, build positive attitude, makes them self-efficient and goal oriented. Including these in addition to their curriculum will significantly help in improving their development.
Self-regulation strategies for learning	It encourages students to strengthen their cognitive skills and abilities, manage time, practice the subject matter, and regulate their efforts.
Psychosocial contextual influences	Integration of students socially and academically helps students in acquiring knowledge from peers and instructors. This is beneficial especially in the case when student is unable to attend the class due to medical reason.
Approach towards learning	Knowing the subject matter with deep concepts and background details assist the students in learning in an effective way.
Demographic	The impact of this construct on the learning of students is found almost equal for each of its sub construct.

LIMITATIONS AND FUTURE SCOPE

Though this study contributes significantly from empirical and theoretical view, certain other aspects are required to be incorporated to enhance maximum benefits from it.

Foremost, the research is limited to students of metropolitan cities and data of rural and remote areas is not included. Although data under study covers different colleges but the probability of a student not belonging to non-metropolitan city is rare. Hence no opinion can be given on model fit in other areas. The study therefore can be extended to include students nationwide.

Second, this study has considered the present behavior and patterns as depicted by the students. Other key parameters such as genetic impact, environmental effects on the student's learning and upbringing, education level of parents, type of learning skills etc. can be further included to strengthen the outcome of this study. These features might influence learners' perception.

This research can be further extended in developing a recommender system for the students to improve their learning behavior at the earliest deviation thereby helping them to enhance their performance.

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Recommendation-Based Meta-Search Engine for Suggesting Relevant Documents Links

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ABSTRACT

The information available online is mostly present in an unstructured form and search engines are indispensable tools especially in higher education organizations for obtaining information from the Internet. Various search engines were developed to help learners to retrieve the information but unfortunately, most of the information retrieved is not relevant. The main objective of this research is to provide relevant document links to the learners using a three-layered meta-search architecture. The first layer retrieves information links from the web based on the learner query, which is then fed to the second layer where filtering and clustering of document links are done based on semantics. The third layer, with the help of a reasoner, categorizes information into relevant and irrelevant information links in the repository. The experimental study was conducted on a training data set using web queries related to the domain of sports, entertainment, and academics. The results indicate that the proposed meta-search engine performs well as compared to another stand-alone search engine with better recall.

KEYWORDS

Clustering, Domain, Meta Search Engine, Ranking, Recommendation

1. INTRODUCTION

Content on the web is billowing and growing at a faster rate. Search engines are productive tools to search the relevant information from the web. Due to the rapid growth of information over the internet, the task for finding the relevant information has become very difficult for every individual search engine. The success or failure of a search engine is unwaveringly reliant upon the user's satisfaction. The search engine users expect the information to be rendered to them in a small period of time. Users also expect that the results must be relevant and appropriate (Satya Sai & Raghavan, 2001). Most of the time the results returned by the search engines cannot entirely satisfy the requirement of the user and the search results are not very accurate and appropriate (Li et al., 2001).

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Recommending relevant information is measured as an imminent factor in searching process nowadays, because current recommendation process is not based on user interest and is still following the predefined and static patterns of retrieved information in-spite of the fact that the resultant information needs to be filtered to meet user's interest and objectives (Gulzar et al., 2019). The lack of any explicit arrangement and a wide variety of data available on the World Wide Web creates a challenge for its users to find the concerned data without extra efforts or without any outer help. It was believed that an individual general-purpose search engine lacks processing capability to cope-up with the amount of information being loaded on web nowadays (Sugiura & Etzioni, 2000; Manning et al., 2008).

There is a Meta-search engine concept which is gaining popularity among users and is built on top of other search engines. The user query in Meta-search engine is run across different components simultaneously, the result generated is ranked and best one is provided to the user (Meng, Yu & Liu, 2002). The primary aim of Meta-search engine is to overcome the inherited differences of individual search engines, and thus provide the finest result from the best search engines. Meta-search engine filters the top N results from individual search engine result and that's why it is able to provide the most inclusive result set which is available on WWW. The traditional search engines crawl the web to retrieve the information, but on the other hand Meta-search do not crawl to provide the search result to the user. The Meta-search send the user query to dissimilar individual search engines at a time and only the top N filtered resultant documents are then visualized by the user in a window.

Meta-search engine too poses a few distinctive challenges in terms of the information which is not similar it gathers from individual engines. The outcome of the search consists of document ranking by individual engines which are also accompanied by a document title, a Snippet and a URL (Fabrizio, 2009; Rashid, 2008). But there are prominent advantages of Meta-search engines against individual engines by increasing the searching coverage on the web to provide high recall. It also increases the information retrieval effectiveness by increasing the precision and solves the problem of scalability of web-search. Search engines help to retrieve the relevant document links, but it is necessary to analyze the validity of the document, website and of the links. The existing search engines fail to apply the cognitive reasoning on the links and the semantics of the text. As a part of Meta-search engine, intelligent algorithms are required to select the relevant links. This research work applies the hierarchical clustering and fuzzy reasoner to club the links and rank the accurate results to cater the need of user requirement. This research work adapts the layered framework for retrieving the links from the web.

The other part of the paper is structured as follows: The following section gives a brief about the related work regarding the recommendation, search engine and meta-search engine. Section 3 explains the framework of the Meta Search engine while as Section 4 shows the parameter calculation followed by section 5 for reasoning and experimental results and conclusion is provided in Section 6.

2. RELATED WORK

This study aims to develop an approach of ranking and personalizing the user information as per interest and the preference of the user. Therefore, a new document recommendation approach based on the intelligent searching concept is presented in the form of a Meta-search engine. This segment will provide an interesting overview of the related work regarding meta-search and recommendation concept. A trained Meta-search was proposed by (Guang-ming & Wen-juan, 2010) based on a neural network (NN) CC4 algorithm for calculating web-page relation obtaining the highest degree of proficient web-pages. The authors provide a basic solution to a big problem related to the users trying to access information in an information pool. The NN algorithm reviews the information related to Web-pages which are then ranked and collected in a trained dictionary in a sorted manner.

Similarly, Raval proposed an engine that was basically powered by the management and mechanization of Google functions to achieve more combination and accurate search results (Vishwas,

& Kumar, 2011). Another Meta-search engine by that works on the principle (Brijeshkumar et al., 2011) of priority and user profiles. The system has a parallel crawling approach which helps to improve the performance of the searching by feeding multiple engines instantly and also reduce the redundancy of the overlapped downloads. The Leonidas et al. have explained the proposed system using a quad-rank mechanism where additional information related to query tokens, data connection and overall result of a meta-search engine is considered. The authors have proved that the proposed technique outshine individual search engine by testing the system for its efficacy and productivity in a real-world scenario at the TREC-2009 Congress (Leonidas et al., 2011).

Moreover, Adeniyiet developed a recommender system that uses web data mining by checking the user's behaviour in the form of data stream clicked by them on RSS web-reader. While surfing the internet the user will get the specific information without even enquiring for it. In this system, they used K- nearest neighbourhood classification algorithm to identify the clicked data stream concerning particular users (Adeniyi, Wei, & Yongquan, 2015). Another hybrid framework for recommender system was developed where user-centric information is being recommended. The basic problem which users are facing which searching information is to choose among the variety of choices which contain both relevant and irrelevant information a right piece of information in their interest. In such situations, if an intelligent searching process is applied that would help in recommending relevant information is of great use as it will help users to make certain decisions to meet their objectives. They integrate different searching techniques to develop a hybrid framework for suggesting relevant information (Zameer & Leema, 2018).

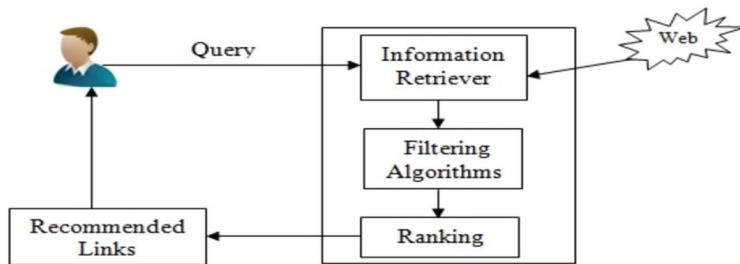
Furthermore, Mishra et al. explained the system which considers sequential information that is present in the web navigating patterns along with the information of the content present in it. The user approval is generated by the SVD algorithm and upper approximation (Rajhans et al., 2015). Zameer developed a query classification technique to recommend relevant information to the users because any recommendation or search engine at core employs information retrieval methods to retrieve and deliver the most useful information. They are classifying the user query in order to obtain the best possible relevant information. The system is able to recognize the user intention in the query itself and based on the applied techniques it generates most relevant recommendations (Zameer & Leema, 2018). Recommendation system based on graphs was suggested which utilize users profile and the positive items ranked in it to generate all undirected, connected and highly connected graphs, with nodes and edges represented by items and correlations respectively. The system finds the recommendation using the entropy and graph connectivity which are new as well as suitable for the users (Kiboom & Kyogu, 2015).

Researchers are advocating the Meta-Search engine capability for providing the qualitative results for different form of domains and suggested a Meta-search engine which determines query relevancy concerned with a web-page and then cluster the retrieved information accordingly. The proposed system is believed to reduce the efforts of users by improving the result quality and performance efficacy to overcome the problem of information overload concerning URL links (Naresh, 2017). Another work where neural networks are used to merge the top computational score effectively and from each individual search engine the top N listed information links for the next stage of processing. They did the ranking based on snippets, titles, position and co-occurrence-based calculation and prove that the ranking methods developed till date were inefficient since only few parameter calculations were done for ranking for each individual engine which later effects precision and recall measures. The response timing was also minimized per 100 links (Vijaya et al., 2016). Likewise, another approach was introduced for reducing the communication and calculation based load from page-ranking algorithm (PRA) and for that purpose they try to gather web-pages regularly and group them inherent scarcity in web. A collective page-rank value was calculated for every group which needs to be shared among the members of the group to provide a scheme of shared update page-ranking along with their merge properties. They kept ranking of errors in a small range to exhibit the intensity of computational reduction (Hideaki et al., 2012).

3. FRAMEWORK FOR META SEARCH ENGINE

Figure 1 describes the general architecture of the recommendation process for Meta-search engine which gives the suitable and authenticated links to the user. The diagram depicts the three-layer architecture developed for the proposed Meta-search engine. The three layers of the generic framework of Meta-search engine consists of Information retriever which is responsible for retrieving links from the various search engines for a given query. The second layer filtered and clustering the retrieved links and also remove redundancy. The third layer reasoning applied fuzzy logic to provide the available link which helps to figure out the relevant links to the user.

Figure 1. General architecture of meta search engine



The architecture of the proposed Meta-search engine as shown in Figure 2. Consists of several components which are explained as follows.

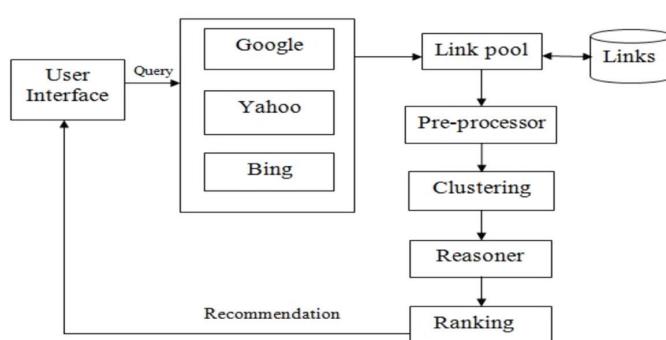
3.1. User Interface

The basic component of the proposed system is the user interface where a user provides an input query which is then fed to each individual engine shown in Figure 2. The link pool component in the proposed system will receive the top N recommended documents from all individual engines which are then rearranged. The document redundancy or duplicate documents are removed on the basis of URLs. The retrieved documents URLs are collected and stored in the database which is later collected and is given for further processing.

3.2. Link Pool

The information dataset which is randomly generated based on the domain of queries given by the users are retrieved in link pool and stored in a database for future use. The individual engines which are used to search the

Figure 2. Proposed meta-search engine framework



information related to a user query are Yahoo, Google, and Bing. In this study, three different domain types are used where user queries are revolved around such as Academic, Sports and Entertainment. As soon as the data set is ready in the link pool, it is then sent to the next phase, pre-processing to filter the retrieved information.

3.3. Pre-Processor

The pre-processing is applied to the whole document to identify the words and phrases of every document which is used for further processing. In pre-processing, the links are extracted from the web pages first and store it as an individual text document. This individual text document is given to the input for the next step. The steps involved in pre-processing are explained below:

Stop word removal → stemming → Top word selection → common words → unique words

User query does not contain all meaningful words, therefore, most of the words don't have semantics and contain irrelevant information which is removed to speed up the search result and also to save memory space. Stemming is a normalization process, which removes the inflectional endings from words or reduces alternative form of words to a general form by restricting the vocabulary space. Stemming can relate words which have different forms based on the same stem or base such as connections, connecting, and connective to common word connect, known as stem or root word. The stemming process improves the effectiveness of the system and reduces the indexing size. Top words (technical word) are selected from the document. From the top n words, common words are separated that is mostly used in the document and then words are compared with common words. From these, only the unique words are selected. The repeated words are removed from the list and unique words are separated.

3.4. Filtering and Clustering

In this layer, the results are filtered and the selected unique words are clustered from the document. In this study, the hierarchical clustering is to combine or cluster the relevant links. The data during the process of clustering is segregated sequentially using a particular distance measure. During the chronological procedure of separation, the algorithm creates a nested partition using a keyword group into an entire cluster tree according to the distance measure without being familiar or recognizing the number of clusters well-ahead. One of the types of clustering known as agglomerative clustering, which uses a bottom-up approach is being applied to combine the links and to form a cluster. The algorithm for the clustering procedure is as follows:

Algorithm
Input: No of nodes with keywords of each node
Output: Cluster hierarchy
Initialization: Number of node (U_i , where $i=1,2,\dots,k$) keywords Disjoint clustering level $L(0) = 0$ Sequence number $n = 0$.
Start
Step 1: Assess all pair-wise distances among nodes Add each node as its own cluster
Step 2: Erect a distance matrix by means of the distance values $Dc [(U_1), (U_2)]$
Step 3: Pair the node with the shortest distance $U = (U_1 \cup U_2) // \text{Merge the node}$
Step 4: increase $n=n+1$, Set the level to $L(n) = dc [(U_1), (U_2)]$
Step 5: Revise the distance matrix Distance between the new clusters $Dc [(U_3), (U)] = \min(Dc [(U_3), (U_1)], Dc [(U_3), (U_2)])$
Step 6: Replicate till the distance matrix is decreased to a single element
Stop

4. PARAMETER CALCULATION

There are three different parameters used in this study on whose basis the data set is being generated and later clustering and ranking of the unique URL links are prepared. The parameters calculated are title-based calculation, bold based calculation and domain-based calculation.

4.1. Title Based Calculation

In this technique, the calculation is done on the basis of the unique title enclosed in the document link. The title of the document is compared to check its frequency with the user query word tokens and the synonyms generated for those query tokens through WordNet which is shown in Table 1.

In Table 1 W1, W2, W3...., Wa is representing input query token words and ‘a’ is the entire count of the query token words. The S1 is the first word synonym of the word W1 (W1S1), and WaSb represent the bth synonym S of the ath token W for a given query, while as C1W1 represents the frequency of the first synonym word present in the unique title link. For each unique link, the title-based calculation is given in Equation 1:

$$T_s(p) = \sum_{i=1}^a \left(\frac{T_s W_i - \max(TW_i) + 1}{\max(TW_i)} \times w_Q + \sum_{j=1}^b \frac{T_s W_i S_j - \max(TW_i S_j) + 1}{\max(TW_i S_j)} \right) \quad (1)$$

Table 1. Frequency generation for query words and synonyms

	W1	W1S1	W2	W2S1	.	.	.	Wa	WaSb
T1	C1W1	C1W1S1	C1W2	C1W2S1	.	.	.	C1Wa	C1WaSb
T2	C2W1	C2W1S1	C2W2	C2W2S1	.	.	.	C2Wa	C2WaSb
T3	C3W1	C3W1S1	C3W2	C3W2S1	.	.	.	C3Wa	C3WaSb
.
.
Ts	CsW1	CsW1S1	CsW2	CsW2S1	.	.	.	CsWa	CsWaSb

In Equation 1, $T_s(p)$ is the S^{th} calculated value of title based unique links and $T_s W_i$ is the frequency of the i^{th} token word in the document title T of the S^{th} unique link. The $\max(TW_i)$ is the frequency of the i^{th} token word in whole unique document links titles and $T_s W_i M_j$ is the frequency of j^{th} synonym of i^{th} query token word in whole unique document links title T of S^{th} link. The $\max(TW_i M_j)$ is the maximum frequency of the j^{th} synonym of the i^{th} token word in whole unique document links titles whereas ‘a’ is the total count of the query token words and ‘b’ is total count of the synonym words of the i^{th} query token and w_Q is the weight-age of the query token and W_s is the weight-age of the synonym word.

4.2. Bold Based Calculation

In this technique the words which are bold in the retrieved URL link are being compared with the user query tokens and their synonyms generated from WordNet, and also to check their frequency

concerning the words which are bold in each link. Table 2 displayed the frequency of the occurrence of query tokens and synonym tokens with respect to each bold link word.

The B_1, B_2, \dots, B_s represents the unique contents in the links and the frequency of a^{th} query token word in content of s^{th} unique link is represented by $B_s W_a$. The $B_s W_a S_b$ is the frequency of the b^{th} synonym of a^{th} query token word in the content of s^{th} unique link. The computation of bold based approach is given in Equation 2:

$$B_s(p) = \sum_{i=1}^a \left(\frac{B_s W_i}{\max(BW_i)} \times w_Q + \sum_{j=1}^b \frac{B_s W_i S_j}{\max(BW_i S_j)} \times w_s \right) \quad (2)$$

Table 2. Frequency of query tokens and synonyms

	W1	W1S1	W2	W2S1	.	.	.	Wa	WaSb
B1	B1W1	B1W1S1	B1W2	B1W2S1	.	.	.	B1Wa	B1WaSb
B2	B2W1	B2W1S1	B2W2	B2W2S1	.	.	.	B2Wa	B2WaSb
B3	B3W1	B3W1S1	B3W2	B3W2S1	.	.	.	B3Wa	B3WaSb
.
.
Bs	BsW1	BsW1S1	BsW2	BsW2S1	.	.	.	BsWa	BsWaSb

In Equation 2, $B_s(p)$ represents the bold word based calculated value of s^{th} unique link and $B_s W_i$ is the frequency of the i^{th} query token word W in bold word of s^{th} unique link, while as $\max(BW_i)$ is the highest frequency of i^{th} query token word W in content of s^{th} unique link. The $B_s W_i S_j$ is the frequency of j^{th} synonym of i^{th} query token word W in the bold word of s^{th} unique link and $\max(BW_i S_j)$ is the highest frequency of j^{th} synonym of i^{th} query token word W in the bold word of s^{th} unique link.

4.3. Domain Based Calculation

The links retrieved from all individual search engines would fall under a particular domain whose value is calculated for every distinctive URL using that particular domain name for each individual search engine. The formula for calculating the domain value for each unique link is given in Equation 3:

$$U_s(p) = \log_{10} \left(\frac{2m - 1 + acc_s}{2m} \right) \quad (3)$$

$U_s(p)$ is the value calculated for S^{th} link of a domain whereas acc_s represents the number of links which are unique in a particular domain and m refer to the number of individual engines used e.g. if the number of links which are unique is 15 and the links which belong to a particular domain is 8 then the value of acc_s for that link is five.

5. REASONER

Reasoner is responsible for ranking and merging the top URL links generated from different individual search engines on the basis of their sensitivity. The result generated along with their values is used

to train the fuzzy logic system by feeding it with the ranked URL links. In recent years fuzzy logic-based interface system emerged as primary classifiers that were used among different fields for a rule-based system because the rule-based systems are used in different applications areas such as medical, entertainment and even error detection systems. In proposing fuzzy interface system, the significant factor is to select the correct rule system but most of the researches have taken this problem in general but in most of the cases there are certain computational methods which are being employed for generating the rules from the regular data.

5.1. Experimental Results

The experiment was conducted using a dataset of user query sessions gathered over the web which was generated in proposed system by capturing the links visited by the users during result retrieved by Meta-search engine. For the generation of dataset the query is input through an interface where the query is passed on to the stack of individual search engine and back again the results generated are displayed on the same interface. In Figure 3 the interface of the proposed system and result for a user query is displayed.

Figure 3. Meta-search engine result for the academic domain



5.2. Performance Analysis

The primary aim of proposed Meta-search engine is to filter the links and rank them using the hierarchical cluster method and fuzzy logic system. The domains were selectively chosen in order to cover a wide variety of queries on internet and the number of randomly chosen test queries for each of the three domains is twenty-five. The queries were fed through the Meta-search engine to all individual search engines and then a group or set of the documents are identified which are relevant, from all the retrieved documents of each individual search engine. The number of the relevant document retrieved was counter for relevancy by the domain expert and the concerned performance measure values are given in Table 3.

In Table 3 domain-based comparison is provided in the form of average precision and recall for existing and the proposed techniques for 25 test queries are shown in Figure 4. The existing techniques were K-mean clustering and Fuzzy logic based and the proposed technique is based on hierarchical clustering and fuzzy logic. The precision value and the number of queries is represented by y-axis and x-axis respectively. The average precision of all domains in the proposed system is maximum for academic and sports 0.85%, while entertainment 0.75% as compared to the existing systems average precision for academic 0.80%, sports 0.82% and least for entertainment 0.73%. It is also evident from

Table 3. Calculation of precision and recall values

Query Domain	Existing System Techniques		Proposed System Techniques	
	K-Means +FL Based URL Ranking		HC+FL Base URLs Ranking	
	Precision	Recall	Precision	Recall
Academic	0.80	0.60	0.85	0.62
Entertainment	0.73	0.75	0.75	0.80
Sports	0.82	0.80	0.85	0.90

the Figure 4 and Figure 5 graph that the precision and recall results achieved by the proposed system is much better due to more class labels in hierarchical systems comparing to k-mean cluster technique.

Figure 6 to Figure 8 displayed the performance analysis of developed meta-search engine for different domains on the basis of user recommended query. From the graph, it is clearly understood that as the user recommendation result is increased there is a decrease in precision and recall value. The x-axis represents user recommended result and y-axis represents the value of precision and recall.

Figure 4. Precision measure of the proposed methodology

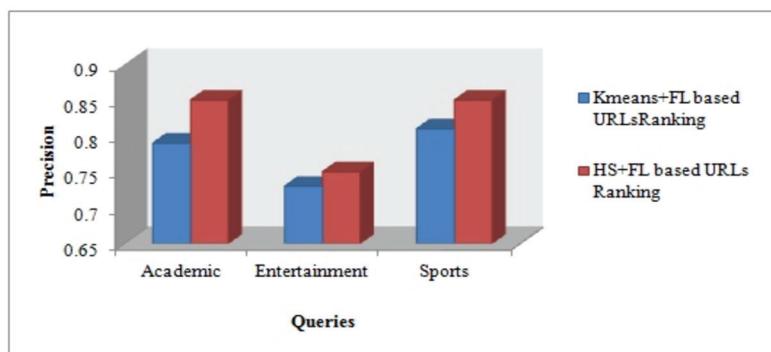


Figure 5. Recall measure of the proposed methodology

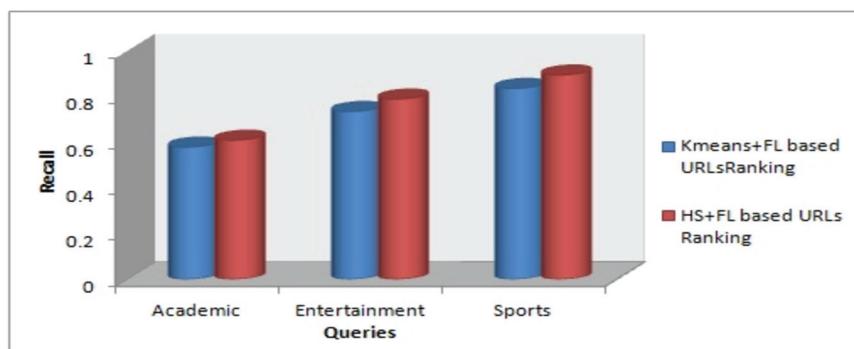


Figure 6. Performance analysis of proposed methodology for academic domain

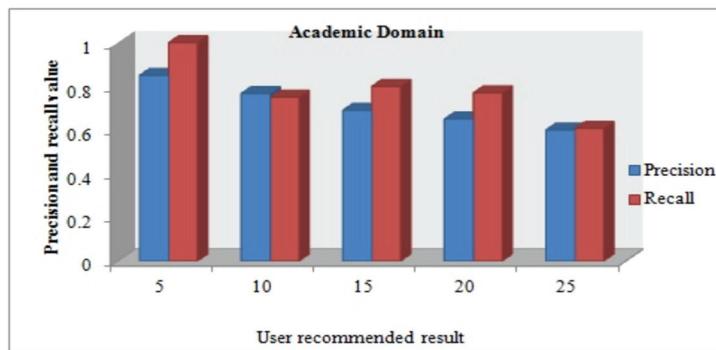


Figure 7. Performance analysis of proposed methodology for entertainment

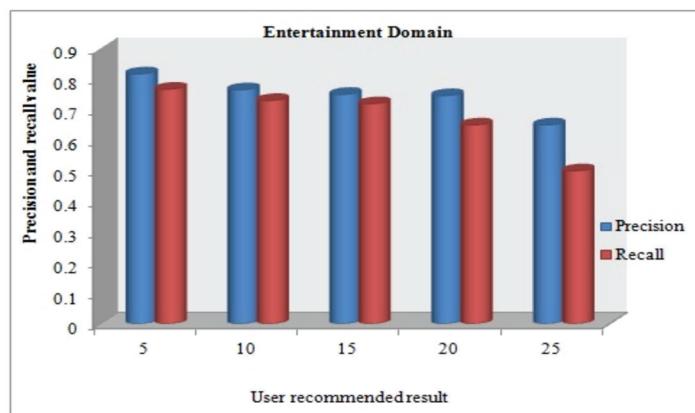
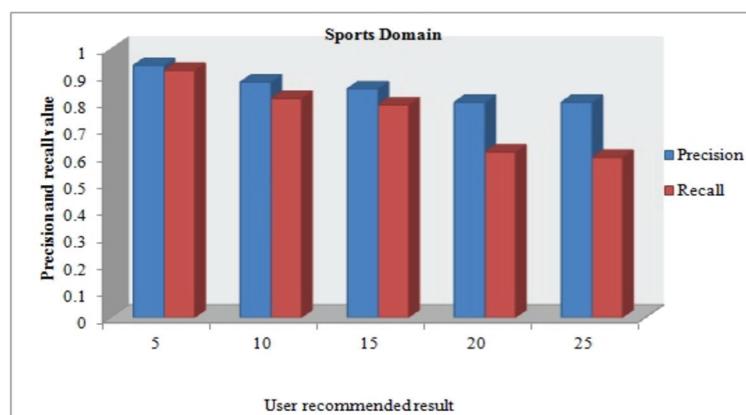


Figure 8. Performance analysis of proposed methodology for sports domain



The proposed research work will also rank the recommended URLs obtained from various search engines. The analysis of three famous search engines Bing, Yahoo, and Google which is based on precision analysis and used in proposed meta-search approach is shown in Table 4. The resulting analysis suggests that the proposed search engine outperforms the individual search engines in terms of better precision score.

Table 4. Average precision for 25 queries in different domain

Domain	Meta-Search	Google	Yahoo	Bing
Sports	0.84	0.75	0.68	0.72
Academic	0.83	0.78	0.70	0.73
Entertainment	0.85	0.77	0.69	0.72

The analysis of the result suggests that the proposed search engine outperforms the individual search engines in terms of better precision score. To check the relevant document links retrieved (First ten document links) with the individual and meta-search engines, a query “data mining” was input to all the engines. The results are displayed in Table 5, which shows that among the three engines the poor performance is shown by Yahoo search engine whose relevant document retrieval score are only 5 among the top 10 documents. On the other hand, Bing and Google were a bit more accurate than Yahoo with 6 relevant links each while as the proposed Meta-search engine tops the ranking list with a qualitative score of 8 relevant document links. The alphabet “R” denotes relevant document link for a particular engine and the symbol “-” denotes an irrelevant link. The relevant document retrieval rate was initially set to 10 and the proposed methodology retrieved 8 relevant documents, while as other individual search engines obtain only maximum of 6 documents links.

Table 5. Top ten relevant document list for a user query

Engine	1	2	3	4	5	6	7	8	9	10	R
Meta-search	R	R	R	R	R	R	-	R	R	-	8
Google	R	R	R	R	R	R	-	-	-	-	6
Bing	R	-	R	-	R	R	-	R	R	-	6
Yahoo	R	-	-	R	-	R	-	R	R	-	5

Table 6 shows the retrieval and ranking performance of different domain using different search engine. The table contains five queries related to sports domain and corresponding retrieval result with ranking of search engine. Based on the retrieval count we rank the search engines. In our proposed work, we utilize the Meta-search engine which is the hybridization of individual engines like Yahoo Google, and Bing. The search engine retrieves the result based on user query and recommended the URLs count.

For example, we have used the user query “Pro kabaddi” and the recommended users URL is “10”, so, while using the proposed Meta-search engine the relevant URLs percentage obtained is 50% for Google, 30% for Yahoo and 20% for Bing. Finally, based on the retrieved URLs count we rank the search engine. From the table we understand, among the three search engines “Google” is

Table 6. Retrieval and ranking performance of selected domains

Domain	Keywords	User Recommended Result	Meta-Search			Rank (%)		
			Google	Yahoo	Bing	Google	Yahoo	Bing
sports	Pro kabaddi	10	5	3	2	1 (50)	2 (20)	3(30)
	IPL match	15	7	3	5	1 (67)	3 (20)	2(13)
	Top Athletes	20	9	5	6	1 (45)	3 (25)	2(30)
	Rio Olympics	10	4	4	2	2 (40)	1(40)	3(20)
	Awards of Sachin	20	8	5	7	1 (40)	3(25)	2(35)
Academic	Examination	15	6	5	4	1 (40)	2 (34)	3(26)
	Results	5	3	1	1	1 (60)	3(20)	2(20)
	Syllabus	20	8	7	5	1(40)	2(35)	3(25)
	Universities details	10	4	2	4	1(40)	3(20)	2(40)
	Out Campus interview	15	6	4	5	1(40)	3(26)	2(34)
Entertainment	Latest movies	20	9	5	6	1(45)	3(25)	2(30)
	Korean drama	10	4	4	2	1(40)	2(40)	3(20)
	Pop songs	10	5	3	2	1 (50)	3(30)	2(20)
	Games	15	7	3	5	1(67)	3(20)	2(13)
	Dup mash	20	8	5	7	1(40)	3(35)	2(25)

better other two. Each query we obtain the relevant URLs for different such engines such as Bing, Yahoo and Google. The search engines were ranked based on the retrieved relevant URLs count.

6. CONCLUSION

The meta-search engine was proposed to recommend the relevant information and personalize search engine result related to user's interest. The hierarchical clustering and fuzzy logic based ranking process were developed, unlike individual search engines that use page ranking system. The proposed search engine utilizes a user dependent methodology to rank the resources of search engines and it was also tested against Yahoo, Bing, and other individual engines for availability, consistency, and relevancy. Result comparison indicates that the search results ranking by using the enhanced fuzzy concept networks in the proposed system are showing more relevancy as per the user's interests rather than ranking obtaining through the general concept of networks in individual engines. The main aim of this paper is to develop a novel ranking system such as URL ranking and search engine ranking based on the hierarchical cluster to optimize the performance of the system and for relevant web page recommendation.

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Incorporating Information Communication Technology Skills in Accounting Education

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ABSTRACT

Information and communications technology (ICT) is widely utilized in the accounting profession and has transformed the accounting functions in business and the role of accountants. Acknowledging the significance of ICT skills in accounting education, many employers and professional associations are calling for integration of accounting curricula with ICT. Therefore, it is vital for potential accounting professionals to be equipped with the most current ICT skills pursued by employers. This study searches the current job market to capture a snapshot of the most in demand graduate skills, in particular, ICT skills. Furthermore, it also lists a number of software systems for accountancy solutions and their supplier firms.

KEYWORDS

Accounting and Finance, Employment, ICT Skills, Learning and Teaching, University

INTRODUCTION

The accounting profession worldwide has come under close examination due to changing technology and globalization of the world economy. Technology has created competitive pressure within the accounting profession that has led to expectations that accounting graduates should develop non-accounting skills with increasing importance given to information communication technology skills. Accounting software and computer technology are considered essential to career by accounting graduates and employers (Kavanagh and Drennan, 2008). There is also more focus on technological skills during academic studies in the guidance published by Accounting associations and standard setters including the American Accounting Association (AAA) and the Association to Advance Collegiate Schools of Business (AACSB), and the American Institute of Certified Public Accountants (AICPA) (Willis, 2016). Most organizations now require ‘Hybrid Accountant’ i.e. combining IT/IS competencies and mainstream accounting capabilities. “Hybrid” accountant blends different skills and knowledge of business management and information management (Ahmed, 2003). Universities across the world are now increasingly conscious of this trend and have been responding with suitable initiatives within the operational framework of degree programmes to develop both the necessary and in-demand interpersonal and applied skills that will make their graduates employable in their chosen field of study.

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100

Interestingly, the impact of the skills challenge has a different dimension in different parts of the world. While many Western nations are faced with the challenge of too many graduates and too few jobs, Middle East countries are trying to reduce their reliance on foreign nationals by developing more local nationals capable of tackling the highly skilled jobs in fields such as accounting and finance and information and communication technology. Several countries in the Middle East, including Qatar have initiated national programmes focused on the development of human capital and the movement towards a knowledge economy. To equip graduates with the required skills in all fields including in Accounting and Finance, Qatar's government launched an initiative known as Qatar National Vision 2030 (QNV 2030). The initiative foresees that in the transition towards knowledge-based economy; future economic success will depend increasingly on the ability of the Qatari nationals to deal with an international order that is knowledge-based and extremely competitive. The vision will allow Qatar to develop its human capital as well as provide an effective example of how to re-skill workforce with up-to-date skills and competencies that will foster analytical and critical thinking as well as creativity and innovation to cater to the changing and complex needs of industry and commerce. In order to achieve sustainable development and maximise the success of related supportive initiatives, it is necessary to start at least from a graduate education perspective. The starting point is therefore a deeper understanding of the gaps and needs that affect the present settings of the graduate education system as well as graduate attributes when analysed against the skills and competencies demanded by employers. As this study is focusing on the importance of ICT skills in accounting education, it is vital to understand the current trends in the field and examine the job market to recognize if ICT skills is one the main areas that are required from accounting graduates. This study will be the first attempt to profile the use of ICT in accounting from a general perspective as well as from a GCC perspective. Given the significance of the finance and accounting profession in Qatar, this paper seeks to capture an overview of the accounting job market and current accounting software solution development. The remainder of the paper is organized as follows. The next section reviews existing literature on ICT skills in accounting education. Thereafter, it highlights the importance and the requirement of ICT Skills in Accounting Job Advertisements and then it identifies the current software's that are in use by accounting firms. Finally, it presents the discussion and conclusion section that outlines the findings and implications of this study.

THE ROLE OF ICT SKILLS IN ACCOUNTING EDUCATION

In the current business environment, Information and Communication Technology (ICT) skills are given prominence by several authors who identify competency in using various applications and tools as an important strategic differentiator for potential accounting and finance graduate-employees. Technological skills reflect graduates' ability to select and use appropriate technology to address diverse tasks and problems in their work environment (Jackson, 2014a, 2014b). The ability to use common software applications used in accounting and finance is an obvious skill that employers look for in graduates. Cox et al. (2013) offer a more streamlined understanding of it, as graduates' expertise in effectively using ICT, and describing the IS and ICTs of core relevance to understand their practical application. Graduates' ability to adapt to technology is also defined as their ability to use current technology, to be able to learn, and be capable of solving the problem at hand. Employers often highly value technical field-specific knowledge (Hernández-March et al., 2009). Literature argues that most graduates lack the necessary computing skills required by the employers, and these graduates suffer from poor perceptions of the skills expected at the workplace (Gibbs et al., 2011; Gaviria et al., 2015; Ezeani & Akpotohwo, 2014). While some studies recommend joint efforts from universities and companies in technology transfer agreements to lessen the gap between higher education and labor market requirements (Hernández-March et al., 2009; Ogundana et al., 2015), others suggest that graduates should receive formal tuition to improve their technological skills to prosper at work (Gibbs et al., 2011). Ragland and Ramachandran (2014) investigated the Excel functions that

are perceived to be important and useful for accounting graduates prior to starting a job in public accounting. The results suggest that accounting students underestimate the importance and usage of some of these Excel functions. Their results also suggest that new hires' perceived knowledge on how to use specific Excel functions in their accounting job is statistically different than students' perceived knowledge on how to use some of the same Excel functions. Willis (2016) also mentioned that excel is an essential skill used in the accounting field and prospective employers value new hires who possess knowledge of this software.

Sprakman et al. (2015) consulted chief financial officers in New Zealand's largest firms and explored their perceptions regarding the IT competencies required of management accounting graduates. Their study identified Excel for analysis as the most important followed by Word, PowerPoint and Outlook. Elsaadani (2015) evaluated the sufficiency of ICT skills of fresh accounting graduates in Egypt and revealed that they should be literate with Internet, word processing software, spreadsheet software, e-mail, commercial accounting software, and database management software. Elsaandi also calls accounting higher education institutions worldwide to keep exploring the requirements of the profession in order to equip graduates with competencies that are demanded by employers. Seethamraju (2010) argued that whether it is auditing, financial accounting or management accounting, relevant information technology skill need to be embedded in the accounting context and train graduates with the help of modern pedagogy. He further argued that many units within accounting courses employ Excel, however, the level of expertise taught is restricted with hardly any university teaching students advanced features such as macros, and other aspects. Tanaka and Sithole (2015) examined the IT skills employer's need and their level of satisfaction with new accounting graduates using survey research. Results of the survey research suggest that students are better trained in word-processing and knowledge of communications software skills, yet employers expect entry level accounting graduates to possess accounting packages knowledge and spreadsheet competencies. The way to address the IT skills deficiencies would require accounting instructors to incorporate advanced excel skills, the teaching of widely used accounting packages.

Senik et al. (2013) explored the expectation gap in information technology (IT) skills development in an accounting degree course in the UK using grounded theory methodology. The findings indicate that some of the required understanding and skills relating to accounting, tax and auditing software is lacking, suggesting an expectation gap. Different opinions concerning who should assume the responsibility for the development of the IT skills of the graduates; the understanding concerning the nature of IT skills; unclear expectations; and a lack of communication among stakeholders in accounting education are the factors perceived to cause the existence of such a gap. According to Chang and Hwang (2003), many in the accounting profession have raised concerns over whether university curriculum courses effectively and efficiently prepare accountants to meet these challenges. Their findings highlighted that educators recognize the importance of IT topics, but educators have difficulty covering all the important IT topics in accounting curricula. To overcome this challenge, accounting firms need to work closely with academicians to find ways to collaborate in teaching the subjects that bring a higher payoff for the resources invested by both colleges and accounting firms.

DEMAND FOR ICT SKILLS IN ACCOUNTING JOB ADVERTISEMENTS

Many online recruitment sites were searched for accounting related jobs in Qatar; the main purpose of this was to identify the graduate attributes in particular ICT skills listed under these advertised job positions. These sites included Gulftalent, Monstergulf, Naukrigulf, Bayt, and Jobs in Qatar. This study was carried out in the May of 2016, and 21 Accounting related positions were retrieved. The results were based on the jobs posted in the last four weeks of May 2016. The short listed vacancies were observed for their required graduate attributes in particular ICT skills. The findings revealed that whether it is cost accounting, Auditing, Finance director or credit analyst, employers require ICT skills from accounting candidates.

Table 1. In demand skills in accounting professional

Position	Skills
Manager of Cost Accounting	1) Knowledge of accounting field; 2) Strong people management skills; 3) Time management skills; 4) Accuracy and attention to detail; 5) Advanced numerical and analytical skills; 6) Excellent negotiation skills; 7) Excellent report writing skills; 8) Good communication Skills; 9) Good presentation skills; 10) Advanced MS office skills.
Senior Manager IT Audit - Banking	1) Be a specialist ICT Auditor; 2) Self-starter; 3) Able to execute audit plan individually 4) Team working skills; 5) Leadership Skills 6) Strong knowledge of ICT audit methodologies; 7) Familiar with corporate, treasury and retail lending products
Senior Finance Manager/ Finance Director	1) Leadership skills; 2) Management experience; 3) Regional experience; 4) Experience working within heavy industry; 5) Excellent ICT skills
Chief Internal Auditor	1) Leadership Skills; 2) Accuracy; 3) Presentation skills; 4) Management skills; 5) Good Reporting skills; 6) Industrial experience; 7) Regional experience; 8) Information Technology skills; 9) Minimum of a BA Honors Degree; 10) CIA Qualified
Payroll Accountant	1) English Language; 2) Accounting principles; 3) Payroll accounting; 4) Knowledge of policy and procedure; 5) Time Management; 6) Business Sills and understanding; 7) Financial awareness; 8) Data gathering and analysis using computing software; 9) Performance management; 10) Written communication; 11) Financial Accounting; 12) 6 to 7 years' experience in Accounts; 13) Bachelor's degree in Accounting or Finance; 14) Industrial experience
Finance Manager	1) Fluency in English; 2) Excellent commercial experience in the management of large budgets and projects; 3) Good IT skills with knowledge of Microsoft office packages; 4) Ability to work independently; 5) Ability to lead; coach and develop a team; 6) Finance degree level qualification; 7) Must be a Qualified Accountant (ACA; ACCA; or CPA); 8) Must have experience in the Middle East
Accountant	1) Ability to analyse issues and recommends solutions; 2) Ability to communicate effectively; 3) Knowledgeable of accounting systems; 4) Ability to multi-task to meet deadlines in a timely manner; 5) Strong interpersonal skills; 6) Demonstrates flexibility with changing priorities; 7) Excellent in Account Package 'Tally ERP' and good exposure in MS Excel; Word; 8) Bachelor's degree in Accounting; Finance; or any related field; 9) At least 5 years of experience; 10) Experience in Construction and GCC is must
Senior Credit Analyst	1) Good Knowledge of banking processes and products; 2) Good knowledge of banking industry; credit function and regulatory guidelines; 3) Very good computer skills; particularly Excel and internet search; 4) Sound knowledge of lending practices / systems; credit policy; risk management; procedures; control procedures; understanding of legal issues related to lending; 5) Credit market awareness; 6) Good level of analytical skills; 7) Good communication Skills; 8) Management/supervision skills; 9) University Graduate in Finance / Accounting / Commerce; 10) Credit training in a reputable financial institution; 11) 5-6 years' experience in similar role and 6 years in a banking/finance environment;
Accounts / Administration Assistant	1) Numerical ability; 2) Attention to detail; 3) Professional manner; 4) Strong organisational and planning skills; 5) Ability to work on own initiative and with minimum supervision; 6) Good communication skills both verbal and written; 7) Good ICT skills
Finance Supervisor - Accounts Receivable	1) Strong computer skills with knowledge of Oracle Financials; 2) Fluent with excellent command in English; 3) Excellent communication 4) Presentation skills 5) Ability to work effectively in a multi-cultural environment; 6) Bachelor's degree; 7) 3 years job-related experience
Finance Supervisor - Credit Card Processing	1) Good knowledge in computer applications; including Microsoft Excel; Word and Power point; 2) User level experience in any ERP system; 3) Strong knowledge in complete interline billing process in passenger revenue accounting; 4) Excellent knowledge of Airline Business including understanding of Operational aspect and business flow; 5) Fluent with excellent command in English; 6) Bachelor degree in Accounting/Commerce; 7) 3 years of job-related experience

continued on following page

Table 1. Continued

Position	Skills
Officer Merchant E-Acquiring	1) Educated to degree level; 2) Strong ICT skills required; 3) Experience of developing new products to grow the merchant acquiring business (such as DCC or Contactless payment)
Senior Investment Accountant	1) Deliver on time; 2) Knowledge sharing skills; 3) Organizing skills; 4) ICT skills; 5) Professional Certification such as ACCA; CPA; CIMA; 6) 6 years in Accounting with experience in investment accounting
Assurance - Senior Associate - Financial Services	1) Problem solving and delivering client solutions; 2) Experience of working on audits; 3) Audit management experience; 4) Experience of interacting with senior level clients and management; 5) Effective communication skills; 6) Team working skills; 7) ICT skills; 8) Ability to take responsibility and use initiative; 9) Ability to work independently; 10) Experience in supervising and developing staff; 11) Knowledge of IAS and IFRS
Senior Project Financial Controller	1) Analytical skills; 2) IT skills, specifically very strong excel skills; 3) Confident and self-assured to be able deal with senior project leaders; 4) Ability to present an objective opinion; 5) Commercially aware; 6) Able to build relationships; 7) Professional working approach; 8) Excellent communication and literacy skills; 9) Good work ethic and keenness to improve
Group CFO	1) Leadership skills 2) Ability to influence senior management / executives; 3) Excellent ICT skills; 4) Strong Character; 5) Highly qualified CFO; 6) Experience in a similar role
Manager; Deal Advisory (Infrastructure and Financing)	1) Detailed knowledge of project financing; 2) Financial modelling skills; 3) Excellent analytical skills; 4) Interpersonal skills; 5) ICT skills; 6) Communication skills; both written and verbal; 7) Strong work initiative; 8) Ability to adapt to new challenges and ideas; 9) Experience of managing transactions; 10) Strong academic record including a post graduate degree from a reputed institution
Senior Accountant	1) Management of team; 2) Good communication; 3) Leadership skills; 4) ICT Skills; 5) Professional qualification such as CPA or CFA; 6) 2 years finance experience
Internal Auditor	1) Strong analytical skills; 2) Communication skills; both written & verbal; 3) Presentation skills; 4) Research skills; 5) Interpersonal skills; 6) Relationship building skills; 7) ICT skills; 8) Ability to multi-task; 9) Thorough attention to detail; 10) Excellent problem-solving skills; 11) Ability to work under pressure; 12) Bachelor's degree in accounting or finance and chartered accountant qualification is preferred; 13) 6+ years of experience in a similar role
Operational Auditor - H&M Shared Services	1) Strong analytical skills; 2) High degree of tact; 3) Self-reliance skills; 4) Technical and ICT skills; 5) Management skills; 6) 4-6 years' experience in operational and financial audits
Reconciliation Officer	1) Banking experience is essential; 2) 2-4 years' experience in a relevant role; 3) University degree level qualified; 4) Experience working with banking IT systems is a key element of this role; 5) The successful candidate must also be capable of meeting tight deadlines and working under pressure; 6) Experience working with ATM functions and credit cards

SOFTWARE SYSTEMS FOR ACCOUNTANCY PROFESSIONS

There are a number of commercial software systems available in the market that provide:

- A cashbook for business users;
- Complete double entry bookkeeping for both business users and their accountants;
- Accounting software with integrated payroll;
- Accounts production for accountants in practice to produce periodic financial statements for their clients from their manual or computerised accounting records;
- Software for specific market segments;
- Customer relationship management (CRM) software for managing clients, billing and marketing.

Table 2. List of accounting software providers

Software Provider With URL	Description
Absolute Accounting Software Ltd www.absolutetax.co.uk	The company has various software solutions to meet the requirements of sole practitioners to multi office firms of Accountants. This is both in a fully integrated package, to a comprehensive tax program, Topup tax, which allows users to continue with their existing Accounts software.
Accounts anywhere www.accountsanywhere.co.uk	Accounts Anywhere are a secure online accountancy service available to businesses and their accountants over the internet. Now available free for the first year to new businesses.
Accounts IQ www.accountsiq.com	Designed for the cloud, AccountsIQ is unique in providing Accounting, Consolidation and Business Intelligence in one powerful solution. This makes it ideal for high potential Start-ups, multi-subsidiary groups, multi-site businesses such as retailers, distributors, franchises, large charities and their accountants.
AccountsPortal www.accountsportal.com	AccountsPortal makes it easy to manage your invoicing, books and accounts. Web-based accounting software that is easy to use, intuitive and flexible. Used by contractors, freelancers, small businesses, bookkeepers and accountants to manage their books from anywhere.
Aplicor www.aplicor.com	Aplicor is an easy-to-use software suite that includes ERP, CRM and ECommerce applications. At every step from suppliers through happy customers, you can trust everything in your business is running smoothly - anytime and anywhere.
Aqilla www.aqilla.com	Developer of web-based accounting solutions designed for medium-sized businesses and organisations. API and plugins ensure easy integration into CRM, Business Intelligence, Excel and other backend systems.
Brightpearl www.brightpearl.co.uk	Inventory Management and Real-time Accounting for Omni-channel Retailers. Powerful, integrated, retail management software proven to help retailers be more profitable. Inventory, orders, customers and finances in a single system.
BTC Software wwwbtcsoftware.co.uk	The company offers Accountancy Practice Management software that allows the user to be in full control of accounting in the organisation.
Capium www.capium.com	Capium's easy to use services make it a complete package that makes life easier for accountants, small and medium sized businesses. No matter if you do not have any accounting or bookkeeping knowledge, Capium works in a way where you can get going quickly.
CaseWare www.caseware.co.uk	Established for over 20 years and operating in 130 countries, CaseWare's best of breed solutions provide reliability and flexibility to accountants in practice or business. In the UK, CaseWare products are used by four of the top five accountancy firms and around half of the Top 100 Practices, in addition to a multitude of mid-tier practices and sole practitioners. CaseWare software is also widely used throughout the corporate sector for the preparation of final accounts and corporation tax filings.
CCH (brand of Wolters Kluwer) www.cch.co.uk	Wolters Kluwer enables tax, finance, compliance, legal and healthcare professionals to be more effective and efficient. As a market-leading global information services company with annual revenues of over €3.6 billion and operations in over 40 countries, we provide information, software and services that deliver vital insights, intelligent tools and the guidance of subject-matter experts.
Clear Books www.clearbooks.co.uk	Clear Books plc develops clear & simple cloud accounting and payroll software for small businesses in the UK.
Digita (Thomson Reuters) www.digita.com	Digita software is developed by the leading provider of technology and information solutions. Based in Exmouth, UK, Digita's software delivers time saving efficiencies to over 2,000 tax and accountancy practices in the UK and Ireland. Our 25 years of experience in understanding the needs of accountants in practice and ongoing feature development has made us the software provider of choice for our customers.

continued on following page

Table 2. Continued

Software Provider With URL	Description
e-economic www.e-economic.co.uk	Cloud accounting platform providing efficient online collaboration between small businesses and accountants.
Eureka! Software www.eureka-software.com	Eureka! Software was formed in 1982 and is now a well-established international company with many years' experience in developing software solutions for the Public and Private Sectors. The company specialises in Flexitime, Time Recording and Accounts Production software.
FinancialForce www.financialforce.com	Founded in 2009, FinancialForce is the leading Cloud ERP vendor with apps built entirely on the Salesforce App Cloud. The company's Financial Management, Professional Services Automation (PSA), and Human Capital Management (HCM) offerings provide services-centric businesses with a platform that organizes sales, services, finance and HR entirely around their customers.
FreeAgent Central www.freeagentcentral.com	FreeAgent provides online accounting software made specifically for freelancers, small business owners and their accountants.
gbooks www.gbooks.co.uk	gbooks uses the latest technologies to make the tax and accounts compliance process as smooth and efficient as possible. gbooks also includes a range of practice management tools to help you manage your practice and staff more profitably. Being fully online, there are no discs to install or networks to run, saving you time and money.
IRIS http://www.iris.co.uk	With 37 years' experience, IRIS is the UK's market leading provider of business-critical software and services to the UK accountancy and payroll sectors. IRIS continues to be the leading supplier to the UK accountancy sector with over 17,000 Accountancy Practices relying on IRIS every day to run their business, and IRIS meets the needs of over 80,000 SMEs through its leading bookkeeping, payroll and HR software solutions. Today our customers choose to consume our award-winning products installed on their desktops, as services from the cloud, or a combination of both.
JustAccounts www.justaccounts.com	JustAccounts is a UK based company, offering an integrated platform that enables UK Contractor Accountants to provide client-facing solutions with powerful efficiency and efficacy.
KashFlow www.kashflow.co.uk	Since 2005, KashFlow has been providing intuitive online accounting software for small business owners. In 2013, KashFlow was acquired by IRIS.
Keytime www.keytime.co.uk	The company has been providing software to accountants for more than 25 years, and claims to sell the best value integrated software on the market today. The company claims that they are the only supplier to accountants who publish live satisfaction rating, and we are honoured to have the trust of over 1,700 practices.
KPMG www.kpmg.com/uk/trinity	KPMG has developed K-Trinity Accounts Production to tackle the frustrations finance teams experience preparing statutory accounts in Word or Excel including manual data entry, last minute adjustments and rounding errors.
Liberty Accounts www.libertyaccounts.com	Online accounting and payroll software for British business.
Liquid Accounts www.liquidaccounts.net	Liquid's online accounting software makes doing your books easy by automating painful tasks, integrating multiple business systems and allowing you to run your business on the go.
Mamut Software Ltd. www.mamut.com/uk	Mamut One Office and Enterprise is a complete and flexible ERP system. The product series cover the total needs of small and mid-sized businesses with single or multiple users at an affordable price.

continued on following page

Table 2. Continued

Software Provider With URL	Description
MyBusiness www.mybiz.co.uk	MyBusiness accounting software for small business is not only easy to use bookkeeping software but it also provides powerful accounting features and provide the information needed for end of year accounts preparation. MyBusiness accounting software has been around for 10 years and was designed and developed with small businesses in mind.
Netsuite www.netsuite.co.uk	NetSuite is the leading integrated cloud business software suite, including business accounting, ERP, CRM and ecommerce software. On July 28, 2016, Oracle announced that it entered into a definitive agreement to acquire NetSuite.
Pinacle Accounts www.pinacleaccounts.co.uk/	Pinacle is a full suite of accountant's software, which integrates accountancy practice data in a single Oracle™ client database. Applications include final accounts generation, taxation, practice management, bureau payroll and book-keeping.
Quickbooks www.quickbooks.co.uk	Accounting software that helps you create custom invoices, manage VAT and see your data in real time. Our software and services help business owners get on top of their finances, accounts, payroll and payments, faster.
Relate www.relate-software.com	Specialising in the Areas of Practice Management, Accounts Production, Company Secretarial, Personal Tax and Corporation Tax. All products work independently or as one fully integrated suite.
Sage http://sage.co.uk/	Sage is the market leader for integrated accounting, payroll and payment systems, supporting the ambition of the world's entrepreneurs. Today over 13,000 colleagues at SAGE support millions of entrepreneurs across 23 countries.
SAP Business By Design www.sap.com/BusinessByDesign	Ideally suited for upper mid-market companies and subsidiaries of large corporations, this complete and integrated SaaS suite supports financials, human resources, sales, procurement, customer service, supply chain management.
TaxCalc www.taxcalc.com	For over 10 years, the company has been supporting taxpaying individuals, business owners and accountancy practices with a comprehensive and modern range of software.
Twinfield www.twinfield.co.uk	Twinfield UK is part of the Wolters Kluwer Tax & Accounting division, the global leading provider of tax, accounting and audit information, software and services. Originating in The Netherlands, Twinfield has grown to be the European market leader in the area of online accounting.
VT www.vtsoftware.co.uk	VT is well known for its inexpensive and easy to use accounts production and bookkeeping software. The packages are widely used, especially by smaller firms of accountants and their clients. A free cash book package is also available.
WinWeb www.winweb.com	Since 1994 WinWeb, a leading cloud computing software provider, has been helping SMEs/SMBs to run their businesses securely online and adapt to the changing world of online commerce, social media and globalisation.
Xero www.xero.com	Xero is a New Zealand-based software company that develops cloud-based accounting software for small and medium-sized businesses. The company has offices in New Zealand, Australia, the United Kingdom, the United States and Singapore. Use Xero accounting software to manage invoicing, bank reconciliation, bookkeeping.

The software for accountancy solutions has been generally provided by a small number of well-established suppliers. However, in the last 5 years a number of smaller software vendors have established themselves in this fast-moving industry. Table 2 lists a number of established and newcomers here in alphabetical order (please note that this is a non-exhaustive list, however, most of the major players are listed).

DISCUSSION AND CONCLUSION

In this study, we look at existing literature, the major providers of accounting software, main software products available in the market, learning opportunities on software, and the latest trends in ICT and Accountancy profession. The findings showed that whether it is cost accounting, Auditing, Finance director or credit analyst, employers require ICT skills from accounting candidates. This study also found that the accountancy profession is changing fast and organizations are increasingly using software for their accounting and finance requirements. In addition, software vendors are increasingly balancing their offerings based on either desktop-based software and/or online software. This study also discovered that the next major development is the move towards online software. Online or cloud-based accounting software is enabling small companies to do bookkeeping tasks themselves thereby significantly reducing costs. Another trend in this industry is the use of data-analytics, for e.g. auditors are now able to verify complete sets of data rather than small samples and at the same time reduce human errors. Vendors that provide web-based solutions are seeing an increase in their business. For example, Sage Software in the Middle East is very famous among businesses, which provides a range of business intelligence, finance, accounting and bookkeeping software solutions. Both these trends highlight that non-accounting professionals could perform a number of tasks that were historically confined to the accountancy professionals. And at the same time, accountancy professionals need to learn new software to make their services more attractive to businesses. To do so, employers need to be involved with educational institutions to form partnerships, which would help develop a curriculum that defines the required necessary technical and soft skills for graduates' future career paths. In addition, employers should collaborate with universities to develop training courses, work placement clubs, career advice clubs and apprenticeships courses, which would enhance graduates' skills and make them work ready. To make a success of Qatar's nationalization program, government should collaborate with both employers and universities to design a curriculum, which delivers skilled graduates.

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Determinants of the Adoption Academic Electronic Books by University Students in a Developing Country

Foluke Okocha, Landmark University, Nigeria

ABSTRACT

Higher education institutions worldwide are transitioning to electronic books which have become a standard platform in providing reading materials. This study investigated the determinants of the adoption of academic e-books by university students in Nigeria. Results showed that a majority of students were aware of electronic books but only 44.5% of students used them often. Despite the availability of these resources, more than 50% of students did not use e-books, also surprising was that majority of students discovered e-books from their lecturers. The study further revealed that performance expectancy, effort expectancy, and facilitating conditions were major determinants in the adoption of e-books by undergraduate students. However, social influence and gender did play a significant role in the intention to adopt electronic books by undergraduate students. This study has practical implications on academic institutions and electronic book publishers in encouraging e-book use and improving e-book features to align with the needs of the millennial students and also providing reliable internet facilities and improving lecturer and institutional support in driving e-book adoption by undergraduate students.

KEYWORDS

Adoption, Electronic Books, Nigeria, University Students

1. INTRODUCTION

1.1. Research Background

The emergence of Electronic Books (e-books) has caused a change in the access of information; information now transcends beyond boundaries and is available and accessible at any time. Higher education institutions worldwide are transitioning to e-books, which have become a standard platform in providing reading materials (Aharony, 2014). Majority of undergraduate students are considered as digital natives who show familiarity with and have great potential to adopt electronic books. However, academic libraries are advised to change how these services are offered to undergraduate students (Ashcroft, 2011).

E-books are digital versions of traditional print books that are readable across a variety of computing platforms including personal computers, tablets, smartphones and purpose-designed

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agents, known as e-book readers (Reitz, 2014). Also, the proliferation of mobile technologies and e-book readers has led to increased access of e-books. Renner predicts that e-books, like e-journals, will be the norm in academia by the year 2020. The benefits of e-books are enormous ranging from its portability, storage size, cost, ease of access, convenience, hyperlink features amongst others.

However, despite the enormous benefits allotted to e-books, students still consider e-books difficult to use and do not find e-book features beneficial or engaging (Huang et al., 2012). The inclusion of e-textbook features, such as increased mobility and accessibility, has not changed students' resistance to this technology. (Gu, Wu, & Xu, 2015; Van Horne, Russell, & Schuh, 2015). Many students still resist e-books and will only switch to e-books when rewards are attached (Abutaleb, 2012). Terpend et al. (2014) in examining the factors that influence students' adoption of e-books attributed ease of use and price of e-books as the major factors influencing the adoption of e-books. However, these findings differed from Gerhart et al. (2015) who stated the adoption of e-books is low due to functional differences from the traditional model. This study seeks to understand the variables that influence the adoption of electronic books.

1.2. Problem Statement

The dearth of current literature in academic libraries in Nigeria has brought about the need for the adoption of e-book in Nigerian Universities (Nwagwu, 2015). However, the acceptance of e-books in Africa is still at its infancy. Maepa and Nkosi (2013) identified factors that have limited the acceptance to include high e-book prices, scarcity of e-books produced in Africa, Internet challenges and lack of framework for digital publishing. The adoption of e-books is slow in spite of the fact that the internet and other mobile technologies which enable e-book use are gaining popularity. The adoption of smartphones in Nigeria is projected to increase to 23.3 million by 2019, yet the projected growth rate in the e-book industry is not yet realized (Shinn, 2011). Brown (2013) argues that e-books are continuously gaining popularity, but successful e-book adoption and user acceptance is not universal as review of prior research studies shows mixed results. Hence, this study focuses on the factors that lead to the adoption of e-books by university students in Nigeria which is the gap this study seeks to clear.

The acceptance of a technology is the major driving factor for its adoption and diffusion in a given society. Several models have been used by researchers to investigate technology acceptance. This study adopts a combination of the UTAUT model, and Innovation Resistance model to propose a framework for the adoption and invariably acceptance of e-books in Nigeria. Unified theory of acceptance and use of technology (UTAUT) propounded by Venkatesh (2003) integrated eight models in explaining the behavioural intention and the actual usage of an information system. The UTAUT model is capable of explaining as high as 70% the use of an information system. It has been proven to be better than previous models. It postulates that four constructs are determinants to the behavioural intention and the actual usage of an information system. They include performance expectancy, effort expectancy, social influence and facilitating conditions. The effect is moderated by age, gender and experience.

1.3. Objective of Study

The overall objective of this study is determining the factors that lead to the acceptance of e-books by university students in Nigeria. The specific objectives include:

- Identify the awareness of rate against the usage ratio of e-books in Nigeria;
- Establish factors that influence acceptance of e-books by students;
- Establish the relationship between gender and the acceptance of e-books.

2. REVIEW OF LITERATURE

Several studies on the adoption of electronic books by undergraduate students have been conducted globally (Verkijika, 2019; Wang & Bai, 2016; Liu & Huang, 2016; Raynard, 2017, Nwagwu, 2015 Aharony, 2014). Several factors have been identified to influence the adoption of electronic books, and these include awareness (Wang & Bai, 2016), perceived usefulness (Joo & Choi, 2015; Shin, 2011), perceived ease of use (Joo & Choi, 2015), techno stress (Verkijika, 2019) and attitude (Wang & Bai, 2016) amongst others. These studies reveal that the adoption of electronic books is a major challenge globally and researchers are seeking to understand reasons influencing its low adoption among millennial students. Potnis, Deosthali, Zhu, and McCustker (2018) examined factors that influenced undergraduate students use of electronic books in the United States using a mixed method study, results revealed that ease of access of electronic books do not eventually lead to use by undergraduate students. The study further showed that environment for information technology use, perceived enjoyment, electronic book features, locus of control and subjective norm influenced the adoption of electronic books in the United States. Similarly, Wang and Bai (2016) conducted a study of university students' awareness, usage and attitude towards electronic books in China. The study revealed that undergraduate students majorly access electronic books on search engines as awareness and usage of library provided e-books were relatively low. The study further showed that undergraduate students used e-books majorly for leisure and showed preference for printed books for academic purposes. Liu and Huang (2016) investigated the reading behavior of undergraduate smart phone users in China; the study showed that reading e-books on smart phone involved more scanning and less in depth reading with minimal concentration. Verkijika (2019) showed the role of techno stress in the adoption of electronic books, results revealed that techno stress played a negative influence on the adoption of digital textbooks. A study by Raynard (2017) has also revealed that the role of marketing and educational strategies in improving the adoption of electronic books globally.

2.1. Theoretical Background and Hypothesis

User acceptance is critical to determine the success or failure of an information system (Davis, 1993). Unified theory of acceptance and use of technology (UTAUT) propounded by Venkatesh (2003) integrated eight models in explaining the behavioural intention and the actual usage of an information system.

The UTAUT model is capable of explaining as high as 70% the use of an information system. It has been proven to be better than previous models. It postulates that four constructs are determinants to the behavioural intention and the actual usage of an information system. They include performance expectancy, effort expectancy, social influence and facilitating conditions. The effect is moderated by age, gender, and experience.

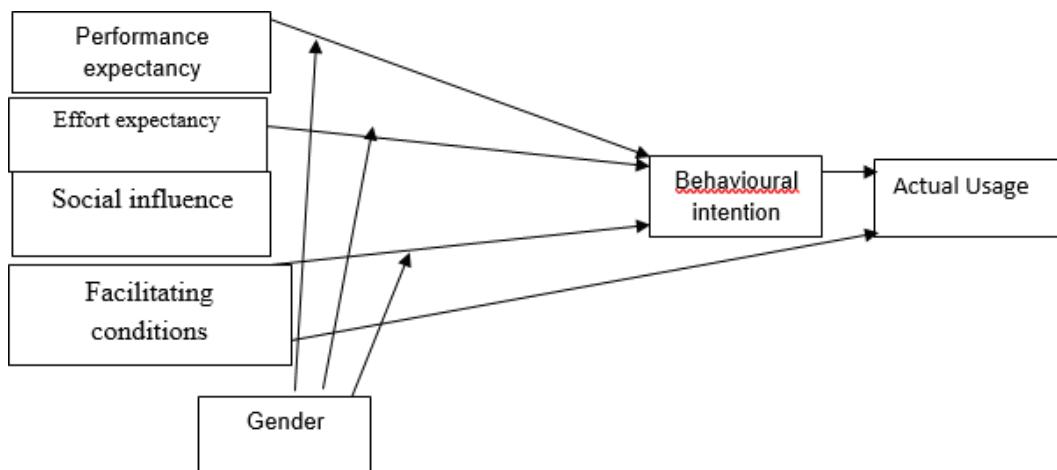
Performance expectancy is the degree a student believes using an e-book will improve academic performance. This has been tested and is the strongest predictor of behavioural intention (Venkatesh et al., 2003). Effort expectancy (EE) refers to the degree of ease associated with reading e-books. Social influence (SI) is the extent to which believes that important others believe e-books should be used. For the purpose of this study this includes lecturers, colleagues, and friends. Finally, facilitating conditions (FC) is the degree a student believes organizational and technical structures support the use of e-books. The Proposed hypothesis for this study is:

- H1:** Performance expectancy will significantly affect students' behavioural intention to read e-books.
- H2:** Effort expectancy will significantly affect students' behavioural intention to read e-books.
- H3:** Social influence will significantly affect students' behavioural intention to read e- books.
- H4:** Facilitating conditions will significantly affect student's intention to read e-books.

The roles of age and gender in the acceptance of technologies have been argued by researchers (Venkatesh et al. 2003; Wang & Wang 2010). Performance expectancy is said to be stronger in men (Venkatesh & Morris, 2000) while Effort Expectancy and Social Influence have more effect in women (Venkatesh & Morris, 2000). Hence:

H5: Gender has moderating effect on performance expectancy, effort expectancy and social influence.

Figure 1. UTAUT model



3. METHODOLOGY

3.1. Data Collection

The study examined the determinants of the adoption of electronic books by undergraduate students in Landmark University. Students were categorized based on College of Study and this included College of Business and Social Science, College of Agricultural Science and College of Science and Engineering. A total of three hundred questionnaires were distributed of which 287 were returned, the questionnaires were further designed based on constructs from the UTAUT model and further designed using the 7-point Likert scale. The questionnaire consisted majorly on close ended questions. The design was guided by the UTAUT model.

3.2. Measures

The questionnaire is designed using the UTAUT model. The study includes four dependent variables (performance expectancy, effort expectancy, social influence & facilitating conditions) and one independent variable (behavioral intention). Table 1 shows constructs and variables adopted from the UTAUT model.

3.3. Reliability of Constructs

3.3.1. Validity and Reliability

The results in Table 2 showed that item loadings were greater than 0.5. All constructs were tested for reliability and it was noted that all constructs were valid having a Cronbach alpha greater than 0.7.

Table 1. Constructs adopted from UTAUT model

Constructs	Variables
Performance Expectancy	Using E-books improves my performance in courses I take E-books are important for my academic success E-books stimulate my interest in my course E-books enable me access books at convenience
Effort expectancy	E-books are easy to search from home I like reading books from the computer screen E-books are easy to locate I like using e-books because I don't have to borrow
Social Influence	Most of my classmates use e-books to support lecture materials My lecturers think it is a good idea to use E-books My class representatives use E-books.
Facilitating Conditions	I have sufficient bandwidth to read E-books I have adequate knowledge necessary to use E-books Internet facilities are fast enough to read E-books My lecturers use e-books to support teaching
Behavioral Intention	I prefer using e-books than to visit the library E-books is a good idea because I don't need to borrow I will like to have a folder of e-books related to my courses Using e-books will improve my performance in courses I take

Table 2. Cronbach Alpha reliability test

Constructs	Cronbach Alpha (Reliability Test)
Performance Expectancy	0.729
Effort Expectancy	0.717
Social Influence	0.734
Facilitating Condition	0.710
Intention to adopt e-books	0.740

4. RESULT

4.1. Demographics

In analysis of the demographic profile of respondents, the majority was male with 68.1%, the respondents were evenly distributed among all levels of study. A higher percentage (58.3%) of respondents' were from college of science and engineering, while the least were from college of agricultural sciences (3.5%) (see Table 3).

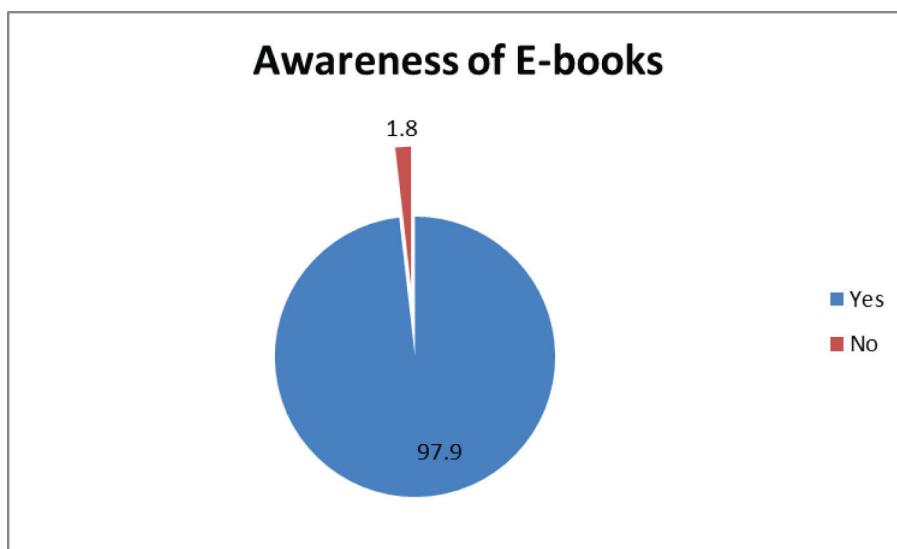
4.2. Awareness and Usage of e-Books

Figure 2 and 3 shows the number of respondents who were aware of e-books; A high percentage (97.9%) of respondents were aware of eBooks. A significant proportion (46.6%) specified they had used e-books once while 44.5% stated that they used e-books often. Only 8.5% of respondents reported never to have used e-books.

Table 3. Gender, level of study and college of respondents

	Frequency	Percentage
Gender		
Male	175	61.8
Female	108	38.2
Level of Study		
100 Level	30	10.6
200 Level	83	29.3
300 Level	62	21.9
400 Level	79	27.9
500 Level	29	10.2
College of Study		
College of Agricultural Sciences	10	3.5
College of Business and Social Sciences	108	38.2
College of Science and Engineering	165	58.3

Figure 2. Awareness and use of e-books



4.3. Awareness and Familiarity With e-Book Services Provided by the University

Table 4 shows 94.7% of respondents were aware the university provides access to e-book services. However, only 49.1% of the respondents were familiar with ebrary which amounted to the e-book service majorly used by the respondents, 34.3% of respondents made use of science direct e-books and only 7.8% of respondents made use of EBSCO e-books. Other e-books used by students were Teal and Oare eBook collections.

Figure 3. Usage of e-books

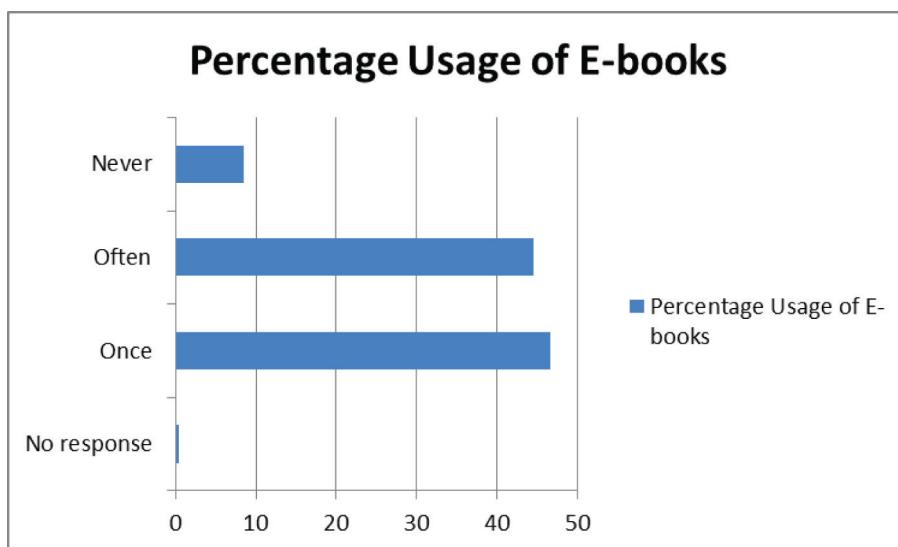


Table 4. e-book services used by respondents

e-Book Services	Frequency	Percentage
E-brary eBooks	139	49.1
Science Direct e-books	97	34.3
Ebsco e-books	22	7.8

4.4. Discovering e-Books

The majority of respondents affirmed colleagues and lecturers were most popular methods of discovering and becoming aware of e-books, followed by library catalogue and library staff as shown in Figure 4. This negates the findings of ebrary (Jisc Collections, 2009) that library staff and library websites were most significant in finding out about e-books. This study contributes to literature on the importance of lecturers and colleagues in the promotion of e-books among students.

4.5. Hypothesis Testing

Table 5 shows that performance expectancy, effort expectancy and facilitating conditions were significant with coefficients less than 0.05, and social influence was not significant. This implies that only performance expectancy, effort expectancy and facilitating conditions explain the intention to use e-books.

Regression analysis showed that Performance Expectancy predicts intention to use electronic books. This finding is consistent with research which states Performance Expectancy as the strongest predictor of intention to use e-books. We therefore accept the hypothesis that performance expectancy influences the acceptance of e-books.

Figure 4. Found out about e-books

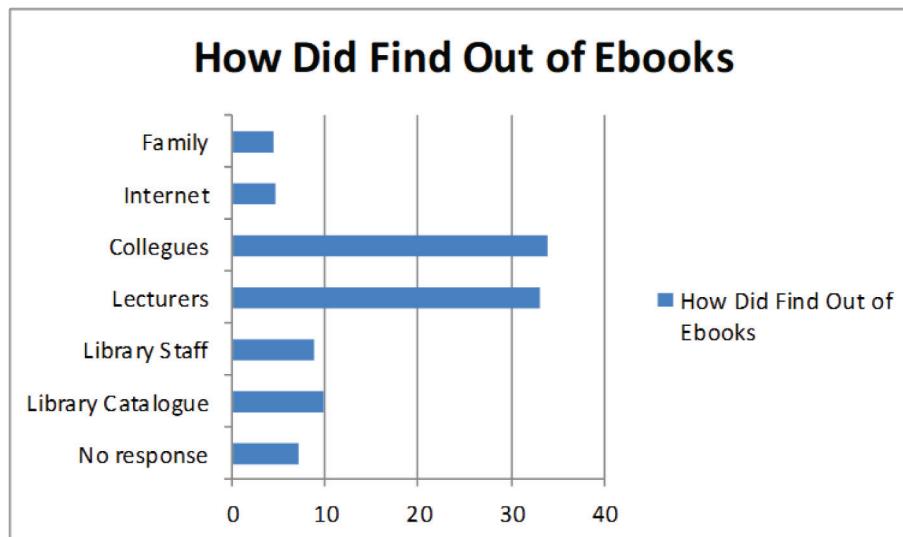


Table 5. Regression analysis of constructs

Model	Unstandardized Coefficients		Standardized Coefficient		Significance
	B	Std. Error	Beta	t	
Constant	1.129	0.475		2.376	0.018
Performance Expectancy	0.239	0.056	0.220	4.277	0.000
Effort Expectancy	0.239	0.053	0.278	0.484	0.000
Social Influence	0.076	0.055	0.091	1.388	0.166
Facilitating Conditions	0.183	0.053	0.217	3.432	0.001

Effort expectancy construct also predicted intention to use electronic books with significance less than 0.01. This finding has implications for the design of electronic books databases. We accept the hypothesis that effort expectancy has significant influence on behavioural intention to use e-books.

Social Influence Construct did not significantly predict intention to use e-books. This implies that the opinion of others is not important in determining adoption of electronic books in Landmark University.

Facilitating Conditions construct is also proven to predict intention to use e-books ($\text{sig}=0.001$; $p<0.005$) internet connectivity, speed of connectivity and lecturers support for e-books are important in determining intention to adopt electronic books. We accept the hypothesis that facilitating conditions significantly influences intention to adopt electronic books.

4.6. Role of Gender on Behavioral Intention

Gender did not show any moderating effect on intention to use e-books as male and female adopt e-books at similar rates which is corroborated by Madaku (2015). We therefore reject the hypothesis that gender has as significant relationship with intention to adopt e-books (see Table 6).

Table 6. Gender moderating user acceptance

Coefficients						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	6.614	.443		14.922	.000
	Gender	.174	.303	.034	.576	.565

4.7. Discussion of Results

The results of this study examined the factors that determine e-book adoption by undergraduate students in Nigeria. The results showed that 97.9% of undergraduate students are aware of electronic books but only 44.5% of students used it often, about 46.6% of students noted that e-books were used only once. These findings raise concern on the factors that limit the continued use of e-book technology which also negates findings by Wang and Bai, 2016) that awareness limits the adoption of electronic books. The study also showed that only 49.1% of undergraduate students were familiar with the E-brary e-book service provided by the university library which is well supported by Wang and Bai (2016) who revealed that usage of library provided e-book services is relatively low as majority of students downloaded e-books from search engines.

The study further investigated the factors that determine the adoption of electronic books by undergraduate students using the Unified theory of Acceptance and Use of Technology (UTAUT), results revealed Performance Expectancy, Effort Expectancy and Facilitating Conditions as major determinants for the adoption of electronic books by undergraduate students in Nigeria. The findings corroborate studies by Yoo and Roh (2017) and Joo and Choi (2015). This study confirms that when students perceive books as important with the ability to improve performance and create an enabling learning experience, it leads to higher rates of adoption. Similarly, effort expectancy is also considered as a significant factor in determining adoption as corroborated by (Verkijika, 2019; Terpend et al., 2014; Hung et al., 2012), which reveal that students consider e-book features difficult to navigate resulting in techno stress. Results also showed that facilitating conditions played a key role in the adoption of electronic books as the availability of reliable internet facilities, lecturer and institutional supports are paramount in determining the adoption of electronic books. This finding is corroborated by Nwagwu (2014) where the role of institutional support is considered paramount in driving e-book adoption. Results further showed that gender did not have significant moderating effect on e-book adoption. These findings have implications for library practitioners and university administrators in promoting the adoption of electronic books in Nigeria.

5. CONCLUSION

The study examined the adoption of electronic books by undergraduate students in Nigeria. Results from the study revealed the high awareness yet low usage of electronic books by undergraduate students in Nigeria. However, the study also evaluated the factors that determine the adoption of electronic books by students using the Unified Theory of acceptance and Use of technology (UTAUT) model. Results showed that Performance Expectancy, Effort Expectancy and Facilitating Conditions influenced the intention to adopt electronic books. It further revealed that gender did not play a moderating role on the adoption of electronic books. This study has practical implications on academic institutions and electronic book publishers in encouraging e-book use and improving e-book features to align with the needs of the millennials also providing reliable internet facilities and providing lecturer and institutional support in driving e-book adoption by undergraduate students.

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An E-Portfolio as an Assessment Strategy in an Open Distance Learning Context

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ABSTRACT

There has been a growing interest in using an e-portfolio as an alternative method of assessment in an open distance eLearning environment. The use of an e-portfolio as another method of assessment in Environmental Education (EE) has not been sufficiently researched. The purpose of this study was to explore how the use of an e-Portfolio as an alternative method of assessment enhances pre-service teachers' technological pedagogy in an environmental education module. Qualitative data was collected using interviews and document analysis. The study employed interpretive paradigm, connectivism theory, and purposive sampling. A qualitative approach was employed to analyse and identify emerging themes from the data. The qualitative findings are that the e-portfolio was significant in assessing sustainable education, enhanced the pre-service teachers' digital pedagogy. Challenges included a lack of computer skills, connectivity, support during compilation of e-portfolio, and sufficient activities to promote teachers' digital pedagogy.

KEYWORDS

Collaboration, Community of Practice, Connectivism, Digital Pedagogy, Environmental Education, Higher Education, Pre-Service Teachers, Technological Competencies

INTRODUCTION

E-portfolios as an alternative assessment tool to enhance pre-service teachers' digital pedagogy has recently become more common in the Open Distance eLearning (ODeL) context. Van Wyk (2017) states that, over the last decade, teachers have become more exposed to technologies that impact on classroom environments, teaching methods, strategies and techniques, and that this technological change requires teachers to have an in-depth understanding of digital pedagogy or technical pedagogical content knowledge (TPCK). This is because recent developments in higher education have shown the need for integrating technology in teaching and learning (Okaz, 2014; Van Wyk, 2017). The use of an e-portfolio as a way of assessment in ODeL is a response to recent developments in higher education where assessment is integral to teaching and learning. This suggests that the need to integrate technology in teaching and learning brought about a need to integrate technology in assessment in ODeL. It would not make sense if the recent developments or transformation of integrating technology in teaching and learning in ODeL omitted assessment because it is inseparable from teaching and learning. The use of an e-portfolio as a method of

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122

assessment in EE has been under-researched. The purpose of this study was to explore how the use of an e-portfolio as an alternative method of assessment enhances pre-service teachers' technological pedagogy in an environmental education module.

BACKGROUND

Global literature reveals that e-portfolios are defined differently based on the various academic environments and their use, but that they convey common features (Bhattacharya & Hartnett, 2007; Hallam & Creagh, 2010; Henrich, 2008; Morze & Buinytska, 2015). E-portfolios are defined differently because they are used in different contexts for different purposes (Dunbar-Hall, Rowley, Bennett, Blom & Hitchcock, 2016; Heinrich, 2008). An e-portfolio was introduced as an alternative way of assessment because higher education is transforming from a paper-based teaching and learning approach to an e-learning approach as mentioned earlier. This change calls for a re-think of pre-service teachers' pedagogy from traditional to digital. According to Boulton (2014), an e-portfolio is a multi-modal evidence-based assessment method currently introduced in most teacher education programmes at higher education institutions locally and globally. Van Wyk (2017) refers to an e-portfolio as an alternative assessment strategy for student-teachers' self-directed learning empowerment that afforded them an opportunity to use various types of information technology (IT) tools such as podcasts, blogs, PowerPoint presentations and e-discussion forums. Transformation in higher education in terms of the use of technologies in teaching and learning as well as assessment is a global trend, meaning that there should be a re-think in terms of preparing pre-service teachers' pedagogy. This is the reason for exploring how the use of an e-portfolio as an alternative method of summative assessment enhances pre-service teachers' technological pedagogy in an environmental education (EE) module.

Smolyaninova and Shilina (2011) argue that teacher education programmes do not satisfactorily prepare pre-service teachers in terms of technological competency. Technological competency in this context means competency in digital pedagogy. An e-portfolio should, as Van Wyk (2017) mentions, provide pre-service teachers with in-depth understanding of digital pedagogy or TPCK.

An honours-level EE module, namely, whole school development through environmental education (WSDEE) at an African university was mostly taken up by pre-service teachers who had not been applying educational technologies in their teaching and learning or assessment activities. This was the case because, in the past, distance education depended on the postal delivery of hardcopy educational materials to the students and their postal delivery of assignments back to the university. However, the distance learning environment has undergone transformation in the digital era, with an increasing emphasis on the use of IT. Consequently, an e-portfolio was introduced to provide an alternative summative assessment method for the WSDEE module with the intention of making the module more suited to the online ODeL environment in enhancing the pre-service students' TPCK.

With regard to this study, an e-portfolio should provide pre-service teachers with technological competencies that enable them to cope with the current demands of teaching and learning in the digital classroom. The lens through which this phenomenon was explored is explained in the following section.

THEORETICAL BASE

Connectivism was used as a lens to explore the introduction of an e-portfolio as an alternative summative assessment tool in ODeL. However, this is not its only purpose: an e-portfolio should enable students to connect with each other as they interact and collaborate using technology to share ideas and evidence. This viewpoint is supported by Siemen's (2004) principles of connectivism that consider learning and knowledge as being situated within a diversity of views of learning and as a process of linking particular nodes of knowledge or data sources, which Downes (2007, p. 23) calls a "network of contacts". Thus, an e-portfolio connects both the lecturer with the pre-service teachers

and the pre-service teachers with one another as a community with the intention of enhancing pre-service teachers' technological pedagogy.

Siemens (2005) points out that, in connectivism, learning begins when knowledge is triggered, and a student connects to and contributes data within a learning community. The author views a community as a group of people with common areas of interest that allow for interaction, sharing, dialoguing and thinking together. An e-portfolio affords the students an opportunity to form such a community of practice.

For this study, connectivism is used in conjunction with the *Mmogo* (meaning togetherness) theory referring to a community of interaction (Roos, 2012). According to Kop and Hill (2008), connectivism's cannot be regarded as a stand-alone learning theory. Theories need to complement one another (Ally, 2004) and the author deemed it necessary to use these two theories together.

An e-portfolio connects the lecturer and the pre-service teachers through summative assessment and enhance their digital pedagogy. Furthermore, it facilitates the formation of a community of practice in which students communicate, collaborate, interact, share ideas, evidence, and dialogue through technology when compiling their e-portfolios (Roos, 2012; Siemens, 2005). The study's guiding research questions are listed below followed by literature review.

RQ1: What is the significance of an e-portfolio as an alternative way of assessment in EE?

RQ2: How does the use of an e-portfolio as another method of assessment enhance pre-service teachers' digital pedagogy?

RQ3: How does the use of an e-portfolio as an alternative assessment tool develop collaborative skills?

LITERATURE REVIEW

Van Wyk (2017) maintains that teachers are obliged to have a clear understanding of digital pedagogy due to technological changes in the teaching and learning environment. Maor (2017) states that e-portfolios are used to create digital pedagogies to enhance the students' learning experience. It is crucial that an e-portfolio is developed by pre-service teachers to enhance their technological pedagogy since the current teaching and learning environment requires such pedagogy. This suggests that digital pedagogy includes digital assessment in the ODeL context; hence, the introduction of an e-portfolio as an alternative method of summative assessment. Smolyaninova and Shilina (2011) highlight that in the field of professional pedagogy, an e-portfolio is used to assess personal achievements, which is relevant to pre-service teachers.

An e-portfolio provides an opportunity to introduce alternative assessment in courses like EE which do not focus on information technology aspects, *per se*. Smolyaninova and Shilina (2011) further indicate that the use of technology provides a systematic approach to assessment for Bachelor/ Master's programme students specialising in education, and the use of an e-portfolio as an alternative assessment tool improves the technological competence of pre-service teachers.

Examples of where e-portfolios have been introduced in South African universities are provided below:

- In the Faculty of Education and the Faculty of Economic and Management Sciences at the University of Stellenbosch (Strydom & Barnard, 2017). At the University of Stellenbosch, students are exposed to blogs which they have to share through Google Hangouts and to upload some artefacts (Strydom & Barnard, 2017);
- In the Economics subject within the Department of Curriculum and Instructional Studies at the University of South Africa (Van Wyk, 2017). An e-portfolio is used as a strategy for assessment at the University of South Africa to explore student teachers' opinions on the helpfulness of an e-portfolio as an empowering tool which can enhance pre-service teachers' digital pedagogy (Van Wyk, 2017).

Van Wyk (2017) has this to say:

e-portfolios must not be seen as ‘nice-to-have’ idea but be used as an integrated technology and pedagogy approach as vital components for the successful implementation of the e-portfolio as an alternative assessment strategy in preservice teachers’ empowerment. (p 288)

This means an e-portfolio should empower pre-service teachers with technological competencies and improve their technological pedagogy which is required in teaching and learning in the digital era.

The three research questions are addressed in the sections below.

The Significance of an E-Portfolio as an Alternative Method of Assessment

The use of an e-portfolio is important because it provides an opportunity to introduce an alternative assessment tool that is appropriate for the digital era. Rather than having to write a traditional examination, student-teachers are assessed on their ability to use digital resources to present evidence of their learning. E-portfolios may also be used to evaluate the success of the courses or modules in expanding the use of IT in the field of professional pedagogy (Bates, 2010; Smolyaninova & Shilina, 2011).

The assessment requirements should start by exploring the types of the interactions that would contribute to the completion of the activity (Dillenbourg, 1999) because activities for e-assessment are aimed at improving learning (Mimirinis, 2018); in this case, both conceptual learning of EE topics and development of technological knowledge.

The Use of an E-Portfolio as a Method of Assessment to Enhance Pre-Service Teachers’ Digital Pedagogy

An e-portfolio may be used as a self-directed learning tool that should enhance pre-service teachers’ technological pedagogy (Van Wyk, 2017). An e-portfolio should empower pre-service teachers with technological competence to meet the requirements of the current classroom context. It is, therefore, imperative to explore how the use of an e-portfolio for summative assessment improves pre-service students’ technological pedagogy.

According to Strydom and Barnard (2017), an e-portfolio may be used in any discipline to showcase skills developed. For this study, an e-portfolio was selected as an example of an alternative summative assessment tool for the WSDEE module being offered by an African University to explore how e-portfolios enable students to provide various types of evidence to demonstrate their learning on sustainability (an EE topic) (Habron, 2015). This study explored how e-portfolios enhance pre-service students’ technological pedagogy because the WSDEE module is taught in the digital space, thus bringing assessment in the EE field in line with the digital era to which pre-service teachers are exposed, especially in the classroom context. Following the above discussion, it can be said that the use of e-portfolios for summative assessment is beneficial to the students.

It has been highlighted by Van Wyk (2017) that teachers must have a clear understanding of digital pedagogy due to technological changes in the teaching and learning environment. Changes in approaches to assessment cannot, therefore, be ignored because it is an integral part of teaching and learning.

The Development of Collaboration Through an E-Portfolio

Collaboration is viewed as one of the essential skills for living in the 21st century (Binkley et al., 2012; New Zealand Ministry of Education, 2007). Therefore, collaboration is important for EE students to share environmental experiences and knowledge (Odeke, 2012). In this case, collaboration is crucial because students must interact and share ideas and evidence during the compilation of their

e-portfolios. This means the compilation of an e-portfolio relates to theories such as *Mmogo* (Roos, 2012; Siemens, 2005).

An e-portfolio is an empowering tool that enhances pre-service student-teachers' self-directed learning in a module where they develop collaborative skills when compiling and sharing evidence (Van Wyk, 2017). Bhattacharya and Hartnett (2007) view collaborative activities as an essential part of an e-portfolio in which the traditional paper-based portfolio is replaced by a digital format to address the requirements of the digital teaching context. This suggests that an e-portfolio can enhance pre-service teachers' technological pedagogy and enable them to collaborate or share ideas relating to EE even beyond the mere compilation of an e-portfolio (Eynon, Gambino, & Torok, 2014). This is facilitated by communicating through technology. Habron (2015) highlights the significance of applied learning and skills needed in EE and explores how e-portfolios enable students to provide a range of evidence to demonstrate their EE learning. In this era, collaboration is facilitated by the use of technology. This means that activities that form part of an e-portfolio should be designed to encourage the desired interaction between the students both to enhance learning and develop collaborative skills.

The implementation of an e-portfolio showed both successes and challenges as outlined below.

Successes

Smolyaninova and Shilin's (2011) findings showed that an e-portfolio could introduce IT into the courses which had no close connection with IT. Furthermore, it enabled the students to upload online learning materials and develop TPCK which is important for future teachers. Considering Smolyaninova and Shilin's (2011) findings, e-portfolios address the need for a new assessment strategy in a transformed education environment. This suggests that employing e-portfolios may yield better results for a university that has a transformed education environment. Belgard (2013) and Garrett (2011) state that employing e-portfolios in teacher education programmes demonstrates improvement like an increase in pedagogical and technical content knowledge. Furthermore, Belgard (2013) posits that students develop collaborative skills when compiling and sharing evidence in the e-portfolio. Van Wyk (2017) states that an e-portfolio affords pre-service students the opportunity to use various types of social media tools and other ICT tools such as podcasts, blogs, PowerPoint presentations, e-discussion forums and WhatsApp groups for subject-related issues. Strydom and Barnard (2017) concur with Van Wyk (2017) that an e-portfolio provides pre-service students an opportunity to explore ICT and other relevant Web 2.0 technologies (social media tools, referring to Facebook and WhatsApp groups). The engagement of students with these technologies by means of an e-portfolio improves pre-service students' technological competencies and enhances their digital pedagogy which is required in the modern classroom environment.

Smolyaninova and Shilina (2011) found that an e-portfolio was successfully employed in the academic processes at the Institute of Education, Psychology and Sociology, Siberian Federal University (SFU) to align educational standards and competencies. This occurred because the system of higher education in Russia was being updated, and the transition warranted the development of a new assessment tool. According to Smolyaninova and Shilina (2011), Web 2.0 technology users had the opportunity to manage the content of the information system considering what they liked and disliked. Furthermore, the users had an opportunity to upload files, which included photographs and shared opinions and ideas, using Facebook as a social network.

The findings of Smolyaninova and Shilin's (2011) reveal that implementing an e-portfolio is a beneficial assessment strategy for universities, with the use of e-portfolios growing exponentially within a period of one year over a range of subjects, which enhanced the IT competency of faculty members as well as students. E-portfolios motivated the SFU administration to develop a university-wide e-learning strategy. Erasmus and Joubert (2017) maintain that one important advantage of e-learning is that "it bridges the gap between a lecturer and a student in different geographical locations so that students can learn anytime and anywhere" (p. 1013). E-portfolios are increasingly being used for the assessment of such learning. Carl and Strydom (2017) state that "In the South African context,

e-portfolios are increasingly being considered in teacher training programmes, to enable student teachers to reflect in, on and about practice in a structured way, whereby they demonstrate their growth and development as professionals” (p. 1). A key point here is that assessment has moved away from solely assessing knowledge, and now includes the assessment of other “skills and attributes” such as “acquisition, integration and application of different types of knowledge” (p. 2), and collaboration.

Challenges

Smolyaninova and Shilina (2011) highlight the risks of using an e-portfolio in the educational university environment, pointing to low ICT competency levels in higher educational institutions of Russia as a challenge. Ololube, Ubogu and Egbebor (2007) state that a similar situation exists in Nigeria, while Erasmus and Joubert (2017) found that low ICT literacy is a problem in South African ODeL higher education institutions. Carl and Strydom (2017) state that “the level of digital skills of students can neither be assumed nor ignored” (p. 8). Other challenges included the difficulties in mastering the use of the software (Bhattacharya & Hartnett, 2007). According to a study by Strydom and Barnard (2017), even the millennial students were not au fait with the required technologies and the level of utilisation was not as good as expected. Most of the pre-service students requested for hands-on training in terms of multimedia skills such as adding images, videos and sound clips and granting access to their respective portfolios when the project began. Carl and Strydom (2017) caution that “although it is important to provide students with the necessary technical skills, special care should be taken to prevent technologies from dominating their time and attention, but rather that the learning processes ought to be carefully explained and scaffolded” (p. 6). Having discussed the academic perspectives on the use of an e-portfolio as an assessment strategy, methodology issues are addressed in the next section.

METHODOLOGY

The methodology section starts by addressing the research paradigm and design. This study aimed to explore how an e-portfolio that is used as an alternative method of assessment enhances pre-service teachers’ digital pedagogy in an EE module. Qualitative research was used to elicit information from students by allowing them to share their lived experiences of compiling an e-portfolio and to explore whether their digital pedagogy was enhanced (McMillan & Schumacher, 2010). In addition, the perspective of the researcher as an insider provided a deeper understanding of the students’ lived experiences of compiling an e-portfolio in an EE honours module (Babbie & Mouton, 2012). Furthermore, a qualitative, phenomenological approach was used to determine how data would be collected, analysed and interpreted with the intention of producing trustworthy results as recommended by Rubin and Babbie (2013).

Purposive sampling was used to choose a sample of students who had registered for the WSDEE module. The sample was comprised of 13 participants. Semi-structured interviews were used to generate data because they allowed probing as the students were perceived to have rich information about the implementation of e-portfolios for summative assessment. Interviews were conducted telephonically after making appointments with students. To avoid the limitations of postal delivery that takes a long time (Dakwa, 2015), telephonic interviews were arranged since the study was conducted in an ODeL environment in which the students were geographically scattered. Purposive sampling enhanced the credibility of the findings in terms of how the use of an e-portfolio for assessment improved future teachers’ technological pedagogy (Palys, 2008). Document analysis was also done by reviewing the e-portfolios of these students.

Ethical principles were observed because ethical clearance was sought and obtained by the project leader prior to the commencement of this study, while consent was also sought from the participants as recommended by Marshall and Rossman (2011). Principles such as privacy, confidentiality, anonymity and informed consent were observed (Marshall & Rossman, 2011).

Analysis of data was done thematically, revealing three themes that were embedded in the data (Feza, 2015; Rubin & Babbie, 2013). Analysis of interview data was continuous, being done after each interview session. Data were transcribed and processed, and key words were identified, coded and clustered into categories. The perusal and analysis of the students' portfolios was done to support the interview data. Overarching themes emerged, namely: the significance of an e-portfolio, technological competencies of preservice students, and the development of collaborative skills.

The main limitation of the study was geographical distance because the study was conducted in an ODeL context which prevented face-to-face interviews and effective probing. One student's call dropped in the middle of the interview and efforts to talk to the student again were in vain. Two students' phones were off despite many attempts made to call while one student's phone rang but was not answered. However, the information gathered from the 9 students who participated was adequate to answer the research questions. The findings are presented in the next section.

DISCUSSION OF THE FINDINGS

Triangulated data from literature, documents and interviews led to the determination of three themes, namely, the significance of assessing EE by means of an e-portfolio; improvement in pre-service teachers' technological competency; and the development of collaborative skills.

The study purposed to answer three research questions.

RQ1: What is the significance of an e-portfolio as an alternative way of assessment in EE?

Findings revealed that an e-portfolio was a useful alternative method of assessment. The portfolio was based on a specific topic in EE, namely, waste management through recycling compared to the traditional way of burning waste. The issue of recycling featured when students were answering the questions on an activity on the Eco-Schools programme¹. An e-portfolio activity on Eco-Schools exposed them to recycling activities because they were required to visit recycling plants to observe the recycling processes which is an environmental strategy to manage waste, and to digitally record their observations, for example, by means of photographs.

In addition, the e-portfolio was used to evaluate the effectiveness of the WSDEE module (Bates, 2010). The process of compiling an e-portfolio enhanced pre-service students' technological pedagogy, particularly electronic assessment on EE (Maher & Gerbic, 2009). One interviewee had this to say about the significance of an e-portfolio as an assessment tool:

An e-portfolio was important because some of us did not know anything about this kind of assessment. Now I know how to do electronic assessment.

Therefore, according to the participant, an e-portfolio was important because it improved the student's knowledge of environmental sustainability on matters such as managing waste through recycling. The success of using an e-portfolio in assessing the module in question supports Maher and Gerbic's (2009) study that showed that students employed an e-portfolio as an assessment tool to create a cross-curricular unit of study on the topic 'Education for Sustainability' for primary school children which could include video clips, sound clips and images. Maher and Gerbic (2009) state that the e-portfolio assessment is also authentic, one of the key principles of the National Qualifications Framework (South African Qualifications Authority, 2000) which addresses practical competence, namely, "the demonstrated ability, in an authentic context, to consider a range of possibilities for action, make considered decisions about which to follow and to perform the chosen action" (p. 17).

RQ2: How does the use of an e-portfolio as an alternative method of assessment enhance EE pre-service teachers' digital pedagogy?

The data from the interviews and document analysis confirmed that an e-portfolio exposes student-teachers to various technologies that could be used in teaching and learning in the digital classroom. This finding supports Van Wyk (2017) who found that an e-portfolio could empower prospective teachers to integrate technology into teaching and learning.

The document analysis revealed photographs that were taken by participants during their visits to the recycling plants which served as evidence for their e-portfolios as this was part of the e-portfolio requirements. After the visits, the pre-service students downloaded the photographs, adjusted them, imbedded and integrated them into an e-portfolio text. The information was also prepared as PowerPoint slides which could be used to teach learners. In this way, the e-portfolio enhanced pre-service teachers' technological pedagogy, agreeing with Maor (2017) who states that e-portfolios may enhance the students' learning experience. When interviewed an interviewee said:

After taking photos from the recycling plant, I learned to download and adjust photographs and even attach them in the portfolio. This will help me to effectively teach solutions to waste.

However, another interviewee said:

I needed to have somebody to show me how to adjust the photographs.

A common view amongst the interviewees was that an e-portfolio afforded them an opportunity to have online assessment that they had not been exposed to before, such as submitting their work via an e-portfolio site. When interviewed, one interviewee said:

An e-portfolio was a good exposure to do things electronically. It was completely new for me to do electronic work. I learnt to prepare a PowerPoint presentation to answer one of the e-portfolio activities and then e-filing to submit an e-portfolio. I also used the internet to search for information. This is one of outstanding things because I became aware that, in other countries, Eco-Schools are progressing more than in South Africa. My greatest challenge was connectivity because I live in a rural area.

It is evident that using an e-portfolio improved pre-service students' technological pedagogy relevant to digital teaching and learning of EE. However, the teachers in rural areas may find it difficult to practise what they learned due to a lack of internet connectivity.

In addition, the pre-service teachers used WhatsApp to share e-portfolio evidence. This concurs with Van Wyk's (2017) evidence that students formed a WhatsApp group to share subject-related issues, thereby developing a community of practice. The interviewees indicated that they would use WhatsApp to communicate information to the learners and parents regarding natural hazards such as floods, cyclones and current events like environmental conferences to keep them updated on environmental issues.

The analysis of documentation was based on the e-portfolios submitted by pre-service teachers. Evidence of activities was mostly photographic. Furthermore, data revealed two scenarios in terms of the submitted e-portfolios. The first scenario was that photographs were embedded in the e-portfolio text and were given captions and aligned to specific sections. The photographs were supported with textual explanations. In this scenario, the students explained what was happening and showed that they were involved.

The second scenario was that the textual discussions were provided without reference to the evidence which also consisted of photographs. The photographs were attached at the end of text

largely copied from the internet without reference to such appendixes. This showed that the work was not the students' effort, confirming Smolyaninova and Shilina's (2011) opinion that among the risks of using an e-portfolio in the educational university environment is plagiarism. This means that some students did not benefit from an e-portfolio to learn about waste management through the recycling process in the field of EE. This spoiled the good spirit of *Mmogo* or working together as a community of practice.

Furthermore, not all preservice teachers in EE were adequately prepared in terms of technological pedagogy because some students failed to submit e-portfolios on the e-portfolio site. This supports the findings of Smolyaninova and Shilina (2011) who mention that preservice teachers are not adequately prepared in terms of technological competency, and Strydom and Barnard (2017) who indicated that irrespective of engaging with 'millennial' students during their study, it was evident that the assumption that all the students could use the necessary technologies as envisaged was not always correct. It can thus be concluded that 'millennials' are not necessarily conversant with the technological pedagogy that is required in the digital teaching and learning context.

In sum, various challenges emerged from the use of e-portfolio such as a lack of connectivity, lack of data and lack of guidance to work online while compiling an e-portfolio.

RQ3: How does the use of an e-portfolio as an alternative assessment tool develop collaborative skills?

Findings revealed that an e-portfolio afforded the students an opportunity to collaborate during the compilation of the e-portfolio, mainly on how an e-portfolio should be written and what should be included as evidence. Collaboration is key if students are to become a community sharing information about the kind of knowledge and specific evidence required during the compilation of an e-portfolio (Ally, 2004; Belgard, 2013; Kop & Hill, 2008; Roos, 2012). This viewpoint is supported by Boulton (2014) who states that an e-portfolio can be used as an alternative method of assessment to showcase collaborative skills. In this study, the students collaborated by sharing photographs as evidence of recycling activities that addressed the issue of sustainability. This was one of the e-portfolio activities, namely, to form a community of practice in their endeavours as they connected and interacted with each other to share information. By using an e-portfolio as an assessment strategy, students were provided with an opportunity to collaborate. The idea is supported by McCormick (2004) who states that employing digital technologies provides opportunities for both "collaborating to learn" and "learning to collaborate" (p. 159), in this case learning about waste management (recycling) and learning to work with others to solve a common problem, a community of practice.

Despite these benefits, collaboration during the compilation of an e-portfolio led to students committing plagiarism, manipulating data and contravening confidentiality when they shared evidence, especially photographs confirming literature as highlighted by Smolyaninova and Shilina (2011). Some of the evidence provided in the e-portfolios such as photographs were simply copied by students, did not have captions and were not referenced in the text. This means students did not learn anything about the issues of waste management through recycling. Essentially, all they learnt was how to cut and paste (Trinchera, 2002). A way of addressing this would be to include an activity on reflection of what transpired throughout the process of compiling an e-portfolio.

CONCLUSION

This study explored how the use of an e-portfolio as an alternative method of assessment in EE enhanced pre-service teachers' digital pedagogy, by investigating the WSDEE module. Three research questions were answered, namely, RQ1: What was the significance of an e-portfolio as an alternative way of assessment in EE?; RQ2: How does the use of an e-portfolio as another method of assessment enhance pre-service teachers' digital pedagogy?; and RQ3: How does the use of an e-portfolio as an alternative assessment tool develop collaborative skills? The pre-service teachers learned how to

prepare an e-portfolio and submitting it online to the university. Based on the answers to the research questions, one conclusion is that using an e-portfolio as an assessment strategy in EE can enhance pre-service teachers' digital pedagogy. However, the use of an e-portfolio for assessment showed that some students did not improve their IT skills.

The author recommends that the university implements a support programme for students who struggle with access to and use of IT, and address the problem of connectivity in rural areas by consulting with the students to establish the intensity of the problem and liaising with authorities and internet suppliers like Telkom, and cell phone companies like Vodacom, M-Net and Cell C to have a way forward on how connectivity could be strengthened. The lecturers should include more activities that would improve pre-service teachers' technological pedagogy.

The areas that need further research are identified as follows: (1) a study could be conducted on how best students can be supported in completing an e-portfolio to enhance their digital pedagogy; (2) an investigation is needed regarding which activities can be included in an e-portfolio to promote pre-service teachers' technological pedagogy; (3) a study is needed to determine how an e-portfolio can be used to address technological knowledge in EE; and related to this, (4) there is a need to investigate why some schools are not involved in the Eco-Schools project because schools that are registered with the project assist in enhancing pre-service student-teachers' digital pedagogy.

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ENDNOTES

- ¹ The Eco-Schools programme is an international programme of the Foundation for Environmental Education (FEE) that was developed to support environmental learning in the classroom. The programme was implemented in South Africa in 2003 by The Wildlife and Environment Society of South Africa (WESSA, 2019).

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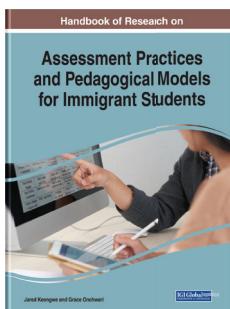
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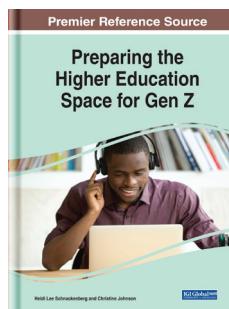
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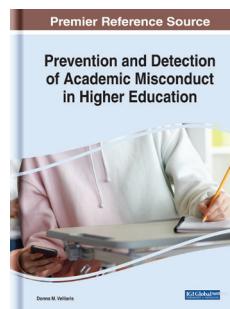
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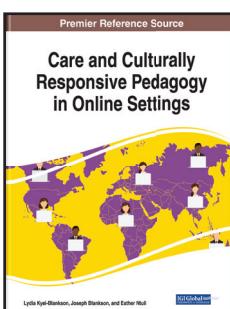
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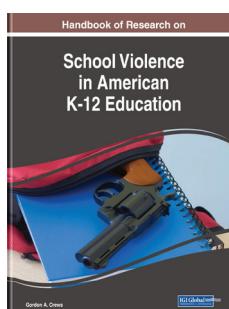
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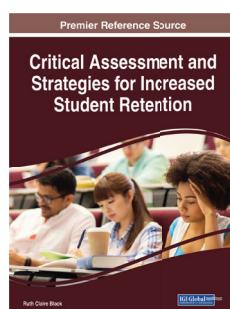
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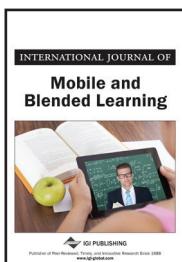
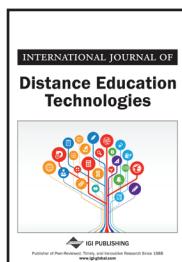
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