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Review of Usability Evaluation Methods and Other Factors for Implementing an Open Source Learning Management System in Saudi Arabia

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ABSTRACT
Possible methods suitable for evaluating the usability of e-learning websites that provide a Learning Management System are examined. In doing so, some systems are suggested which system and which usability evaluation might be used with a focus on the Saudi educational context and open-source solutions so as to aid those considering to adopt. Other issues related to implementation besides software usability are also highlighted including the appropriateness of the Technology Acceptance Model which takes usability into account.

KEYWORDS
Software usability; Usability evaluation; Learning Management System; Technology Acceptance Model; Open source; Moodle

1 INTRODUCTION
This review of the literature examines possible methods for evaluating the usability of e-learning or Learning Management Systems (LMS) for academic institutions, especially those in Saudi Arabia that seek a low-cost solution. The information may also be applicable to other similar contexts to be useful for anyone considering implementing an LMS and evaluating its usability, and where an LMS may also be referred to as an e-learning platform, Course Management System (CMS), or Virtual Learning Environment (VLE). The purpose is to give valuable information that may inform decision makers faced by the choice of evaluation methods for evaluating the usability of an LMS while subject to time, cost and other constraints.

In addition, the paper gives a brief overview of Moodle as one example of an open-source LMS since the cost factor is an important consideration for these institutions, and it also highlights some relevant issues besides software usability that may be important in deciding which LMS to implement. This wider consideration is necessary because regardless of how easy to use or effective a certain technology is, it cannot serve its purpose without a proper implementation [1]. This also leads to highlighting the Technology Acceptance Model (TAM) as a possible theoretical framework for studying the acceptance of an LMS based on its usefulness and usability.

2 LEARNING MANAGEMENT SYSTEMS
An LMS and all other such systems mentioned above rely on a computer connected to the Internet, and make it possible for students to learn by obtaining course materials, sending assignments, taking quizzes, communicating with their teachers and fellow learners, etc. For teachers, an LMS assists by allowing them to create, make available, manage, customise and modify a range of digital content and learning objects, to reuse that content and track their students’ learning, and for a university, an LMS enables it to expand its student body though delivering courses to students around the world. Since the advent of the Internet, various technologies have been used to enhance learning, such as email, Bulletin Board Systems (BBS),
blogs, wikis, and chat clients, but a typical LMS offers many more features to provide a more comprehensive learning environment.

Notably, an LMS enables the communication to be conducted remotely, and either synchronously or non-synchronously. That is, an LMS removes the restrictions of time and distance in providing an educational environment [2]. This offers many advantages for learners, especially in terms of being able to learn at their own pace at their own convenience, and from anywhere as long as they have the aforementioned physical hardware requirements. It does however, impose on students the need to be independent, collaborative and active participants.

In short, an LMS is characterised by its provision of four types of spaces: (1) information space for providing educational content and reference materials, (2) exhibition space to exhibit learning products, such as documents and videos, (3) an interaction space for users to communicate and exchange information, and (4) production space where processes are implemented to generate traces of learning, such as exercises and tests [3]. As a piece of software, a typical LMS would be described as being multiplatform, having a graphical interface, based on a client-server architecture, and which allows for multimedia, information management, communication and user interaction.

One way of distinguishing most LMS’s is by describing them as being either proprietary or open-source. By open source is meant that the source code is openly available, which enables users to have access to the source code, modify it, add features and redistribute the software. These are typically available for free. A closed-source LMS on the other hand does not provide open-source access to the code, which is typically a proprietary LMS provided by a commercial entity and is not therefore free. A few examples of popular commercial LMS’s are Blackboard, WebCT, Brightspace, and WizIQ, and of open-source ones are Moodle, Sakai, Ilias, ATutor, Canvas, and Schoology. In deciding between these two types, important factors to consider would be features, supported technologies, license fees, support and maintenance, security, and IT resources. In comparison, although commercial LMS’s may be costlier, they generally come with better support, whereas open-source LMS’s are usually obtainable free of charge and are more flexible and customisable.

Delivering a course of study through a Learning Management System (LMS) has increased dramatically in Saudi Arabia in recent years [4]. A major reason for this trend is Saudi Arabia becoming the largest market for information and communication technologies in the region [5], and the huge budget allocation for e-learning systems and encouraging their implementation by the Ministry of Higher Education. One of the earliest LMS’s to be implemented was EMES (E-Learning Management Electronic System) at King AbdulAziz University in 2007. Although most implementations are in universities, LMS’s have now also been introduced into K-12 public schools in Saudi Arabia [6].

Of the 34 universities in the kingdom (as of 2015), a Ministry of Higher Education (MoHE) survey of 25 of them revealed that Blackboard is by far the most commonly used LMS [64]. It is used by 76% of the universities in the sample (Table 1) although many of these universities have only been developed in recent years as part of the kingdom’s drive to transform itself into a ‘knowledge economy’ [65]. In this sample, Moodle is only used by one single institution (University of
Tabuk), so there is a lot of scope to promote open source alternatives.

Table 1: Types of LMS's in use in Saudi universities

<table>
<thead>
<tr>
<th>No.</th>
<th>LMS</th>
<th>No. of Universities</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>1</td>
<td>Blackboard</td>
<td>19</td>
<td>76%</td>
</tr>
<tr>
<td>2</td>
<td>None or not yet installed</td>
<td>3</td>
<td>12%</td>
</tr>
<tr>
<td>3</td>
<td>Desire2Learn</td>
<td>2</td>
<td>8%</td>
</tr>
<tr>
<td>4</td>
<td>Moodle</td>
<td>1</td>
<td>4%</td>
</tr>
<tr>
<td></td>
<td>TOTAL</td>
<td>25</td>
<td>100%</td>
</tr>
</tbody>
</table>

The situation is more or less similar in other countries as well in that there is a discernible diffusion of online education. Reference [66] identified four distinguishable stages of this diffusion at a selected Mexican university over a 13 year period (1996-2009). It was noticed that initially, online education began as individual initiatives by academics in the late 1990s who emerged as agents of change and stimulated interest in other academics, which led to the formation of small communities sharing information and experiences. The next stage (1999-2002) was characterised by a more active role in the diffusion, and the third stage (2003-2007) by a clearer structured focus centred on the use of ICT for teaching and learning. During the subsequent period (2008-2009), a clear institutional policy had not been defined by the university examined. Although the periods may differ for other universities and countries, similar diffusion characteristics can be observed, and with it, issues such as selecting and evaluating a suitable LMS have become important.

### 3 LMS USABILITY

#### 3.1 LMS Selection

Besides the above criteria for selecting an LMS, its evaluation may be undertaken from a pedagogical or institutional perspective [7], or by conducting a usability evaluation, or a combination of these. The use of an LMS, which plays a central role in this arrangement for learning, introduces potential software usability issues at both ends, and usability has become an important concern in developing an LMS [8]-[9]. The problem is that evaluating an LMS can be a complex task, as found for instance when evaluating the effectiveness of an open source LMS [10]. The price and feature list of an LMS are not therefore the only factors to consider. In particular, a technologically mediated educational process should be expected to provide an easy to use, clear and understandable interface, accessible content and course materials, and an efficient means for a two-way communication between the teachers and students.

#### 3.2 Usability

Usability is an important software quality attribute recognised in the standard ISO/IEC 9126-1. The same standard defines usability as “the capability of the software product to be understood, learned, used, and attractive to the user, when used under specified conditions”. The traditional attributes of usability, as described by Nielsen [11], were that the software should be easy to learn, efficient to use, easy to remember, have few errors, and be subjectively pleasing, which may be labelled as learnability, efficiency, memorability, reliability and satisfaction respectively. He [11] further introduced the concept of web usability as describing web pages that are intuitively organised, easy to navigate, and which help users find the information they seek with ease. This
position is supported by Roy & Pattnaik [12] who also argued that the most important aspects of a website from a usability point of view to satisfy users, are the user friendliness of its navigation system, and its effectiveness in enabling users to accomplish tasks. Effectiveness is in relation to performance in being able to accomplish tasks, which may be measured for instance, by number of users being able to accomplish them within a certain time. A site would be considered as user-friendly by its users if they can easily interact with it in order to perform the tasks required of them [13].

Although different researchers have defined usability in terms of different components, the components that may be particularly important for ensuring a highly usable e-learning system are learnability, rememberability, efficiency in use, reliability and user satisfaction [14]. Learnability for instance, refers to the degree of learning required to accomplish tasks, and which may be measured by the time taken to perform them, and general satisfaction of the user would be ensured by making them want to continue to use the system happily; want to see it improved in some way, or prefer not to use it or to use another system in its place. Evaluation based on a range of factors is essential for evaluating usability because usability does not pertain to any one of them exclusively, and a range of technical, attitudinal, cognitive and other factors provides a more balanced indication of usability. An ideal LMS would be one that has all such components expected of an LMS, and which can ensure students can learn effectively from an institutional and also system perspective [15].

In a study specifically on the usability of e-learning systems, [16] recommended that such a system can only be considered as usable if it is easy to use and useful for learners with respect to accomplishing their learning tasks, that is, if the software is able to help them improve in their learning. Others have also highlighted further motivational aspects as being important for e-learning, such as a feedback mechanism, comprehensiveness, and curiosity [17]; interactivity, avoiding interruptions or distractions to learning, and providing a continuous feeling of challenge [18].

3.3 Importance of Considering Usability

For software in general, enhancing usability can lead to improvements such as making it easier to use the software, reducing time spent in learning to use it, improvements in productivity, greater user satisfaction, etc. The usability of websites has always been a matter of concern since the very beginning of the Internet era [19], and the characteristics of human-computer interaction play a major role in defining their usability [20]. Some usability aspects can also be subjective, as it is also affected by users’ cognitive and perceptual abilities [21].

Usability is an especially important consideration for e-learning software because it can help to develop systems with improved didactical and pedagogical approaches [22]. For an LMS, the consideration of usability is moreover important because it can affect the learning experience for students and their academic performance [23]-[24]. Any lacking in usability compromises the quality of the online course delivery system, can cause waste of time, and increase the need for and cost of providing training.

In spite of such potential benefits, usability is often neglected in designing and implementing e-learning software [25]. The reason for a lack of usability evaluation may be that in comparison to other tests, it is considered tedious, least rewarding and expensive to implement [26], and it
may also require training and close coordination between developers and programmers. Moreover, only a few studies have been conducted, and there is still no standard adopted for evaluating the usability of learning management systems.

### 3.4 Usability Evaluation Methods

Importantly, the effectiveness of educational software also relies on some principles that distinguishes it from other web-based software, so these would need to be taken into account when selecting an evaluation method. These include the design of learning objects and learning activities, the medium of presentation, and the provision for communication between teachers and students [27]. And for methodology, one possible framework that can be applied is the DECIDE framework based on the following six components [28]: (1) Determine goals for the evaluation to address, (2) Explore questions to be answered, (3) Choose evaluation paradigm and techniques for answering those questions, (4) Identify practical issues to be addressed, (5) Decide on how to deal with ethical issues, and (6) Evaluate, interpret and present the data.

Many usability evaluation methods have been devised for evaluating various kinds of software including web-based software. These methods may be categorised as: (1) Survey questionnaire based methods, (2) Other non-survey structured methods, (2) Inspection based methods, and (4) Non-user involved methods. There are several examples of the first type, such as Software Usability Measurement Inventory (SUMI), System Usability Scale (SUS), Questionnaire for User Interaction Satisfaction (QUIS), Website Analysis and Measurement Inventory (WAMMI), Computer System Usability Questionnaire (CSUQ), and Usefulness, Satisfaction and Ease of Use (USE). Of these, WAMMI has been specifically prepared for evaluating websites [29], so it would appear that it may be particularly suitable for evaluating an LMS.

The Think Aloud approach, which is another form of systematic method, may also be used for websites as an alternative to WAMMI, but it is likely to be more time consuming [30], and unlike WAMMI, the results cannot be used to compare usability between different systems [31]. Another possible alternative is eye-tracking, but it requires special equipment and technical expertise [32], and Heuristic Evaluation, an inspection based method, has been shown to be particularly useful for detecting structural defects of sites [33]. Other methods also used are interviews, surveys, expert reviews, and personas. However, the decision of which method to adopt in evaluating usability would be subject to the typical constraints of time and cost [26], and depend on such factors as the stage of the software development lifecycle (SDLC), availability of skills and expertise in evaluation [34], and the extent of need for an objective, systematic and complex evaluation. It is also possible to combine different methods, as done by [27] in a study that combined evaluation from three different categories identified above, namely heuristic evaluation, usability questionnaire, and a task-driven technique. As for sample size in evaluating usability, as pointed out by Nielsen [11], it is usually sufficient to determine this quickly with as little as three to five users [35].

The System Usability Scale (SUS) mentioned above is a very short, “quick and dirty” [36], and freely available usability evaluation questionnaire widely used for measuring usability. It is recognised as a robust tool [37], even for small sample sizes [38]. A comparison of five different tools (SUS, QUIS, CSUQ and two vendor specific ones), has shown that along with the CSUQ, the
SUS achieved the goal of providing a reliable measure across a range of sample sizes the quickest [38]. This tool comprises of 10 items (5 positively and 5 negatively worded statements), which are assessed using a five-point Likert scale ranging from strongly disagree to strongly agree. A survey by [39] listed 14 products for which the SUS questionnaire was used for testing usability and proposed a further 9. Although e-learning platforms were not included in either of their lists under the category of web products, e-learning platforms can also be assessed using SUS like other web products.

3.5 LMS Usability Evaluation

The SUS has been used for evaluating the usability of an LMS by [40] who evaluated the SPIRAL platform; [41] who used it to evaluate a distributed learning resource repository called DELTA; [42] who used it to measure user satisfaction of three edutainment platforms; [43] who evaluated the UNITE e-learning platform in nine schools that used it; [44] who used it for evaluating the usability of a Moodle based VLE in conjunction with heuristic and cooperative evaluation; [45] who assessed the Topolor system which combines social e-learning with adaptive e-learning; [46] who used it to assess the perceived usability of a simulation based e-learning system, and in eleven studies conducted by [24]. These latter studies together involved 769 students in which eClass and Moodle were evaluated. The ‘perceived usability’ of these LMS’s was found to be satisfactory, especially in terms of validity and reliability. In the study by [44], all three tools identified the existence of usability issues.

Reference [47] developed an instrument for evaluating the usability of an LMS. with respect to its user interface in terms of features, its web application features, and other features specifically related to the LMS. The LMS evaluated was an in-house system designed around the time Moodle was made, and the heuristic evaluation of Nielsen was applied, which involved identifying its functioning and optimum operating conditions. In addition, they checked for its compliance with international standards: ISO 9241 based on the criteria of efficiency, effectiveness and satisfaction, and ISO 9126 based on learnability, operability and comprehensibility. This led to devising six questions for evaluation from which the following essential attributes were identified: searchability, communicability, reliability, configurability, design, comprehensibility, ease of use, and navigability. Six experts were hired to evaluate the system. This method enabled serious usability problems to be uncovered, especially in terms of reliability in the form of frequent interruptions, error messages and failures, but also communicability, searchability and configurability. The software scored highest in terms of comprehensibility.

Reference [10] compared a range of open source LMS’s based on a simple evaluation of technical factors and features to find one suitable for a higher education institution. Commercial ones were not included because the objective was to find a cost effective solution, but there was also a requirement to have all the major features expected to be found in a commercial product. Five open source LMS’s were selected from fifty on UNESCO’s website: Moodle (v.2.2), Atutor (v.2.0.3), Ilias (v.4.2.1), EFront (v.3.6.10) and Claroline (v.1.10). All five of them are themselves based on open source technologies, namely PHP, a server-side scripting language, and MySQL, a database management system. The analysis was undertaken by creating courses, updating their contents, and creating learning activities. In terms of usability, all of them were found to be easy to
use. Three of them – Moodle, ATutor and Ilias – excel with respect to providing flexible language support, usage statistics, and an advanced assessment system; EFront stood out alone by having the most visually attractive interface, and Moodle by providing the ability to track user logging, rich graphical statistics of activities and reports, and more advanced access and security controls. Moodle was also found to have certain features not present in the other LMS’s at the time of comparison, such as support for external video conferencing, file transfer, and whiteboard tools that can be integrated in the LMS. Since their first recommendation was Moodle, more details are given of this LMS.

3.6 Moodle

Moodle (Modular Object-Oriented Dynamic Learning Environment) is web-based course management system that is recognised as a popular LMS. It is available for free and is based on open-source technologies, which allows it to be easily modified and adapted. Moodle provides a wide range of features typical of an LMS, such as a registration system for both instructors and learners, user profiles, assignments, class schedules, wikis, chats, glossary, email, performance statistics, etc. Several studies have evaluated Moodle, some focusing on specific modules [48]-[49], [27] and others have compared Moodle with other LMS’s [50]-[51].

Moreover, Moodle is designed to provide a collaborative learning environment based on the pedagogical principles of social constructivism, has multi-lingual support, and it supports the SCORM (Sharable Content Object Reference Model) and IMS (Instructional Management System) open standards for an LMS. Support for these open standards is beneficial because it ensures greater interoperability, portability, reusability and sequencing for the LMS [52], and also accessibility, adaptability, durability, and maintainability [27]. The SCORM specification for instance, contains elements of provisions by IEEE, AICC and IMS in a single document, which makes it easy to implement.

3.7 Consideration of Other Factors

From the perspective of project management, many other factors would also need to be considered besides those already considered above, namely price, features and technical factors, in deciding which open source LMS to implement. In the case of an institution for instance, it should ensure the LMS is in line with its vision and mission, and that it can easily handle the number of potential users [53].

A study by [53] highlights examples of such challenges in implementing an e-learning system faced by a university in Saudi Arabia, which they ascertained through adopting a case study approach. Their findings show that various issues can arise that must therefore be considered beforehand. These issues include the time it would take to develop online courses from scratch, availability and sustainability of human resources, and uncertainties related to technology. Technological uncertainty and the issue with human resources can also change over time, which may require changes in the implementation.

Apart from arranging for the e-learning system in an attempt to improve the quality of student learning and in a way that it could evolve in line with educational change processes, they also had to convince the institution to adopt the technology and overcome the initial “course of techno-hype” [53], which was challenging and necessitated a number of changes to the original plan. These changes included adopting Moodle instead to benefit from better specifications, providing
improved interactivity, and meeting the requirements of the Saudi MoHE (Ministry of Higher Education) to blend the course with face-to-face teaching. There may also be legal issues to consider, as currently, Saudi Arabia does not permit the offering of online degrees.

Furthermore, cultural issues also need to be considered, as it was found to present a major challenge in the case of Saudi Arabia. Some faculty members found it difficult to adapt to the new way of teaching, and some students experienced difficulties. Difficulties for students was not exclusive to Saudi students, as the phenomenon has also been reported by others, such as [54] and by [55] for Jordanian students. Overcoming such cultural issues would require training, which can be time consuming and costly. In some countries, other such issues peculiar to that place may arise. For instance, when [1] investigated the implementation of an e-learning system in a university in Pakistan, English proficiency and electricity failure were found to be the most significant barriers. However, some LMS’s such as Moodle do have multilingual support and the problem of frequent power outages only restricts synchronous learning, not asynchronous learning.

For developing countries generally, limited resources and lack of technical expertise can be restricting factors to proper implementation, as can cost of technology, deficient strategies, resistance to change, poor course delivery and competition [56]. As pointed out by [57], most developing countries lack quality experts to implement and maintain information and communication technologies. Lack of computer skills is not only prevalent in developing countries however, as it is also not uncommon in developed countries. Reference [58] identified four barriers to adopting an LMS in a university in New Zealand: computer skills, conceptions of an LMS’s role, desire for recreating old work practices, and emotions. Computer skills were highlighted as barriers, a ‘cognitive load’ and hindrance to mastering the functionality of an LMS. Difficulties were experienced especially by staff who lacked even basic computer skills, and the researchers also faced issues relating to getting users to interact with each other. The study also showed the potential of technology to arouse negative emotions of frustration and exhibiting reluctance to change. Consequently, there was a tendency to replicate some past practices to ease the LMS adoption process. For instance, they preferred to perform certain tasks the way they were previously accustomed to doing. Nonetheless, the LMS implementation was successful overall, as the institution was praised for its strong technical support, which shows the importance of this factor in making an implementation successful. Other such enabling factors identified were learning from the implementations of other institutions, and allowing for a feedback mechanism.

The above study highlights the importance of taking the users into account. A study by [59] specifically analysed how learners interact with an e-learning site by means of a survey with a view to assessing the effectiveness of e-learning material used by a particular Indian e-learning portal, and to predict the acceptability of the adaptive environment for learners. The learners reported perceiving e-learning as valuable due to its role in reducing time, effort and money in retrieving information. Moreover, a vast majority of the 146 students surveyed expressed satisfaction with the e-learning environment due to the aforementioned and various other benefits, such as convenience, scope for interaction, ease in seeking clarification,
etc. User satisfaction is an important component of usability, and factors such as usefulness and ease of use perceived by users makes it easier for them to accept the technology and new way of learning.

3.8 The Technology Acceptance Model

A useful theoretical framework that can be applied for understanding the likely acceptance and usage of the implementation of an LMS is the Technology Acceptance Model (TAM), an information systems theory proposed by [60] that takes into account perceived usefulness and perceived ease of use. That is, the usefulness and ease of use perceived by users are considered to be predictors of the attitude to accepting a technology. Reference [61] used this model for the e-learning context in an empirical study involving students from a university in Taiwan. They found it to have good internal consistency; that the more useful the system is perceived to be and the easier or friendlier the system interface is to use, the users are indeed more willing to use it. Likewise, user satisfaction is closely linked with active participation and commitment [62].

In an adaptation of TAM specifically for e-learning systems, [63] combined the model with Innovation Diffusion Theory (IDT) to investigate factors that may affect the behavioural intentions of 552 business employees in Taiwan to use an e-learning system. The study validated both TAM and IDT for the organisational context as providing better results overall when combined. Although the results confirmed the research model and hypotheses, those who had expectations for the system to be usable in terms of it being simple to understand and easy to use were disappointed, as it did not prove helpful in improving job performance. To address these findings, they therefore recommended for e-learning systems to be designed in a way that is relevant to employees’ and user-friendly for enhancing the perception of ease of use. This confirms the view that two constructs of usefulness and ease of use are important factors in determining the extent to which an e-learning system would be accepted.

4 CONCLUSION

A number of software usability evaluation methods were identified in this paper that can be adopted for evaluating the usability of a learning management system. It also defined an LMS, identified its characteristics, examined some issues in evaluating an LMS, described usability and identified its components relevant to an LMS, established the importance of considering usability, and highlighted other related factors to consider in implementing an LMS. The Technology Acceptance Model was also introduced as a theoretical framework for understanding technology acceptance in terms of perceived usefulness, and perceived ease of use as one important aspect of usability.

Given that many universities in Saudi Arabia have only been established in recent years, the finding that many existing universities use a proprietary LMS, and the neglect of usability considerations, there is plenty of scope for promoting both an awareness of the importance of usability and adopting open source based learning management systems for supporting e-learning. It is recommended to conduct a thorough investigation of usability issues related to the use of an LMS. Moreover, the newness of the technology and the finding that some universities are not currently using any LMS shows the potential for applying the Technology Acceptance Model in further research in this context.

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Interpreting the Experiences of Teachers Using Educational Online Technologies to Interact with Content in Blended Tertiary Environments: A Phenomenological Study

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ABSTRACT

Although educational online technologies (EOTs) have enhanced the dissemination of learning in higher education, key EOT obstacles have hindered their effectiveness, preventing widespread implementation. The persistence of these obstacles suggests that tertiary education institutes (TEIs) have experienced difficulties in understanding their key stakeholders’ EOT needs. This research made an interpretation of key stakeholders’ EOT experiences, to establish their existing EOT needs and challenges, and provide a foundation from which to recommend methods for effective EOT support. It analysed the experiences of 10 students and 10 teachers from New Zealand and Australia and interpreted the meanings of these phenomena through an abstraction of local and global themes. This paper is the sixth in a series of six publications that presents the local themes. It documents the interpretations of teachers’ experiences with content, in reference to their use of two types of EOTs: learning management systems, and online video platforms. These interpretations, which include descriptions of teachers’ EOT challenges, helped to inform a set of recommendations for effective EOT use, to assist TEIs in their efforts to address EOT challenges and meet their stakeholders’ needs.

KEYWORDS

Tertiary education, blended learning, online technology, student experiences, phenomenology

1 INTRODUCTION

Educational online technologies (EOTs) have revolutionised the delivery of online education, making a significant contribution to the global increase in demand for higher learning. In an era of considerable online growth, their rapid emergence, adoption and demand has engendered significant advances across the higher education sector. Traditional classroom spaces have evolved into dynamic blended tertiary environments (BTEs), providing tertiary education institutes (TEIs) with a modern means through which to augment course delivery. These transformations signal exciting prospects for teachers and students, the key stakeholders in BTEs.

Despite the growth and demand for technology-based learning, considerable obstacles impede the use of EOTs. Such challenges include, but are not limited to attitudinal pre-dispositions, insubstantial training, and inadequacies in instructional design support [2]. Other challenges include resistance to change, ineffective EOT usage, lack of motivation, technical constraints, and accessibility [3]. These challenges pose a clear risk to the future success of BTEs [4], and create difficulties for stakeholders as they deliver and engage in learning.

Significant efforts have been made to learn more about EOT challenges. These have resulted in considerable subject-specific research, with varied and noteworthy contributions to the literature. Some studies have considered technology integration into blended environments [5], technology to support institutional roles [6], barriers to adoption of online learning [7], and the needs of online students [8]. However, while “our research foundation is rich” [9], not all problems have been adequately identified and addressed.

The continuation of these challenges suggests that TEIs have experienced difficulties in

1 Predictions about future growth, along with forecasts for EOT use are discussed in the first of these six papers [1].
understanding their key stakeholders’ EOT needs. Over time, these needs have evolved, and in an environment of rapid technological change have not been addressed effectively. With their operations based in a dynamic environment, TEIs must maintain relevance by evolving and adapting to meet their stakeholders’ needs. However, doing this effectively requires that they have sound, up-to-date understandings of their stakeholders’ EOT challenges, to deliver relevant and meaningful support.

Through a phenomenological approach, this research aimed to interpret key stakeholders’ EOT experiences, establish their existing EOT needs and challenges, and recommend methods for effective EOT support. Using a 5-step qualitative analysis of data, it analysed the EOT experiences of ten students and ten teachers, categorised these to reflect the nature of their interactions with other key entities and then interpreted their meanings through an abstraction of local and global themes. The global themes delivered a broad set of interpretations about the meaning of key stakeholders’ experiences with other students, other teachers and content, and the local themes developed meanings that were specific to their use of distinct EOTs.

This paper is the sixth in a series of six publications that present the local themes of this research, through written interpretations that describe the meaning of the phenomena. It documents teachers’ EOT experiences with content, in reference to their use of two different EOTs: Learning management systems (LMS) (Blackboard), and online video platforms (YouTube). Included in its interpretations are descriptions of stakeholders’ EOT challenges. These delivered a realistic portrayal of the phenomena to help strengthen knowledge about stakeholders’ needs. The interpretations helped to inform a set of recommendations for effective EOT use in teacher-to-content interactions. They were designed to assist TEIs to adapt to meet their stakeholders’ needs by providing a basis from which to tackle EOT challenges and deliver support.

To lay a sound basis for this phenomenological study, the author undertook preliminary research, which clarified and verified issues from the literature, and created a basis for the selection of participants. It identified EOTs in BTEs [14], produced a classification system for EOTs [15][16], identified key stakeholders in BTEs [17], identified the EOT challenges of key stakeholders [3] and discussed a key challenge (resistance to change) in using EOTs [18].

2 METHODOLOGY

The analysis of this data was guided by the methodology of interpretive phenomenology. It aimed to make an interpretation of the meanings of stakeholders’ experiences [39]; [40]; [41]. Linked to the principles of Heideggerian philosophy [42], this analysis of experience [29] abstracted themes from students’ and teachers’ experiences into a range of interpretations, to illuminate the phenomena [40] of EOT activity. This choice in methodology was influenced by the research aim, which aimed to interpret key stakeholders’ EOT experiences in BTEs, the key research questions [43], which were: What were the EOT experiences of key stakeholders in BTEs? and What interpretations could be made from their meanings? It was also influenced by the researcher’s “interest in the meaning of a phenomenon as it [was] lived by other subjects” [27].

A group of ten students and ten teachers from TEIs in New Zealand and Australia were chosen as participants using a purposive sampling strategy [41]. This ensured that the data would be gathered from those with first-hand experiences of the phenomena [44]. The rationale for this number was based on literature about qualitative and phenomenological research. Nicholls [28] for example, explained that “phenomenological studies … commonly use[d] as few as five … participants” (p. 639). Rawat [45] also stated that usually “four or five respondents” were chosen for such interviews. It was on this basis that 20 participants were chosen [27]; [28]; [39].
Further criteria were set in the selection of participants. To be interviewed, teachers had to be on full-time tenure with an accredited TEI, delivering a course in a blended learning modality. Students had to be aged 18 years or older, enrolled full time with an accredited TEI and in a course delivered in a blended learning modality. Teachers were identified from TEI website profiles of staff teaching in New Zealand or Australia. Students were identified with the help of a staff member at each TEI. Invitations sent out stated that participation was voluntary.

The rationale for the selection of only teachers and students was based on a study by the author [17], which identified key stakeholders in BTEs. In this study, students were recognised as key stakeholders because of the requirement for them to “buy into” blended learning, “participate fully, and be convinced” of its value [17]. Teachers were acknowledged as key stakeholders due to their direct involvement in the teaching and learning process and their every-day focus on and influence over learning activity.

The phenomenological interviews followed a semi-structured format and were conducted using web-based conferencing technology (Skype) and recorded using Pamela software. Participants set aside approximately 45 minutes to engage [46] and were asked a set of 27 questions. They responded with first-hand narratives [35]; [47]; [44] of their EOT experiences, which included descriptions about their use of different EOTs to interact with various key entities (students, teachers and content). The situational aspects of their descriptions were crucial to the study, since understandings of a phenomenon [i.e. EOT use] had to be “connected to a specific context in which the phenomenon [had been] experienced” [i.e., a BTE] [27].

To encourage a candid portrayal of the phenomena, the questions were developed to draw out experiences that included descriptions of stakeholders’ EOT challenges. Probes were used to clarify and encourage participants’ in-depth explanations [48]; [37]; [44]. The questions were also framed to encourage their recollections of encounters with different key entities. These types of encounters were based on the classification by interaction taxonomy augmented by Culatta [19] and the original classification proposed by Moore [20]. These categorised technologies by the relationship between learners and other entities. The first three interaction types of the original taxonomy were learner to expert, learner to learner, and learner to content. Culatta [19] presented a fourth category: learner to context. Tuapawa, Sher, and Gu [15][16], recommended a fifth category: learner to media. These categories were adapted to interviews with teachers, as follows: (1) teacher to student, (2) teacher to teacher, (3) teacher to content, (4) teacher to context, and (5) teacher to media. The use of a relationship-based taxonomy for arranging the questions helped refine stakeholders’ experiences into recognisable EOT interactions. It revealed distinctions between the phenomena in different key relationships, and established a structure through which to arrange the themes or meanings of the phenomena [44]. Table 1 outlines the questions asked of teachers about their EOT experiences with content.

### Table 1

<table>
<thead>
<tr>
<th>Interaction type</th>
<th>Questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher-to-content</td>
<td>(a) Describe an experience in which you used an EOT in a teacher-to-content interaction while studying in a BTE?</td>
</tr>
<tr>
<td></td>
<td>(b) Did you face issues or challenges using the EOT? Explain.</td>
</tr>
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<td></td>
<td>(c) What do you think would be a solution to this issue?</td>
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<tr>
<td></td>
<td>(d) What do you think would have helped you make more meaningful use of this EOT?</td>
</tr>
<tr>
<td></td>
<td>(e) Did you experience benefits in using this EOT? Explain.</td>
</tr>
</tbody>
</table>

Recordings of the interviews were transcribed using pre-formatted templates. This process, enabled the researcher to become deeply familiar with the content [49] and prepare it for analysis.
Yin’s [50] five phases of qualitative analysis, compiling, disassembling, reassembling, interpreting, and concluding, were used to structure and conduct the analysis. Table 2 shows the connection between these phases, and the techniques used.

**Table 2**

<table>
<thead>
<tr>
<th>Phases of qualitative analysis vs phenomenological research techniques</th>
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<td><strong>Stage</strong></td>
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NVivo software [21] was used to import, compile, and organise the interview transcripts into an organised structure [50]. These data were disassembled and coded, and the data were separated into categories that matched to the interview questions. These categories represented the data clearly and enabled it to be assigned, referenced and held in manageable groupings [22]. Table 3 shows the link between the labels used for coding, and the questions.

**Table 3**

<table>
<thead>
<tr>
<th>Nodes linked to teacher interview questions</th>
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</thead>
<tbody>
<tr>
<td><strong>Node</strong></td>
</tr>
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</table>

The data were reassembled, and moved from the nodal position into analytic memos [50], where they were used to elaborate ideas [21] and develop understandings about the phenomena [23]. Finally, the data were subjected to a thematic analysis, which involved an abstraction of local and global themes [39]. In this process, the essential meanings of the phenomena, were discovered through engagement with the descriptions of the experiences [44]. These were written into a series of interpretations to illuminate the phenomena [40] of EOT use. The global themes developed broad interpretations of the phenomena, whereas the local themes derived meanings from the use of individual EOTs.

The example in Figure 1 demonstrates how the data were gathered, transcribed, sorted and coded using nodes, refined into a teacher-to-content based memo and interpreted through an analysis of themes. These provided the foundation for the discussion of results in this paper.

**Figure 1**: Process of data analysis
This section discusses the local themes that were abstracted from teachers’ EOT experiences with content. They are delivered as a series of written interpretations of teachers’ lived experiences [40]; [44] and organised into two sections based on the EOT types teachers had identified: Learning management systems (LMS)(Blackboard), and online video platforms (YouTube). Each section includes a description of the EOT brand exemplar, and an interpretation of teachers’ experiences, which include their comments on EOT issues, challenges, usage, and solutions. The labels used to describe the EOT types are based on the Pentexonomy [15][16], a robust, contextualised and multi-dimensional framework for categorising EOTs.

EOT: Learning management system
Example: Blackboard

Description Blackboard is a comprehensive and flexible e-Learning software platform that provides a complete course and learning management system [24]. It is can serve as a ‘repository’ for learning resources, or be used in more innovative ways such as ‘an e-learning portal around a particular programme of work or sets of activities’ [14].

Experiences Teachers’ experiences using Blackboard to interact with content revealed that their EOT activity involved editing materials, providing links to resources, and marking and uploading assessment material. Negative views of Blackboard involved problems with usability and technical issues, large file sizes, and copyrighted content. One teacher described Blackboard as the ‘central [means] to formalising content’, and commented on its value for disseminating materials. ‘I like being able to take content …and upload [it] to Blackboard,’ he said, ‘because then … [it exists] in a virtual area that everyone can access.’ Another teacher used Blackboard as an upload point for his lecture recordings, and as a repository for slides that students would later use for course revision. ‘You haven’t got anything locally on your computer…it’s all on Blackboard.’ This meant that teachers ‘[didn’t] have to download anything to [their] computer, [they could] do it all online’, which ‘[was] handy’. One teacher adapted her content to suit both distance students and on-campus students, so that ‘all students’ had access to ‘all the material every week that [they had] lectures.’ Another ‘put material up…which [was] fairly low quality’ to ensure that ‘students who [were] out in the wild, and might not have a very good [internet] connection’ could access the learning materials. Some uploaded content that included ‘PowerPoints and mp3 recordings of the lectures’. Others made ‘tutorial links’ available, and some developed content that instructed students ‘where they should be at’ in their course progress.

Using Blackboard to edit and maintain content meant ‘there was no printing out…no formatting’ because ‘it was [all] there online’. For teachers interacting with assessment content, Blackboard also provided an efficient method for ‘online marking’, which ‘[made] it easier’. ‘You [could] mark and give feedback online, without having to put anything down on paper.’ Explaining the ease in doing this, one teacher said ‘it’s there online, [you] put the marks in, put comments in’…and ‘then at the end of the course, you download the spreadsheet, and can get [access] to all the marks.’ Pleased with Blackboard’s efficient assessment methods, one teacher stated that it was just easier to mark online.’ Despite these benefits, various challenges impacted teachers’ experiences with

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2 This discussion also includes a small amount of data from interviews with blended learning experts, some of whom were teachers.

3 It is important to note that the views expressed by participants reflected the state of development of software at a particular point in time, the ways in which it was implemented and maintained, and the manner in which it was used. Notwithstanding these realities, much was gained from their comments.
content. ‘Blackboard has quirks’, said one teacher, ‘it suddenly freezes…it is slow’. Expressing her frustration, she added ‘I find Blackboard very annoying’ because ‘the screen layout is messy’ and requires that I ‘constantly change tabs’. Blackboard was described by others as ‘clunky’. Some experienced problems interacting with assessment functions. ‘You end up with several different places you can enter marks’. This led to ‘a bit of uncertainty’ as to whether ‘comments…[were]…going to get to the student’. One teacher recommended improving ‘the interface, [it] need [ed] cleaning up’, and ‘could do with some smoothing’ out.

Another challenge related to oversized file uploads which contained media-rich content. ‘Often the recordings…[could] be very large.’ While ‘that’s great if you’ve got a good download speed…if [however] you’re out in the country, that’s not good’. Teachers suggested taking time to consider how ‘bandwidth issues’ impacted content interactions. Having a built in ‘way of lowering the quality’ of files would improve its efficiency. Another teacher recommended creating or augmenting the ‘system … [to] enable…lower [quality] downloads…to make it easier’, since the use of large files ‘ha[d] become an issue.’ Stating where the responsibility lay, one teacher stated that ‘the manufacturers at Blackboard need[ed] to work at it, and come up with some answers.’ Another commented on the importance of achieving a balance between download speed and quality visual content. ‘It’s a mixture, [but] visual people learn better with visual prompts.’ While improvements to content were justified, some felt that ‘technology was still not there in almost all of these aspects.’ Reflecting on the content issues he experienced using Blackboard, one teacher remarked ‘I would love them to come into my office, when I’m having a hard time so I [could ask] ‘why is it doing this? Why can’t it do this?’ Some also expressed frustration over Blackboard’s lack of ‘intuitive design’, describing its ‘html style’ as ‘outdated’. One recommended that ‘the design of the environment be more customisable.’

Teachers recognised the work involved in creating and delivering effective content, but asserted that in some cases the system made it ‘problematic.’ ‘Copyright issues’ around posting academic content also raised challenges for teachers. ‘We’ve got to be very careful about putting up chapters’. Acknowledging the need for access to this content, one admitted ‘you’ve got people who are away from libraries…who may be out in the middle of nowhere’ where unfortunately, ‘there are no libraries’. While these users ‘rely on…online journals’, help is limited because ‘our copyright rules get in our way…and really slow things down.’ Teachers said that while ‘having some of the chapters online would be good…we can’t do it.’

### EOT:

**Online video platform**

**Example:** YouTube

**Description** YouTube is designed to enable users to upload and share videos that can be viewed by anyone [25]. It utilises repositories to enable users to manage their profiles, share content and collaborate [26]. YouTube is being used extensively to showcase video clips that support learning. ‘One of the trends’ is to ‘put [the media clips] on YouTube…instead of using local storage or LMS’ [14].

**Experiences** Themes from teachers’ experiences about the use of YouTube to interact with content showed they valued it as a means to view, edit and upload teaching materials that showcased hands-on tasks, and delivered practical learning experiences. They valued the level of ‘currency’ that YouTube content added to their teaching. The difficulty with ‘textbook examples’ was that ‘even if you’re using a 2014 textbook,’ the examples within these chapters ‘[were] 2013, 2012.’ Explaining the advantage of using online videos, one teacher stated that ‘you [could] use really current examples’ to support learning activity. One teacher used YouTube as a repository for teaching content, and had a ‘YouTube channel that [she] put videos on’ and also a ‘class YouTube channel’ which contained ‘links to useful websites and games’ to support student activity. Teachers also valued YouTube’s ability to handle large files. ‘What’s awesome about this [capability], is that…it splits your files up, [and] while it’s
uploading, you [could] put all the [supporting video] info up.’ Similarly, another teacher valued being able to store files on YouTube ‘instead of using local storage or LMS storage’.

Despite the advantages of using YouTube to interact with content, some teachers experienced a lack of ‘control over what you’re linking to in the long term.’ Explaining this problem, one teacher indicated that ‘a YouTube video’ planned for use during class ‘might [later] not be there, or might be replaced with something inappropriate.’ File owners occasionally removed their files from YouTube, creating issues for teachers who interacted with this content on an ongoing basis. ‘More often than not,’ she explained, ‘the videos I’d linked to had been made private,’ preventing access to learning material.’ Other video clips ‘had been…taken down for copyright treasons’, which increased the workloads of teachers who had to ‘run around trying to update links.’ ‘Trying to keep those links up to date’ was difficult, but teachers knew it was important to ‘make sure there had been no exchange to inappropriate materials.’ Referring to one example, a teacher explained how she ‘had a link to a commercial site, which used a game [that taught] people how to reference correctly.’ She had ‘checked it again before the lecture’, only to find that ‘it now linked to a spam site’. This had happened because ‘the URL had been let go’, and now the site contained ‘flashing gaudy advertising’. Reflecting on the possible outcome, she admitted that ‘this [interaction] could have [had an adverse effect in class] and made [her] look crappy’.

Other challenges with YouTube involved creating content intended for upload. ‘Technical issues with the screen capture’ gave one teacher difficulty, and she had ‘to fiddle around…to get it to work.’ Frustrated, she explained that while ‘sometimes it would work’, she didn’t know ‘how to make it work reliably’. The potential for these issues occurring created anxiety. ‘You [did not] want to give a half-hour lecture’ she stated, ‘and then find out you didn’t record the sound, [and realize that the students would] … see… the slides [without] sound, it [would] not [be] very good.’ Admitting however, that expecting free software to work consistently without failure was unreasonable, she admitted ‘I’m expecting a lot.’ Training was recommended as a solution. ‘Someone [should] give you a workshop and show you how to do this,’ because ‘there [were] so many tools, it’s very complicated…[and it’s] almost bewildering how many…you can actually use.’ Others felt that while ‘there [was] support there…there could be more.’ Some said that ‘effort’ was required ‘to get over the hard part’. One teacher praised the efforts of her institute’s education development centre, which provided one-of-one EOT help to teachers. For others, ‘it’s better if someone can give you a workshop and show you how to do this.’ ‘Workshops or seminars for academics to come along’ was recommended as a way to help teacher’s improve their YouTube skills.

One teacher was reluctant to engage with YouTube content unless the files were ‘recorded to the quality of the lectures…on TV or on TED talks’, which filmed using ‘multiple perspectives’, and were more likely to increase ‘engagement’ levels. Otherwise, he asserted, ‘you get people standing up’ and walking out, ‘and it just doesn’t work’. Searching for a solution, he continued ‘if I was going to record my lectures’ for uploading to YouTube, ‘I’d want multiple angles, and the same treatment as TED talks.’ Comments like these about YouTube emphasised how the perceived level of content quality influenced teachers buy-in to its use. Content was often developed using other EOTs, and then ‘uploaded to Youtube. For example, one teacher explained ‘sometimes [we] use Jing, but most of us will use Camtasia or Adobe Connect, do it locally’, and copy it to YouTube. In doing ‘content preparation’, teachers found they could ‘merge from one [EOT] to another’.

Other teachers’ experiences involved the use of Moodle, Mindomo, PeerWise, Word Cloud, Echo360, Prezi, Jing, Camtasia, Google Drive, WikiEducator, Vimeo, Blogger.

Teachers experiences using EOTs to interact with content were varied and informative. Their descriptions indicated that effective EOT use
contributed to enriched teacher-to-content interactions, whereas ineffective use created challenges that negatively impacted on their activity. Teachers’ descriptions of EOT challenges revealed the reality of their experiences, and the extent to which these obstacles limited their engagement with content. Some expressed frustration, disappointment, and annoyance when faced with technical or usability issues. Despite negative experiences, general recognition of the role EOTs played in enabling engagement was evident. Teachers indicated that improvements to EOT usability, technical support, and design would reduce certain challenges, and enhance their interactions with content. Their recommendations for solutions to challenges signaled that they wanted change and relevant support, to ensure their commitment to EOT use. Teachers valued EOTs that afforded the efficient editing, linking, marking, uploading and demonstration of content.

4 RECOMMENDATIONS

A summary of recommendations for addressing some of the EOT challenges described in teachers’ experiences is outlined below:

- TEIs investigate the potential for extending, enabling and improving LMS features to accommodate teachers’ online course delivery and assessment needs
- Managers urge and facilitate teachers’ ongoing needs-based training for LMS use, to ensure they have relevant skills to undertake effective online course construction and delivery
- Teachers consider bandwidth limitations, and ensure that online file sizes do not impede access to learning, but can be downloaded efficiently
- Teachers ensure teaching content from external sources is current and appropriate for course delivery
- Teachers investigate the potential and feasibility for developing higher quality video lecture recordings, e.g. capture in-class activity from multiple angles
- Teachers ensure that sound and audio equipment works effectively to support in-class learning experiences

5 CONCLUSION

This research made a phenomenological interpretation of key stakeholders’ EOT experiences to strengthen understandings about their EOT needs and challenges and provide a basis from which to recommend methods for effective EOT support. It analysed the EOT experiences of ten students and ten teachers from TEIs in New Zealand and Australia and interpreted the meanings of the phenomena through an abstraction of themes. This paper was the sixth in a series of six publications that presented the local themes of this research. It documented the interpretations of teachers’ EOT experiences with content, in reference to their use of two different types of EOTs: Learning management systems (LMS)(Blackboard), and online video platforms (YouTube). These interpretations, which delivered insights into the reality of teachers’ EOT challenges and needs, helped to inform a set of recommendations for effective EOT use, to assist TEIs in their efforts to address EOT challenges and needs through relevant, meaningful EOT support.

The small sample size normally used in phenomenological studies makes it challenging to generalise results across large groups [44]. However, the descriptions of first-hand experiences provides a rich and authentic means from which to extract in-depth levels of knowledge about the phenomena. Although an interpretive phenomenological approach supported the researcher’s “interest in the meaning of a phenomenon as it [was] lived by other subjects”, it also permitted their personal preconceptions to affect the analysis of data [27].

The interpretations in this research could be used to support understandings about other similar EOTs. For example, the themes drawn from students’ experiences with Blackboard could in some cases be applied to Moodle. This research
has the potential to be replicated and applied to other TEI stakeholders, such as administrators or educational support staff, to strengthen understandings of their EOT challenges and needs.

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A Comparative Analysis of the Performance of Three Machine Learning Algorithms for Tweets on Nigerian dataset

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ABSTRACT

The popularity of Twitter as a social media platform is increasingly becoming very important, this has no doubt impact positively on the business, social and political aspect of our lives, and hence, the need for researchers to focus on Twitter opinion mining became crucial. Despite the increase in the number of Twitter users in Nigeria generating a huge amount of data from the discussions on national issues became a challenge; limited research has been carried out on Twitter data sources from Nigerian context. The objective of this paper is to use Twitter data from Nigeria to carry out a comparative analysis of the performance criteria based on accuracy, precision and recall on three classification algorithms. The purpose of which is to find out the best algorithm that fits the dataset. Dataset used was gathered using Twitter Application Programming Interface (API) given a trending hash tag on national issues. This dataset was preprocessed before modeling. Twitter opinion mining classification algorithms: Naïve Bayse, Support Vector Machine (SVM) and Maximum Entropy were chosen, modeled and evaluated. Findings from this research show that dataset from Nigeria can be used to mine the opinions of citizens on national issues; it also shows that SVM was disappointing using the dataset, while Naïve Bayse classifier outperform others with accuracy of 83%; this is implying that the best among the three models can classify tweets wrongly with the rate of 17%. The best model (Naïve Bayse) was implemented as Software; the Software downloads and automatically classifies tweets into three opinions namely positive, negative and neutral.

KEYWORDS

Social Media, Twitter, Data Mining, Classification Algorithms

1 INTRODUCTION

Since the advent of the World Wide Web (WWW) by Tim Berners-Lee (1993), documents of all sorts of formats, content and description have been collected and inter-connected with hyperlinks making it the biggest repository of data ever built [28]. Despite the dynamic, unstructured nature, redundancy and discrepancy of WWW, it is the most important data collection regularly used for reference because of the broad variety of topics covered and the continuous contributions of resources and publishers [28]. Increase in utilization of social media such as a Facebook, Twitter, etc, leads to the generation of massive amount of data at high rate, especially now that organizations innovatively device means to attract customers using these social media platform [10]. This data mostly contain vital information which can be used nationally and internationally for business purposes and decision making. For social media users, social interaction has turn out to be an indispensable part of their lives [26]. Therefore, it is easier to get their opinion from their social interaction on social media. Among the trending social media, Twitter has attracted several types of research in significant areas like predicting electoral events, the stock market, consumer brand etc [1]. Twitter was just created and introduced in 2006 but it has gain popularity in that it has more than 500 million users who send more than 400 million tweets daily [15]. This popularity and fast spread of tweets make Twitter data worthy of research for information exploration. Also because it is easy to obtain Twitter dataset using Twitter API, Twitter turns out to be a suitable data source for research.
Several types of research have been carried out using Twitter datasets for citizens’ opinion mining and the research has provided an insight into the citizens’ opinion. Volume and magnitudes of re-tweets as well as the sentiments in the tweets correlated with the public opinion polls, results in a South Korean election [11]. In another study [1] use Twitter data for electoral prediction and come up with 88% prediction accuracy in the 2012 US presidential election. Messages of Twitter users can be used to predict their voting behavior [14]. Confronted with huge collections of data, we have now created new needs to help us make better managerial choices. The needs as opined by [28] “were an automatic summarization of data, extraction of the “essence” of information stored, and the discovery of patterns in raw data”.

Opinion mining and sentiment analysis are the trending research using Twitter datasets. Opinion mining is taking over the traditional and web-based surveys carried out by companies in order to find public opinion about their products and services, it also assists people and organizations interested in knowing what other people say about their products, service topic, issue and event to find a perfect choice for which they are looking for [2]. Several data mining algorithms for both supervised and unsupervised learning have been used in classifying Twitter datasets such as Support Vector Machine (SVM), Naïve Bayes classifier, k-nearness, Maximum Entropy etc. [5] [7] [9].

This paper presents the result of a comparison of three supervised learning classification algorithms namely Naïve Bayes classifier, Support Vector Machine (SVM) and Maximum Entropy for classification of tweets of citizens related to the trending topic in Nigerian government administration.

Twitter
Twitter is an online social networking service where users post and read messages. The messages referred to as tweets are short messages of a maximum length of 140 characters, the character limit applies to plain text and emoticons and excludes quotes, polls, videos, and images, giving users additional room for discussion. A message once tweeted can be re-tweeted by followers of the user of the original messages and a retweet can be re-tweeted by followers of the person that retweet the tweet and this continue subsequently. Thus, a tweet can reach a large number of individuals within a short period of time thereby getting the opinion of a large number of users all over the world.

**Twitter Search API**

The Twitter Search API is part of Twitter’s REST API. It allows programmers to have access to a sample of recent tweets published in the past 7 days by querying against the indices of recent or popular Tweets. It requires a programmer to supply authentication before accessing the search API.

**2 RELATED WORKS**

Several research works have been carried out on tweets data mining from sentiments analysis to political prediction [11]. Research by [16] shows how to collect Twitter corpus for sentiment analysis and opinion mining automatically; also Twitter can be used as a source to identify and predict changes in social issues as shown by [13].

User classification on Twitter was addressed by [17] through inferring user attributes such as political orientation or ethnicity by using noticeable information such as the user behavior, network structure and the linguistic content of the user’s feed. A framework for detecting and tracking political abuse was described by [19]. Wegrzyn-wolska, [26] has conducted a content analysis of social network by analyzing the intensity and polarity of opinion and developed a system that collects, evaluate and rate tweets automatically for trend evaluation using Twitter dataset related to French presidential election. De Groot,[5] implemented a sentiment analysis tool that classifies tweets related to popular mobile phones and their brands. Using tweets analysis, [24] build model that automatically detect target stake holders based on firm communication and reaction of readers on news headlines through Twitter. O’Banion and Birnbaum, [14] described an approach through the use of predictive modeling using SVM to mine preference data from messages of Twitter users, which are then used on other individuals.
whose preferences are not known. An approach based on the combination of two sentiment analysis classifiers on one classification task was presented by [6] and the approach improves the accuracy of the independent classifiers. Comparison of twitter classification algorithms has been treated in literature for instance [27][25][1][6][8]. Naïve Bayes, Maximum Entropy, and Support Vector Machine were described in the literature by previous studies [9][16][8][23][1]. The popularity of twitter resulted in many researches for national decision opinion mining purposes using Twitter dataset [5][13][14][22][18]. Despite the reasonable performance achieved by some of this research, limited studies have been done on Twitter data sources from Nigeria; since the approaches were tested using data sources from other countries, they might not work for Nigerian dataset because dataset usually differs in terms of location, the data available and the population through which the data was obtained. This research is aimed to use Twitter dataset from Nigeria to build, evaluate and compare the performance of opinion mining models using three classification algorithms and use the most appropriate algorithm to develop software for determining citizens’ opinion on national issues.

3 METHODOLOGY

Every data mining task usually follows a particular data mining process model, irrespective of the chosen model, the activities of data acquisition, preprocessing, modeling, evaluation and deployment have to be executed. In this study, CRSP-DM model is used and the activities involved are described subsequently in this section.

3.1 Data collection

Twitter Search API was used to acquire data related to trending national decisions in Nigeria from February to November, 2016; the data was gathered using a popular hashtag such as #2016budget, #fuelsubsidy and #budgetpadding. The Sample of the collected tweets is shown in figure 1.

Figure 1 Sample of collected tweets

3.2 Data Preprocessing

A sample of tweets consisting of positive, negative and neutral sentiments was selected for modeling; the selected tweets were manually labeled based on the tweets’ sentiments. 60 percent of the manually labeled sample was used for training and 40 percent for testing the model. The raw Twitter data are noisy; using the library regular expressions in python programming language the tweets were cleaned as follows:

1. Word lengthening: people repeat some characters in words e.g. Gooooood, sorrrrrrrry e.t.c; the repeated characters were removed leaving only two repetitions as in Good and Sorry respectively.
2. URL and Username removal: Urls e.g https://t.co/TpUgaTCJUG and usernames e.g @daily_trust were also removed.
3. Stop words filtering: Stop words are common and high-frequency words like “an”, “at”, “the”, “of”, “and”, e.t.c. removal of stop words improves the performance of feature extraction algorithm by reducing the dimensionality of the data sets thereby making keywords left in the datasets to be identified more easily by feature extraction techniques. Stop words to be removed are taken from the available list of stop words; stop words are iterated in chosen word list and removed from text. This technique is implemented in this research using python as it is supported by NLTK.

After cleaning the dataset, features were constructed using T is tweet and W is feature (“W of T” or ‘T has W’) which result in high accuracy [2] together with the use of Uni-gram dataset as it gives more accuracy and require less
training time than bigram datasets (Ismail et al., 2016).

### 3.3 Modeling

In the field of classification in opinion mining, machine learning algorithms are generally used [1]. We used three popular classification algorithms to model the constructed dataset.

#### i. Naïve Bayes Algorithms

The classifier was chosen according to findings from [16], Naïve Bayes classifier resulted to better performance. Naïve Bayes classification is based on Bayes theorem

$$P(c|x) = \frac{P(c) \cdot P(x|c)}{P(x)}$$

Where

- $P(c|x)$ is the posterior probability of class (target) given predictor (attribute)
- $P(c)$ is the posterior probability of class
- $P(x|c)$ is the likelihood which is the probability of predictor given class
- $P(x)$ is the prior probability of predictor

To find the probability of tweet’s class given the tweet, we adopt equation 2 as used in [21].

$$P(C/t) = P(C) \prod_{i=1}^{n} P(f_i | C)$$

Where C represents the class negative, positive and neutral; t represents tweet; f represents the feature.

The classifier was built using NLTK implementation of Naïve Bayes algorithm using the training set as an argument.

#### ii. Support Vector Machine

The Support Vector Machine (SVM) classifier was chosen according to findings from [1] that Support Vector Machine (SVM) classifier perform better than Naive Bayes, Maximum Entropy and Artificial Neural Networks based supervised classifiers.

Given the optimal hyperplane function

$$h(x) = wT x + b,$$

for any new point $z$, SVM classifier predict its class as

$$\hat{y} = \text{sign}(h(z)) = \text{sign}(wT z + b)$$

where the $\text{sign}(\cdot)$ function returns +1 if its argument is positive, and –1 if its argument is negative[12].

SVMs are inherently two-class classifiers; a multi-class problem is done by constructing of multiclass SVMs, where a two-class classifier is built over a feature vector $\Phi(\vec{x}, y)$ derived from the pair consisting of the input features and the class of the datum.

At test time, the classifier chooses the class

$$y = \arg\max_y \hat{w}^T \Phi(\vec{x}, y')$$

The margin during training is the gap between this value for the correct class and for the nearest other class, and so the quadratic program formulation will require that

$$\forall i \forall y \neq y_i \hat{w}^T \Phi(\vec{x}_i, y) - \hat{w}^T \Phi(\vec{x}_i, y') \geq 1 - \xi;$$

The classifier was built using NLTK implementation of Support Vector Machine using the training set as an argument.

#### iii. Maximum Entropy

The Maximum Entropy classifier uses a model that is very similar to the model employed by the naive Bayes classifier. But rather than using probabilities to set the model’s parameters, it uses search techniques to find a set of parameters that will maximize the performance of the classifier. In particular, it looks for the set of parameters that maximizes the total likelihood of the training corpus, which is defined as:

$$P(\text{features}) = \frac{\Sigma_{x \mid \text{in} \text{corpus}} P(\text{label}(x) \mid \text{features}(x))}{\Sigma_{\text{label}} P(\text{label}, \text{features})}$$

Where $P(\text{label} | \text{features})$, the probability that an input whose features will have a class label, is defined as:

$$P(\text{label} | \text{features}) = \frac{P(\text{label}, \text{features})}{\Sigma_{\text{label}} P(\text{label}, \text{features})}$$

The classifier was built using NLTK implementation of Maximum Entropy, using the training set as an argument.
### 3.4 Evaluation

Confusion matrix was chosen as the tool for model assessment. The test architecture is shown in Figure 2 and the test result is described later in the discussion section.

![Test Architecture](image1)

Figure 2 Test architecture

After the modeling stage, the model was assessed to ensure it meets the right criteria, that is, the model was evaluated to ensure it can classify unseen tweets with a reasonable accuracy. Confusion matrix was chosen as a tool to evaluate the model. Confusion matrix evaluates the performance of a classification model based on the number of correctly and incorrectly predicted items by the model. The numbers are tabulated in a Table called the confusion matrix. Table 3.3 shows the confusion matrix for binary classification model. Where a and b are the two classes, $X_{ij}$ gives the number of items in class i that are predicted to be in class j.

Table 1 Two Class Confusion Matrix

<table>
<thead>
<tr>
<th>Actual class</th>
<th>Predicted class</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td>A</td>
<td>$X_{aa}$</td>
</tr>
<tr>
<td>B</td>
<td>$X_{ba}$</td>
</tr>
</tbody>
</table>

### 3.5 Proposed System

After modeling and evaluation, the model that gave the overall performance was implemented as software, which has the capability to download tweets given a hashtag (category related to national issues in Nigeria) and automatically classify and give statistics of the classified tweets using the build model. Figure 3 depicts the overall system architecture.

![System Architecture](image2)

Figure 3 System architecture

### 4 RESULTS AND DISCUSSION

Three classification algorithms were trained and tested on the same dataset; the measures used for the algorithm performance evaluation were accuracy, precision and recall. Table 2 illustrates the results based on accuracy, precision and recall for the three classifiers (Naïve Bayes, SVC and Maximum Entropy). The result of this experiment showed that Naïve Bayes was more accurate while support vector machine was more reliable. However, 46% difference in accuracy is worth the cost of 1% reliability since we are not considering a critical system. This experiment result shows that Naïve Bayes outperform SVC in terms of accuracy and recall. The result concur with prior research supporting findings by[8] and differed with findings by findings as in [1][5], this opposing results could be attributed as a result of the use of different datasets in training the model which is implying that
different source of data might sometimes require different modeling process.

Naïve Bayse being the best classifier using our dataset was implemented as an application that downloads tweets given hashtag and automatically classifies the tweets into one of the three opinions. Figure 4 illustrates the interface of the software.

![Figure 4. Main interface of the application](image)

**Table 2. Performances of Naïve Bayse, SVC and Maximum Entropy classifiers**

<table>
<thead>
<tr>
<th>Classifier</th>
<th>Accuracy (%)</th>
<th>Precision (%)</th>
<th>Recall (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Naïve Bayse</td>
<td>83</td>
<td>99</td>
<td>83</td>
</tr>
<tr>
<td>SVC</td>
<td>37</td>
<td>100</td>
<td>42</td>
</tr>
<tr>
<td>Maximum Entropy</td>
<td>82</td>
<td>99</td>
<td>86</td>
</tr>
</tbody>
</table>

5 CONCLUSIONS

In this research, Twitter data from Nigeria have been utilized for the purpose of classifying users’ opinion from their tweets. Twitter datasets contain relevant information about user’s opinion that can be used to obtain citizens’ opinion regarding national issues. Twitter dataset from Nigeria was collected over the period of February to November, 2016 using Twitter search API. The dataset was subjected to preprocessing steps such as data selection, data cleaning, and construction before being used for modeling. After testing the three classifiers (Naïve Bayse, SVC and Maximum Entropy), the result of the experiment shows that Naïve Bayse outperformed with accuracy of 83%, 99% precision and 83% recall using our datasets. This implies that the best among the three models can classify tweets wrongly with the rate of 17%. However, this does not imply that Naïve Bayse would always be the best algorithm as some algorithms appear to be promising using different datasets; this is because dataset differs in terms of location, and the population the data was collected.

5.1 Limitations

This study has sampling limitation because some Nigerian citizens do not have access to Internet, and some have access to Internet but may not use Twitter. Also, the dataset used was localized to trending topics being discussed in Nigeria only.

5.2 Future Research

In this research, we have compared the performance of three classification algorithms-Naïve Bayse, Support vector machine and Maximum entropy- using dataset of tweets from Nigeria with Naïve Bayse outperforming the other two. However, this research can be improved in future by:

i. Using more training and testing datasets.

ii. Using other classification algorithms such as decision tree, K* etc on the same data sources.

iii. Mixing the Nigerian dataset with foreign dataset in order to generalized the outcome.

iv. Using k-fold cross validation approach for evaluating the models.

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Chinese And Moroccan Higher Education MOOCs: Rationale, Implementation and Challenges

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Abstract—Integrating technology in teaching helps students to understand all the concepts they are taught in class. Technology makes teaching a walk in the park, a paperless class is environmental friendly, teachers are able to track their students’ progress, students can access eBooks and other learning information at anytime of the day, anywhere and distance learning has been made possible. The rapid increase use of information technologies and E-learning throughout educational institutions is changing the way teachers and students learn, work, and establish collaboration. Recent declarations from top Universities to turn to new forms of educational delivery called MOOCs (Massive Open Online Courses) The MOOC movement have recently invaded the field of higher education in the world to the point that some describe it as the undisputed future of the university. Authors claim that online learning and hybrid devices are becoming more responsive to learners’ needs at a time where constrained educational budgets and accompanying decrease in professional development opportunities makes it hard for the universities to keep up with the expectations and demands of the 21st century learners. In line with this, this paper sets out first to present the MOOC framework, placing it in the wider context of open, online learning. Then, it discusses how the key elements of openness, anytime and anywhere learning of this new educational trend can meet learners’ needs for flexibility, collaboration and agency. This paper also argues for the need to adopt a blended learning approach that combines both online and face-to-face experiences to optimize learning in Moroccan higher education. Finally, some challenges are discussed.

Keywords—blended learning; learner’s needs; massive open online course (MOOC); multi-access learning; open education.

I. INTRODUCTION

The education sector is growing in the world with respect to quality of education and the technology used for delivering the required information to the students. The paper reflects on the use of technology in education systems of two Asian countries i.e. Morocco and China based on the statistics gathered from different sources. The statistics issued by UNICEF reflect that adult literacy rate in China is 93.7% as compared to 56.4% in Morocco which reflects that the Chinese are paying more attention in making their population as asset through education. China being the leading nations in Asia has focused on use of technology in their class rooms even for distant learning in the far flung areas of the country. Dale F. Eickelman in his book Knowledge and Power in Morocco, contended “The Education of a Twentieth-Century Notable that Morocco had to struggle with evolution of its education system mainly due to Islamic notables hindering the ways for modern education specifically based on modern technology”. Integrating technology in teaching helps students to understand all the concepts they are taught in class. Technology makes teaching a walk in the park, a paperless class is environmental friendly, teachers are able to track their students’ progress, students can access eBooks and other learning information at any time of the day, anywhere and distance learning has been made possible.

China has a large number of students, many of whom study online. Digital education has made it possible for many people get access to education. China recently opened up its education system.

II. BREAKING DOWN THE ACRONYM

Integrating technology in teaching helps students to understand all the concepts they are taught in class. Technology makes teaching a walk in the park, a paperless class is environmental friendly, teachers are able to track their students’ progress, students can access eBooks and other learning information at any time of the day, anywhere and distance learning has been made possible. MOOC is an acronym; it stands for massive, open, online, course. The course is massive because it involves a large numbers of participants, including both instructors and learners who cannot be physically present same time same place around a specific topic of learning. The course is open because the material put by the facilitators, the work done by the participants are accessible to or shared between all the people taking it. It is also open in the sense that it is free. Participants might pay to get a credit through an institution,
but they do not pay for participating in the course. The course is also distributed online because all the blog posts, articles, tweets and tags are shared online by the participants taking it. MOOCs are planned courses in the sense that they have a start and ending sessions. They have also facilitators, course materials, and participants. (Masters, 2011)

III. JUSTIFYING A MOOC APPROACH TO HIGHER EDUCATION IN CHINA AND MOROCCO

According to a research conducted by the British council, and by Jeremy Chan (2013), China has the biggest market for academic and education items in the world. While considering education as a commodity, the largest education market is the country of China. To be specific, it has been estimated that the number of students in Chinese educational facilities is about 400 million, if not more. Further, it is claimed that about 7.5 percent of the figure, that is, 30 million students are in the higher education sector. The students grouped together are estimated to be equivalent to the population of 3 countries including U.S, Australia and UK.

As a matter of fact, many areas of society have undergone rapid change enabled by technology; however, education has been by comparison in a dormant state. This is because most universities in Morocco continue to offer the majority of their courses face-to-face. Consequently, easy access is most of the time limited to only those learners who live within the areas surrounding the institutions. The increase in university enrollments, the regrettable rates of dropping out, the demands of the twenty-first century learners, and technological development make a radical shift to new approaches in higher education in Morocco necessary. Therefore, dialogue has started recently on the future of the Moroccan university, the importance of catching up with the technological advancement, and responding to the different demands of the new generation of Students. In fact, the literature emphasizes that research on how people learn has adopted new perspectives as a result of the advent of new technologies that affect the teaching/learning process. According to Calkins and Vogt (2013) “Next generation learning” research is informed by:

- A deepened understanding of learning: how, where, and why students (and people of all age) learn most effectively.
- A deepened understanding of learners: what’s required to engage and meet students’ complex, individual needs.
- The recognition that the world has changed: so thoroughly, in fact, that it requires a much higher level of achievement for much higher percentages of students.

In this respect, the massive open online course (MOOC) trend has lately emerged in higher education in the world, and the advocates claim the anytime/anywhere mantra and the principle of multi-access learning that underlie the MOOC movement can attend to learners’ needs for personalization, flexibility, and agency. Code (2010) explains that learners’ agency is reflected in their choice and abilities to interact with personal, behavioral, environmental, and social factors that make up their learning context. So, learner agency can be carried out through three different ways: personal, proxy, and collective. Personal agency refers the learners’ ability to initiate action. Proxy agency is a socially mediated form of agency through which individuals decide to have others act at their own will in order to attain the results they desire. Collective agency makes it possible for people to use interactive and dynamic means to work together towards common objectives (Bandura, 2001). To demonstrate, MOOCs make it possible for learners who cannot attend classes regularly to have access to live-video or video-recorded lectures and assignments whenever and wherever they can. Hence, this mode of learning fosters learners’ ability to control their own pace of learning. Also, one of the prominent aspects of the MOOC framework is how learners can learn from each other within an online course community.

Cadi Ayyad University of Marrakech is the pioneer and leader in the educational innovation called MOOC in both Morocco and Africa. Since 2013 the university has started filming courses and putting them online available to students via the university's servers. In an interview with the Maghreb Arab Press Mr. Miraoui, the president of the university, stated that 65,000 students were enrolled in 2014, 18 000 more than the year before, for only 1400 teachers. This is why the university launched its own MOOC to facilitate access to education for learners who work in crowded classes, and optimize faculty resources. The camera of Réussite, a program produced by the group Jeune Afrique, Canal+ and Galaxie Press, reported the experience of a Professor of Physics who can now, thanks to the MOOC technology, give a tutorial session to five hundred students at a time. In a traditional university this tutorial cannot be given but in small groups of maximum 25 students because of the size of the laboratory. The MOOC can solve the problems of making such kind of tutorials, mainly: not enough laboratories, not enough equipment, and not enough time.

IV. A BLENDED LEARNING APPROACH TO INTEGRATING MOOCs IN MOROCCO

The recent years has seen Morocco invest more on green technologies. This influence can be linked to the Chinese influence in the continent. Notably, the bilateral relation between China and Morocco has seen the country benefit more in terms of technology of education. This is mainly because it is unlikely that the Moroccan universities can abandon face to face lectures as the main delivery mode. However, since the learning styles and requirements of learners differ, it’s mandatory for these institutions to use a blend of learning approaches to be responsive to these differences. Adapting the MOOC principle to the Moroccan university context, a university may use some version of a
course management system application to connect all students within a specific department. Through this platform, students can access videos of lectures not just but their group teacher but also teachers of the same subject in the department, track assignments and progress, interact with professors and peers, and review other supporting materials, like PowerPoint presentations or scholarly articles. At a larger scope, teachers of the same major across universities of the country can collaborate to structure online courses and allow students to benefit from the lectures of not just their own teachers but other teachers in other universities, attending hence to different learning styles. These include face-to-face traditional instructor-led lectures, synchronous online, and asynchronous online modes.

A. Synchronous Online

According to Irvine et.al (2013), in a synchronous online framework, learners on campus are together in a multi-access enabled classroom and have the instructor present in the classroom with them. Learners who cannot attend participate by joining in via Internet webcam and content can be exchanged between participants using desktop sharing.

B. Asynchronous Online

McKinney et.al (2009) argues that having an asynchronous access to archived synchronous learning events may be a suitable option for those who are unable to attend synchronously. Students can listen to or view archive recordings of lectures (podcasts). To move the asynchronous group beyond merely watching archived class videos, student collaboration can be enhanced through discussion boards, separate personalized synchronous student-led or teaching assistant-led sessions for a pod within a different time zone.

V. THE RISE OF E-LEARNING IN CHINA

Technology has become a very critical facet of the modern society and its footprints have been felt in the education sector the most. In the contemporary Moroccan and Chinese societies, technology has been embedded in to learning with the sheer objective of improving results and learning experience. A precise comparison of how technology has been integrated in to the education systems of the two countries indicates that China has recorded more success but both countries have reported advantages as well as disadvantages of technologically hinged learning. Market of E-learning in China can be separated in three sectors: The first sector: online degree education, The second sector: enterprise E-learning, language training and the last one is professional training for certificates.

From 2004 to 2012, online degree education has been quadrupled. In 2012, the overall market revenue reached 64.6 billion RMB ($10.4 billion approximately) and there were 1095 thousand new registers professional E-training courses and 1270 thousand new students for university E-learning courses. Online professional trainings and language trainings also take a stable rate of increase.

In China, for online higher education, students should take exams to get the degree certificate and many universities including Beijing University and TsingHua University give this kind of courses to educate Chinese people.

VI. LEARNERS’ MOTIVATION AND INVOLVEMENT

In the context of distance learning research, how to motivate student to use MOOCs for learning is one of the most frequently studied variables. It results from the interplay of goals, emotions, and the person’s sense of personal agency. Motivated students for learning, spent more time and effort to achieve higher levels of performance than those who were not confident and motivated. Pintrich and De Groot affirm that student with high learning motivation tended to engage in more meta-cognitive strategies and were likely to persist at a task than student with low learning motivation. Current research also suggests that learning involvement is another variable that influences students’ learning and satisfaction within traditional and/or online learning environments. Learning involvement is defined as the degree to which learners interact with other learning component (i.e., learning content, learning activities, peer learners, tutors, and instructors) and are engaged in the learning process. Our research team is interested to the periodic learners because the fixation of learning periods has a major role in learning by encouraging their personal touch. They become more involved and provide the best of themselves; this also helps to empower them. The purpose of this paper is to propose a process of collection and transformation of traces and calculation of activities’ indicators. In order to measure learners’ motivation and involvement in distance learning, we will address the collection of traces of learners’ activities in Moodle platform.

VII. CHALLENGES and Future Prospects

With China being the largest higher education market in the world (25 million students at undergraduate level) and at the same time having the largest internet population worldwide
MOOCs has huge potential in China. To implement a MOOC framework in Morocco or in China and create a meaningful learning environment a variety of issues need to be addressed; these are mainly institutional, pedagogical and technological factors (Singh, 2003).

The institutional factors are mainly related to the preparedness of the organization, the availability of content and infrastructure, and the implementation of a needs analysis to understand learners' needs.

MOOCs are free of charge courses for massive number of learners on the web; it must be considered that course design and the way of presenting course materials, and interactivity through social networks and study groups [13].

The Pedagogical or Andragogical dimension is concerned with the combination of content (content analysis), the learner needs (audience analysis), and learning objectives (goal analysis). The pedagogical or andragogical dimension also addresses the choice of the most appropriate delivery method. It is also concerned with whether both the teachers and students have the knowledge required to use new technologies and, possibly, more sophisticated instructional practices.

The technology issues need include creating a learning environment and the tools to deliver the learning program. They include also the choice of the most effective learning management system, that would manage multiple delivery types and a learning content management system that catalogs the actual content (online content modules) for the learning program.

VIII. CONCLUSION

The use of technology in the Republic of China's education system is highly advanced as compared to the Morocco's system of education. Technological advancement in the education in China has seen many graduates and high school students in China perform well in the world market where digital technology is highly valued. It is estimated that the education market in China has attracted over 450 million students and thus the use of technology in teaching has improved efficiency and accountability. It is however important to note that Morocco is also embracing technology in education and it is an issue that is very essential for the ultimate improvement of the education sector.

Moroccan higher institutions need to adopt reform strategies that are mainly informed by students' needs. These institutions need also to provide via multi-access learning delivery modes. In this respect, the multi-access Learning framework that underlies MOOCs supports student choice and agency. When talking about MOOCs as an educational technology, the primary focus should not be the technology itself, but rather the pedagogy. That is to say, we should first specify the learning experiences we want to create, the learning outcomes we want to achieve and then enable them with technology.

REFERENCES

Stabilization of Particle Filter Based Vertebrae Tracking in Lumbar Spinal Videofluoroscopy

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ABSTRACT

Tracking of spinal vertebrae in videofluoroscopy video is useful for diagnosis of certain spine pathologies, such as vertebral fractures, spondylolisthesis and low back pain. The aim of this work is to improve a semi-automatic method for vertebrae tracking based on particle filter. The process starts with vertebrae model construction by splining hand-selected landmark points, then the particle filter tracks the vertebrae in each frame. While the process successfully tracks the vertebrae, the trajectories are quite jittery. This paper aims to improve the overall tracking by smoothing the tracking trajectory using curve fitting function. The tracking results are more natural with very little noise.

Keywords:
Objects tracking, Particle filter, Lumbar vertebrae, Videofluoroscopy, Smoothing.

1. INTRODUCTION

The low back supports the weight of the upper body and provides mobility for everyday motions such as bending and twisting. Muscles in the low back are responsible for flexing and rotating the hips while walking, as well as supporting the spinal column, all those movements could affect intervertebral joint. Hence, the Low Back Pain (LBP) is classified as one of the most common health problems. Researchers in [1] have found that nearly 10% of the world's population (including children) suffers from low back pain and one third of work-related disabilities are due to low back pain. (That is why several studies still deal with this area). In [2] authors demonstrate that irregular motions in one intervertebral joint can affect adjacent joint motion. In [3] a strong relation between the abnormal kinematic behaviour of the lumbar spine and low back pain was proved by using an electromagnetic tracking system. Motion irregularities in the lower lumbar spine can produce compensatory effects in the upper lumbar spine [4].

1.1. Medical Imaging

Medical image visualisation- is a helpful tool in disease diagnosis and in monitoring, as well as in surgical and therapeutic guidance [5].

Many techniques have developed to measure the vertebra motion [6] [7] [8] based on vertebrae segmentation [9] [10]. X-rays, the most used imaging technique, provides detailed information about the geometry, aberrant features, and positions of individual vertebrae, but only for select static postures. Videofluoroscopy however, provides similar information to X-rays in real time. It allows vertebral positions to be observed throughout their course of motion. Compared to X-rays, the videofluoroscopy provide less details about geometry and structural anomalies, and it contains noise which is quantum in nature and typically modelled as a Poisson-distribution [11] [12].

A classical examination with videofluoroscopy technique can produce a sequence of hundreds of images, which makes it a challenge to track the motions of vertebrae accurately. The segmentation and the tracking of objects movements is a complex and still an open problem; with many applications as such as video coding, robotics, video surveillance, and medical imaging.

The aim of this work is to improve the vertebrae tracking based on Particle Filter in lumbar spinal videofluoroscopy using a polynomial fit.

1.2. Objects Tracking

The tracking of real-world objects is a challenging problem due to noise, occlusion, and the presence of other moving objects. The main difficulty in video tracking is to associate the location of the targets in the successive frames, especially when the objects move fast relative to the frame rate [13]. The tracking systems normally use a model that describes how the target's image can change considering the possible movements of the tracked object. Many Algorithm have been implemented to
surmount these difficulties; they can be classified into two categories: deterministic methods and Probabilistic methods [14].

**Deterministic methods** are connecting each object in previous frame with single object in current frame using a group of motion characteristics. The characteristics of the objects commonly used are proximity (limited displacement hypothesis) and appearance (similarity of form and/or photometric content and/or motion). In object-based models, targets can be characterized by color or contour histograms, a contour map (open or closed contour of the object), or a combination of these models. In [15] information on the contours contained in the objects is used to track people. The distance measurement between tracked object and observations is a correlation measure calculated on the contours of the object.

**Probabilistic methods** Observations obtained by a detection algorithm are often corrupted by noise. In addition, the movement or appearance of an object may vary slightly between two consecutive frames. Probabilistic methods allow to manage these variations by adding uncertainty to the model of the object and the models of the observation. The tracking of a single target is then obtained by filtering methods such as Kalman filter or particle filter.

### 1.3. Related Works

In a previous work [16] authors present a technique to track the vertebrae using particle filters with image gradient based likelihood measurement, Balkovec et al. [17] developed an iterative template matching algorithm to obtain precise time-course details about individual vertebrae and intervertebral motions from videofluoroscopy images.

### 2. MATERIALS AND METHODS

Poor image contrast, image noise, image distortion, and soft-tissue-induced changes in vertebrae appearance, all those causes make the tracking of individual vertebrae in videofluoroscopy images very challenging. In this paper, we seek to overcome these challenges by following the process below (figure 1).
2.1. Image Acquisition and Processing

Image distortion in videofluoroscopy has various sources. [18] pointed out that, in addition to perspective, the curved image intensifier produces ‘pin-cushion’ distortions [19] where straight lines are curved outwards from the center. The correction method devised in [18] overcomes this problem using a calibration approach. They used a calibration grid composed of wire markers. The grid was placed between the subject and image intensifier and its corners were digitized. Linear correction of object coordinates was then performed within each grid box. Pincushion distortion was corrected using the formula:

$$s = r \left( \frac{1}{1 + C \left( \frac{r}{R} \right)^2} \right)$$  \hspace{1cm} (1)

Where $s$ is the modified radial distance to a pixel that was at radius $r$ from the center, and $R$ and $C$ are the radius to a corner of the image and the radial distortion coefficient, respectively. To find the radial distortion coefficient $C$, we start to adjust it until all squares on the grid appeared to be approximately the same size (Figure 1(b)) and the lines across the image are straight, then use it to correct all images.

In the processing step, images were enhanced using an adaptive noise removal filtering, followed by a median filtering and to increase the dynamic range of the histogram, an adaptive histogram equalization was processed.

2.2. Tracking Algorithm

2.2.1. Semi-automatic selection
Semi-automatic video object segmentation approach consists of two steps: interactive initialization and automatic tracking. A system using this strategy therefore comprises two corresponding components. The interactive segmentation in the first frame where the user specifies the contour of a semantic object easily and fast with a computer-aided segmentation tool. The manually segmented frame is then used to initialize the automatic tracking component.

In this work, we follow this approach using Canny edge detector as a segmentation tool to detect the edge in the first frame, then the user selects few land marks along the vertebra outline basing on the edge detected by canny, these hand-selected points are then fitted with parametric splines (independently to X and Y coordinates) to form the vertebra contour model.

2.2.2. Particle filter

As mentioned above, particle filter is a probabilistic tracking method based on Bayesian perspective. It estimates the internal states $X_k$ in dynamical systems when partial observations $Y_k$ are made, at any time step $k$. To define the problem of tracking, consider the evolution of the state sequence $(X_k, k \in N)$ of a target given by:

$$X_k = f_k(X_{k-1}, W_{k-1})$$

(2)

$f_k$: nonlinear function of state $X_{k-1}$, $\{W_{k-1}, k \in N\}$ is the process noise sequence. The aim is to estimate $X_k$ from measurements

$$Y_k = G_k(X_k, V_k)$$

(3)

$G_k$: nonlinear function of state $X_{k-1}$, $\{V_k, k \in N\}$ is the measurement noise sequence.

According to Bayesian perspective, the tracking problem is to calculate some degree of belief in the state $X_t$ at time $k$, given the data $Y_{1:k}$ up to time $k$. Thus, it requires to construct the probability density function $p(X_t|Y_{1:k})$. The prediction stage involves using the system model (1) to obtain the prior probability density function of the state at time via the equation:

$$p(X_k|Y_{1:k-1})$$

(4)

$$= \int p(X_k|X_{k-1})p(X_{k-1}|Y_{1:k-1}) \, dX_{k-1}$$

The probabilistic model of the state evolution $p(X_k|X_{k-1})$ is defined by the system equation (2) and the known statistics of $W_{k-1}$.

To apply particle filtering for visual tracking, the first issue that needs to be addressed is how to represent the state and the likelihood models, in a previous work [16] authors present a technique to track the vertebrae using particle filters with image gradient based likelihood measurement, the sate of a vertebra model at a time step $k$ is given by $e_k = (x_k; y_k; \theta_k)$ where $x_k$ and $y_k$ are the image coordinates of the contour centre and $\theta_k$ is the orientation relative to the centre of mass of the contour.

The likelihood measurement is based on the aggregation of intensity gradient information along each vertebra boundary. The gradient-based likelihood measurement $\varphi(p)$ is given by:

$$\varphi(x^n_t) = \frac{\sum_{n=1}^{N} \max_{i=1}^{M} \{y_{i,n}\}}{1 + \varepsilon D_n}$$

(5)

where $N$ is the number of normal search line segments, $y_{i,n}$ is the gradient at the ith point/pixel along the line $n$, $D_n$ is the Euclidian distance between the point with the maximum gradient and the vertebrae contour model, and $\varepsilon = 0.1$ is a weighing factor. Then likelihood is computed as follows:

$$p(y_k|x^n_k) = \frac{\varphi(x^n_t)}{\sum_{n=1}^{N} \varphi(x^n_t)}$$

(6)

2.3. Data Adjustment

2.3.1. Previous results

The proposed tracking technique in the section above is evaluated on a lumbar spinal videofluoroscopy sequences of frontal view.

Figure 2. Tracking results for the frontal view with lateral flexion to the right: frames 20 and 100

Using subjective evaluation, the tracking shows good results and all the vertebrae were correctly tracked throughout the sequences (figure 1). To appraise the method objectively, the image coordinates and rotation angles of the contour centre of the second vertebra were recorded and plotted in figures 3 and 4.
As it is shown on Figure 3 and Figure 4, the vertebrae trajectory is very jittery. (and doesn't give the correct tracking.)

2.3.2. Results Improvement

To make the tracking trajectory appear more natural, results obtained from the tracking process have been smoothed using a general polynomial fit. Then the centre coordinates and rotation angles of the vertebrae model are adjusted accordingly.

3. Results and Discussion

In this experiment, the performance of the whole system is evaluated. The system ran in the same way as described in 2.2. Firstly, the accuracy on the reported location of the vertebra was tested. One of the vertebra in the video was tracked. The corners will be extracted and reported. Throughout a video sequence of 218 frames was tested. The test results are shown in Figure 3 and Figure 4.

Particle filter based parameters are then recorded and smoothed using the polynomial fitting function. Improved results are shown on Figure 5 and Figure 6. The tracking results of PF can be seen here, while the improved results can be found in here.

4. Conclusion

In this paper, we focused on improving lumbar vertebrae tracking using curve fitting function to adjust the trajectory resulted from the particle filter tracking algorithm.

The proposed technique produces more natural and accurate tracking results. While this technique has been used here in the context of vertebrae tracking, we believe that can useful whenever the tracking results are jittery.

References


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