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AAOU Journal is the official journal of the Asian Association of Open Universities (AAOU). The journal is an international peer-reviewed journal published twice a year. It welcomes high-quality papers on topics in Open and Distance Education (ODE). Papers submitted to the journal may be an empirical study, case study or critical literature review. It should bring readers new information, knowledge, evaluations of theories or best practices of ODE.

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Asian Association of Open Universities Journal
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The British Library
Editorial

Preface
I am pleased to present the second 2016 issue of the AAOU Journal. In this issue, we have two open submissions on subjects of interest to our readers. There are also five papers which were winners and finalists in the paper awards at the 29th Annual Conference of the Asian Association of Open Universities (AAOU, 2015).

These articles cover a broad range of topics in the area of open and distance education (ODE). Vighnarajah, Hassan, Aziz and Ooi examine the information-seeking behaviour of their distance learning students in using library resources for their research and learning activities. Aluwihare and De Silva investigate the institutional and personal factors which affect their university’s bachelor’s degree engineering students in prolonging the completion time of their degrees. Rehal illustrates how transformative education and training through open and distance e-learning may increase the quality, quantity and relevance of health professionals’ training in the Philippines. Lee, Lau and Yip report a collaborative project which helps in building student-teachers’ capacity to learn and teach science-related interdisciplinary subjects. Pugoy, Habito and Figueroa present a study that proposes mobile solutions to aid learners with poor Internet connectivity in accessing open education resources. Wang, Wu, Zhan, Wang and Tang’s paper proposes a minimum spanning tree based approach for the clustering of online learning resources. Wong, Zeng and Ho compare and analyse the research trends in the field of open and distance learning as reflected in journal articles published in 2005 and 2015.

We wish to express our thanks to all the authors for their contributions and sharing of experiences in these articles. Also, we are much obliged to the reviewers for their thoughtful suggestions and expert comments in the review process. Again, thanks also go to the Emerald team and staff of the AAOU Secretariat for their support and assistance in the production of this issue.

We hope that you will find this collection of articles useful. It is our aim to provide a forum for academics and professionals to contribute high-quality research papers that provide new knowledge which informs our ODE practices and offers directions and insights for further research.

If you wish to submit a paper on ODE topics to us, you are welcome to click here for details, available at: www.emeraldgrouppublishing.com/services/publishing/aaouj/authors.htm

Kam Cheong LI
Profiling information-seeking behaviour of distance learning students in Wawasan Open University

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Abstract

Purpose – Wawasan Open University Library undertook a survey study, based on the Wilson’s revised model of information behaviour (1999), to profile information-seeking behaviour of their distance students in using library resources in their research and learning activities. The paper aims to discuss these issues.

Design/methodology/approach – Using random sampling method, samples were selected to ensure proper representation of the population across four schools of studies and five regional centres. A total of 550 questionnaires were sent to undergraduate and postgraduate students, and 435 completed questionnaires were returned with a success response rate of 79 per cent.

Findings – Findings indicated significant differences between undergraduate and postgraduate students in using the university’s MyDigital Library and physical library for their information needs. Findings also indicated significant difference between first-year and post-first-year students in using internet search engines as part of their information-seeking process.

Practical implications – Students improving on their information-seeking behaviour in the learning and research work paved way for them to better experience university vivacity and not isolate themselves from distance learning.

Originality/value – This paper acknowledges the importance of promoting good information-seeking behaviour among distance learners in the scholarship of learning and research work. The paper also amplifies the important role library plays in minimizing students’ sense of isolation in university learning experience.

Keywords Information needs, Information-seeking behaviour, Distance learning, Wawasan Open University, Wilson’s model of information behaviour

Paper type Research paper
Introduction
The emergence and development of technology-aided distance education is a relatively new approach in the Malaysian educational landscape. With the recent exponential technological development in educational practices, a growing number of institutions have attempted to service distance education programmes via various modes, some favouring more face-to-face contact hours while others take a liking for engagement in the online learning environment. Regardless on these modes of delivery, what is certain is the need for students to be technologically literate for them to successfully savour the university learning experience.

Wawasan Open University offered the first suite of 11 programmes in 2007 and is now offering a suite of 47 programmes. Wawasan Open University is one of the three full-fledged distance learning institutions in Malaysia that deliver distance learning programmes with a heavier focus on engagement in online learning environment. While this mode is not uncommon in many of the full-fledged and recognized distance learning institutions such as IGNOU and Athabasca University, it is imperative to pay consideration to the competency of students in engaging and interacting in the online learning environment, particularly in the process of information search and effectively utilizing the said information for learning and research work.

This responsibility is shouldered by the Tun Dr Lim Chong Eu Library of Wawasan Open University, which adheres to the Guidelines for Distance Learning Library Services; (Distance Learning Section Guidelines Committee, 2004, p. 607):

Members of the distance learning community, including those with disabilities, must therefore be provided effective and appropriate library services and resources, which may differ from, but must be equivalent to those provided for students and faculty in traditional campus settings.

Based on this philosophy of the Bill of Rights for the Distance Learning Community, the Standard for Access for Achievement of Superior Academic Skills requires the library of distance learning institutions, despite circumstances of geographical distance, limited face-to-face contact hours and other aspects relevant to the provisions of distance learning, to provide services and resources equivalent to conventional institutions (American Library Association, 2008). This is a standard of practice for library services that is often undervalued in some distance learning institutions, which ultimately leads to the common perception that the library is no more than an avenue for collection of books and resources, which is certainly not the case.

The ensuing discussion attempts to highlight the significant role of the library in distance learning institutions, specifically by investigating the profiling of information-seeking behaviour of distance learners in Wawasan Open University.

Information-seeking behaviour and its role in the scholarship of learning and research
Information-seeking behaviour refers to the process of seeking, collecting, analysing and utilizing information in a meaningful manner (Byström and Hansen, 2005), and this is an iterative process until the user acquires the intended information. Figure 1 illustrates Wilson’s (1999) information-seeking model that is commonly used in demonstrating the steps in information-seeking behaviour.

While this model was developed during the infancy of distance learning and online learning, the model still acts as a robust framework to explore and assess both off-line and online information-seeking behaviours. The fundamental concepts that form the basis of this model are the components information use, information need and information
exchange. Over the years, these features remain relevant and invariably describe the interrelationship among concepts of information-seeking behaviour of users (Wilson, 2006).

In fact, the published article which presented the Wilson’s model inspired the development of information research and has been cited over 100 times in book chapters, reports, conference proceedings and ISI journal databases, including *Journal of the American Society for Information Science and Technology, Journal of Documentation, Information Processing and Management* and *Library and Information Science Research* (Bawden, 2006, p. 672). This suggests continued interest in the works of Wilson’s model.

Wilson (1999, p. 249) describes information seeking as “activities a person may engage in when identifying their own needs for information, searching for such information in any way, and using or transferring that information”. In the context of the study, this description of information-seeking behaviour translates to distance learners’ active and purposeful information seeking that results from the need to complete course assignments, preparation for tutorial discussion, engagement in workshops and engagement in research work.

While information seeking can be achieved without (physical collection of resources) or with (digital collection of resources) computing assistance, the latter is becoming more significantly associated with the internet and ubiquitous computing. For instance, there is this growing social aspect of information seeking that Shah *et al.* (2014, p. 23) elucidate as “current work [information seeking] coincides with a combination of new technologies, such as Web 2.0 and social media/networking tools, and changes in human behaviour, including people’s increasing tendency to quickly and ubiquitously share and connect with others through new interfaces and devices”. They further argued that it is this confluence of modes of seeking and sharing information that sparked the need to better comprehend information-seeking behaviour in this changing trend of technological development. Although a substantial body of literature exists expounding both theoretical and empirical findings on profiling information-seeking behaviour in a variety of contexts, still there is an enduring concern in observing such behaviours that correlate with the changing online environment in distance education – and this begs the question, “What are some of the challenges that distance learners face in information search and information utilization in the age of Internet data mining?”

Looking across both dimensions of emerging technological developments and expansion of distance education, it becomes clear that information-seeking behaviour is
an individualistic process, and invariably, the information needs for every individual is different depending on the necessities for learning and research work. Moreover, students being digital natives of the internet age do not warrant possessing effective information-searching skills (Brown et al., 2003) or being “functionally information illiterate” (Majka, 2001), asserting the fact that “techno-savvy is not synonymous with information-literate” (Alman et al., 2012).

Loh (2013, p. 250) argues “[w]ith the overconfidence of the information skills, students are able to fulfil simple information needs, searching information to answer simple questions that exhibit only surface learning. However, they are unable to explore deeper concepts or determine if they have really reduced uncertainty successfully”.

Further to this, Dubicki (2010) also agreed that students are often confused and frustrated despite having the convenience of access to the internet. This is likely due to students’ lack of knowledge and incompetency in evaluating information available on the internet in terms of relevance, accuracy and/or authority (Williams et al., 2008).

All these contentions only reinforce the fact that despite having ubiquitous access to the internet, students still need guidance to improve on their information-seeking skills (Lahlafi et al., 2012). Later studies have also highlighted that poor information search also causes students, especially distance learners, to develop a sense of isolation from the learning process, as well as from the university experience in general (Vighnarajah and Santhiram, 2014). Recognizing this key importance, the mandate falls onto the library to cultivate effective information-seeking behaviour among students, and this measure has initiated the library to take a shift to acknowledging the presence of increasingly complex information systems, among others, online repositories, e-resources, and electronic information sources (Devi and Dlamini, 2014; Head, 2013; Kadli and Kumbar, 2013; Kumar, 2013). In view of the aforementioned, the ensuing discussion attempts to study information-seeking behaviour of distance learners in Wawasan Open University, one of the premier distance learning institutions in Malaysia.

**Research objectives**

The primary aim of this study was to explore and profile information-seeking behaviour among distance learning students in Wawasan Open University. In the context of this study, information-seeking behaviour refers to both the process of information search as well as effective utilization of information obtained from the information search process.

The following objectives were developed, based on relevant literature governing information-seeking behaviour in distance learning, to guide the direction of the study:

1. to identify the problems faced in information search among distance learning students in Wawasan Open University;
2. to identify the problems faced in effective utilization of information among distance learning students in Wawasan Open University; and
3. to examine the relationship between problems faced in information search and effective utilization of information.

**Methodology**

This study adopted the survey research design for several reasons. First, the survey research allowed the researchers to obtain the students’ perceptions and practice in seeking information and utilizing the said information for learning and research activities across different schools, i.e., School of Business Administration, School of Science and
Technology, School of Foundation and Liberal Studies and School of Education, Languages and Communications. Second, this measure was particularly important considering the university has regional centres in five different states, namely, Kuala Lumpur, Penang, Ipoh, Johor Bahru and Kuching. These regional centres act as a student recruitment centre, and they provide the provisions of tutorial rooms, libraries and other relevant academic and operational facilities. Finally, this survey measure allowed for quantitative analysis that highlights statistical significance for relevant extrapolation of research findings, especially in the area of information management in distance learning.

The population of the study involved distance learners from the five regional centres that provide courses serviced by the four Schools. At this juncture, it must be noted that this is a preliminary study executed in relation to a larger funded research that also attempts to study information-seeking behaviour of distance learners in Wawasan Open University. This preliminary study aims to gauge the challenges faced in survey administration among distance learners in the university. One of the major challenges faced in gathering data in distance learning institutions was chances of low response rate due to the nature of distance learning mode. In the context of this study, tutorial attendance is optional and hence no obligatory measures are taken on the more commonly practice of 80 per cent attendance rate in conventional universities.

Based on the population across four schools of studies and five regional centres, a random sample of size of 550 respondents was decided. This figure satiated Krejcie and Morgan's (1970) requirement of randomly chosen sample size where the sample proportion will be within ± 0.05 of the population proportion with a 95 per cent level of confidence. Without prejudice on any particular programme of study or preference of regional centre, 110 questionnaires were distributed to each regional centre for data collection purposes.

With advice sought from the respective regional centres on active average attendance rate for the tutorial weekends, the questionnaires were couriered to the respective regional centres to be administered accordingly to the tutorial classes identified by the researchers. In the sampling process, emphasis was also placed on avoiding data duplicates from students who attend both the first and second tutorial weekends. This particular emphasis on data duplication also drew attention to the fact that response to the administered survey was not course dependent but should focus on their (student’s) overall information-seeking behaviour. Relevant concerns were highlighted to the staff at the respective regional centres that assisted in the administration of the survey.

During the administration process, clear instructions were given, and students were assured on the anonymity of their response to the survey instrument. The survey instrument was developed based on literature governing information-seeking behaviour among distance learners (Liu and Zheng, 2004) and completed with the researchers’ experience in the field.

Prior to the administration process, the survey instrument was tested for face validity, content validity and construct validity by three experts in the field. One expert was a professor who provided constructive comments to the psychometric design of the items and ensured the proper context of the items to the distance learning. The other two experts were an associate professor and head of library services who both addressed expertise in the field of information-seeking behaviour in complex information systems such as online repositories, electronic information sources, OPAC and other relevant information databases. In general, these experts provided comments to improve the comprehensibility of the items and relevance of the items to reflect appropriate information-seeking behaviour. The reliability of the instrument was also satisfactory, yielding Cronbach’s $\alpha$ value of 0.810.
The instrument was divided into three major sections. The first section aimed to elicit respondents’ demographic information like age, gender, entry qualification, etc. The second section aimed to elicit respondents’ use of library services such as frequency of access to library services, satisfaction regarding information resources, extent of use of internet search engines, etc. The third section aimed to elicit respondents’ information search such as types of online information needs, problems faced in information search, problems faced in effectively utilizing information, etc. In general, items were presented on two types of scales: one where respondents had to check the boxes (more than one) to items that were relevant to them and the other responding to a five-point Likert scale ranging from “never” (1) to “always” (5).

Results and findings
Findings of the study drew attention to statistical data imperative to profile information-seeking behaviour among distance learners in Wawasan Open University. Findings of this study also bear importance to distance learners in other distance learning institutions that share similar parameters to Wawasan Open University.

From the total of 550 questionnaires administered, 435 completed questionnaires were returned accounting for a success response rate of 79 per cent. Table I presents the demographic findings of the 435 respondents. Based on the figures presented, 43.2 per cent ($n = 188$) of the respondents were male students whereas 56.8 per cent ($n = 247$) were female students. Almost half (51.5 per cent, $n = 224$) of the respondents were between the ages of 21 and 29 years while 30 per cent of the respondents ($n = 130$) were between the ages of 30 and 39 years. The remaining respondents were between the ages of 40 and 49 years and above 50 years, respectively. For the student status, a vast majority (76.8 per cent, $n = 334$) of the respondents were undergraduate students whereas rest (23.2 per cent, $n = 101$) of them were postgraduate students. Also, the majority (66.7 per cent, $n = 290$) of the respondents had more than one year of learning experience.

In the ensuing discussion, findings of the study are presented in accordance to the research objectives of the study to facilitate comprehension.

Research objective 1: to identify the problems faced in information search among distance learning students in Wawasan Open University.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gender</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>188</td>
<td>43.2</td>
</tr>
<tr>
<td>Female</td>
<td>247</td>
<td>56.8</td>
</tr>
<tr>
<td><strong>Age</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21-29 years</td>
<td>224</td>
<td>51.5</td>
</tr>
<tr>
<td>30-39 years</td>
<td>130</td>
<td>29.9</td>
</tr>
<tr>
<td>40-49 years</td>
<td>63</td>
<td>14.5</td>
</tr>
<tr>
<td>Above 50 years</td>
<td>18</td>
<td>4.1</td>
</tr>
<tr>
<td><strong>Student status</strong></td>
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<td></td>
</tr>
<tr>
<td>Undergraduate</td>
<td>334</td>
<td>76.8</td>
</tr>
<tr>
<td>Postgraduate</td>
<td>101</td>
<td>23.2</td>
</tr>
<tr>
<td><strong>Year of study</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>One year</td>
<td>145</td>
<td>33.3</td>
</tr>
<tr>
<td>Above one year</td>
<td>250</td>
<td>66.7</td>
</tr>
</tbody>
</table>

Table I. Demographic findings
There were seven major problems that distance learners experience in their information-seeking process. Figure 2 illustrates the problems faced by distance learners in their information-seeking process. The most significant problem they face is the inability to determine the appropriateness of the information they obtained (22 per cent). While this is not an uncommon concern among distance learners, findings do seem to imply that this particular problem leads to other relevant problems, mainly, not being able to locate information (19 per cent) and considering that information are outdated (14 per cent). The other concern that must be noted in this finding is how distance learners are not aware that relevant information is available in the library, whether in the form of hard copies or digital copies (12 per cent).

Given the vested interest in profiling information-seeking behaviour of distance learners, further analysis was conducted to examine their awareness of searching for information using the provisions of both MyDigital Library database and internet search engines. Referring to Figure 3, descriptive results clearly indicate that students, in their scholarly learning and research work, require guidance in searching for

![Figure 2. Problems faced by distance learners in their information-seeking process](image1)

![Figure 3. Percentage of respondents who required guidance with online information search](image2)
information using MyDigital Library database and internet search engines such as Google and Yahoo.

An independent sample t-test was used to statistically compare differences between undergraduate and postgraduate students in using digital library as their major source of information search in their learning and research work. Referring to Table II, the results indicate that there exists a significant difference ($t = 3.415, p < 0.01$) in the scores between undergraduate students ($M = 0.20, \ SD = 0.403$) and postgraduate students ($M = 0.39, \ SD = 0.489$) in using MyDigital Library. Results also indicate a significant difference ($t = 3.234, p < 0.01$) in the scores between undergraduate students ($M = 0.18, \ SD = 0.271$) and postgraduate students ($M = 0.29, \ SD = 0.326$) in using the physical library.

While the results did not reveal any significant differences between undergraduate and postgraduate students in using internet search engines for their learning and research work, results did indicate significant differences ($t = 2.097, p < 0.05$) between first-year students ($M = 0.81, \ SD = 0.396$) and post-first-year students ($M = 0.89, \ SD = 0.318$) in using internet search engines. In other words, post-first-year students are more likely to refer to internet search engines for information compared to the first-year students (Table III).

Research objective 2: to identify the problems faced in effective utilization of information among distance learners in Wawasan Open University.

There were eight major problems that distance learners experienced in effectively utilizing information they obtained from the information search process. Refer to Figure 4.

The critical concern here is that distance learners were uncertain on how to integrate information into their assignments and research work (21 per cent). This is closely followed with the uncertainty on how to cite information (17 per cent), lack of local context in the information (15 per cent), poor use of information leads to high Turnitin similarity index (15 per cent) and uncertain over the quality of information obtained (14 per cent). Poor employment of these essential skills will surely impede any distance learner from progressing in the scholarship of learning and research.

<table>
<thead>
<tr>
<th>Dependent variable (Y)</th>
<th>Independent variable (X)</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
<th>SE mean</th>
<th>t</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>MyDigital Library</td>
<td>Student status</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
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<td>334</td>
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<td>0.403</td>
<td>0.022</td>
<td>3.415</td>
<td>0.001**</td>
<td></td>
</tr>
<tr>
<td>Postgraduate</td>
<td>101</td>
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<td>0.489</td>
<td>0.049</td>
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<td></td>
</tr>
<tr>
<td>Physical library</td>
<td>Student status</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Undergraduate</td>
<td>334</td>
<td>0.18</td>
<td>0.271</td>
<td>0.0149</td>
<td>3.234</td>
<td>0.001**</td>
<td></td>
</tr>
<tr>
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<td>0.29</td>
<td>0.326</td>
<td>0.0325</td>
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<td></td>
</tr>
</tbody>
</table>

Note: **$p < 0.01$**

<table>
<thead>
<tr>
<th>Dependent variable (Y)</th>
<th>Independent variable (X)</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
<th>SE Mean</th>
<th>t</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internet search engines</td>
<td>Year of study</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>First year</td>
<td>145</td>
<td>0.81</td>
<td>0.396</td>
<td>0.033</td>
<td>2.097</td>
<td>0.05*</td>
<td></td>
</tr>
<tr>
<td>Post-first year</td>
<td>290</td>
<td>0.89</td>
<td>0.318</td>
<td>0.019</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: *$p < 0.05$*
Further inferential analysis on these results revealed some interesting findings that necessitate relevant stakeholders, Library Support and Academics among others, to provide informative support in the relevant areas of concern. Referring to Table I, an independent sample t-test was used to statistically compare differences between undergraduate and postgraduate students in their understanding of information content. Results revealed that there exist a significant difference ($t = 2.364, p < 0.05$) in the scores between undergraduate students ($M = 0.16, SD = 0.366$) and postgraduate students ($M = 0.08, SD = 0.271$). In other words, undergraduate students face more problems in understanding the content of the information they obtained compared to postgraduate students (Table IV).

In addition, independent sample $t$-test was used to statistically compare differences between years of study (first year vs post-first year) in their understanding of the language used in the information. Results revealed that there exists a significant difference ($t = 1.702, p < 0.05$) in the scores for first-year student ($M = 0.17, SD = 0.379$) and post-first-year students ($M = 0.11, SD = 0.314$). Significant differences ($t = 2.017, p < 0.05$) in mean were also obtained for first-year ($M = 0.37, SD = 0.483$) and post-first-year students ($M = 0.27, SD = 0.444$) in properly citing information they obtained from the search process (Table V).

### Table IV.

<table>
<thead>
<tr>
<th>Dependent variable ($Y$)</th>
<th>Independent variable ($X$)</th>
<th>$n$</th>
<th>$Mean$</th>
<th>$SD$</th>
<th>$SE$ mean</th>
<th>$t$</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>I do not understand the information content</td>
<td>Student status</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Undergraduate</td>
<td>334</td>
<td>0.16</td>
<td>0.366</td>
<td>0.020</td>
<td>2.364</td>
<td>0.001**</td>
</tr>
<tr>
<td></td>
<td>Postgraduate</td>
<td>101</td>
<td>0.08</td>
<td>0.271</td>
<td>0.027</td>
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<td></td>
</tr>
</tbody>
</table>

Note: **$p < 0.01$**
Research objective 3: to examine the relationship between problems faced in information search and effective utilization of information.

A simple linear regression analysis was used to examine the relationship between problems faced in information search process and effective utilization of information. A positive correlation was found between both variables ($\beta = 0.565, p < 0.001$). The results indicate that problems faced in information search process significantly predicts effective utilization of information, with 32 per cent prediction of the variance ($F(1,433) = 202.619, p < 0.01$) (Table VI).

Discussion and implications

The aim of this study was to explore and profile information-seeking behaviour among distance learners in Wawasan Open University. The operational definition of information-seeking behaviour refers to both the process of information search as well as effective utilization of information obtained from the information search process. Directed by this aim, specific objectives included identifying the problems faced in the information search process, problems faced in effective utilization of information and finally examining the relationship between these two factors.

Several implications were drawn from the findings of the study which address significant importance to the understanding of information-search behaviour of distance learners in Wawasan Open University. These implications also possess the potential to be extrapolated to other context of information-seeking behaviour of distance learners that shares similar parameters with this study. Findings of the study provide statistical evidence to the convictions that distance learners are not familiar with information-seeking processes and the subsequent process of effective utilization of information. In addition, findings have also revealed that unfamiliarity with information-search process mostly affects either undergraduate learners or first-year distance learners.

While this finding may have been somewhat anticipated, what is enlightening is that poor information-search behaviour can lead to distance learners to develop a sense of

<table>
<thead>
<tr>
<th>Independent variable (Y)</th>
<th>Independent variable (X)</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
<th>SE</th>
<th>mean</th>
<th>t</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Language used in the information is too difficult</td>
<td>Year of study</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>First year</td>
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Note: *p < 0.05

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Note: **p < 0.001
isolation in the scholarship of learning and research. In a qualitative study investigating cases of student isolation among distance learners, Vighnarajah and Santhiram (2014) found that poor engagement with library services was among the precursors that led students to isolate themselves from the different interactions one would expect from a university learning experience. They further emphasized that distance learners will find it difficult to search for information online particularly if they are unfamiliar with search engine technology and library databases such as EBSCO Host Business Source Complete, Books 24 x 7 and eBrary. If not attended to accordingly in the early stages of the learning and research work, students who experience difficulties in effectively searching for information and utilizing the said information could find themselves in a situation of feeling a sense of isolation. This is a situation that should not be taken lightly as it may lead, almost always impulsively, to other relevant learning concerns, such as developing the perceptions of incompetency of learning and the encumbrance of returning to learning, more so of engaging in distance learning.

In light of the aforementioned implication, relevant stakeholders must play their role in guiding students to improve on their information-seeking behaviour. The library plays the most crucial role in this perspective of facilitating distance learners who are not accustomed to effective information-search behaviour and utilization of information, and this should be sustained as a continuous effort in the scholarship of learning and research. This view is in line with Kumar (2013) who emphasizes that the library should organize more programmes and seminars to disseminate awareness among students on effectively collaborating with the library for information search and utilization. Also, it is imperative that these affected groups of distance learners are made aware of this concern to encourage them to seek the necessary guidance from the relevant stakeholders – this is a critical finding that requires attention on part of the library as well as the users (distance learners). For instance, Devi and Dlamini (2014) point out that while 92 per cent of library users are aware of e-resources, 32 per cent of this group finds it difficult to use these e-resources for their immediate needs. Moreover, it is crucial that these measures by the library must be supported by relevant academics and faculties.

It was also interesting to note from the findings that experiencing problems in information search positively correlates with effective utilization of information. In other words, students who experience problems in searching for information are most likely, with 32 per cent of possibility, to experience problems in effectively utilizing the said information mainly with concerns towards integration of information, citation of information and chances of plagiarizing work.

This is a matter of grave concern as pointed out by Head and Eisenberg (as cited in Head, 2013, p. 474): “Eighty percent – eight in ten of the students PIL surveyed in 2010 – reported having overwhelming difficulties with getting started on research assignments and determining the nature and scope of what their instructors required of them”. PIL, acronym for Project Information Literacy, was a series of national studies that attempted to investigate the scenario of a college student in an era of digital age. With support from major institutions such as Institute of Museum and Library Services, Cengage Learning, Harvard’s Berkman Center for Internet and Society and ProQuest, PIL addressed the findings of surveys and interviews of more than 11,000 students from 57 colleges and universities across the USA.

Hence, it is imperative for students to develop a sense of awareness of this positive correlation between information search and information utilization in an attempt for them to take the necessary measures to seek for guidance from
the relevant stakeholders. However, it was even more alarming to discover that the services of a librarian were tremendously underutilized: “Across all PIL surveys, students tremendously underutilize librarians. Eight out of ten of the respondents (80%) in PIL’s 2009 survey reported rarely, if ever, turning to librarians for help with defining topics or searching for sources when working on course-related research assignments” (Head and Eisenberg, 2009, p. 475).

All in all, findings of this study highlighted many important quantitative aspects relevant to information search and information utilization. In an attempt for further improvement, this researchers hope to commence an extended study in the near future aimed at eliciting more profound analysis of larger data set. Among others, this includes determining significant statistical differences between genders and between junior and more senior distance learners in their engagement in information search and information utilization. This extended study also aims to complement these quantitative findings by focussing on qualitative exploration to gain invaluable insight into the cognitive practices of these distance learners when dealing with information search and information utilization – for instance, establishing phenomenological understanding, through means of interviews and observations, of why and how distance learners go about in their information search and information utilization. In this study, the quantitative results did not highlight any particular findings that would satisfactorily explain these phenomena other than identifying the significant differences and/or strength of relationship among variables. Certainly, consolidation of quantitative and qualitative data will provide added value to the aim of this study in profiling information-seeking behaviour of distance learning students in Wawasan Open University.

**Conclusion**
Emergence of the internet in the frontiers of distance learning has impacted the delivery of education in more ways than one. This attempt to understand the profiling of information-seeking behaviour among distance learners is no more than a fraction of a larger quality assurance measure to advise and guide students on how to industriously experience distance learning at its best. All in all, results from this study have confirmed that distance learners (at least, in the context of Wawasan Open University) experience critical difficulties in effectively searching for information and utilizing the said information in the scholarship of learning and research. Also, efforts are required from library and relevant stakeholders in guiding distance learners to successfully acquire and manage information in this digital age. This paper reports the preliminary findings and is by no means a comprehensive review on profiling information-seeking behaviour among distance learners. With this in mind and ardour to investigate further into the various facades of profiling information-seeking behaviour, the scope of research has been extended to study a wider population of distance learners in Wawasan Open University.

**References**


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Prolonged time taken to complete the degree programmes at the Faculty of Engineering Technology of the Open University of Sri Lanka

Barriers and remedies

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Abstract

Purpose – It has been observed that the students attending the bachelor’s degree programmes offered by the Faculty of Engineering Technology (FET) at the Open University of Sri Lanka (OUSL) take extraordinarily longer period to complete their degrees. The purpose of this paper is to identify the institutional barrier, student-related personal barrier and psychological barrier behind the prolonged duration of completion of the said degrees.

Design/methodology/approach – A well-developed questionnaire was administered among a selected sample of graduates who were awarded the Bachelor of Technology (Engineering) and Bachelor of Industrial Studies degrees within the past ten years.

Findings – Results indicate that institutional barriers such as poor academic counselling and guidance; laboratory sessions being inappropriate/not sufficient to understand the course material; inadequate facilities, such as library resources, and lack of laboratory facilities at the regional centres have contributed immensely to the lengthy duration taken to complete the degrees. Personal factors such as work-related challenges, travelling time and cost of commuting to the main centre located in Colombo and inability to spend the required time expected of the programme have played major roles in the prolonged completion. Results indicate that the cost of tuition is not a major barrier for on-time completion. Psychological barriers such as possessing a limited repertoire of study strategies, lack of understanding of open and distance learning (ODL) methods and deficiency of continuous motivation had a tremendous impact on the delayed graduation. A high satisfaction rate was observed regarding the ODL tools that were used within the programmes and the formative and summative evaluation criteria. Approximately 75 per cent of the sample approved of the five remedies suggested.

Originality/value – Findings of this study provide insight for shortening the duration of the bachelor’s degree programmes offered by the FET at the OUSL.

Keywords Time, Engineering, Barriers, Degrees, Remedies

Paper type Research paper

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Introduction
Faculty of Engineering Technology (FET) at the Open University of Sri Lanka (OUSL), the only national university, offers engineering programmes via open and distance learning (ODL) in Sri Lanka. The faculty has completed 30 years of existence and has produced graduates in the disciplines of agriculture, civil, mechanical, mechatronics, computer, electrical, electronics and communication engineering and in industrial studies in agriculture, textile manufacture and apparel technology.

As widely accepted, engineering education is the most difficult to teach as a distance learning course as it needs hands-on experience with machines (Ariadurai and Manohanthan, 2008). The FET, being one of the pioneers among all academic institutions of the world in delivering engineering programmes in distance education mode, adopts competitive pedagogical methods and tools for efficient and effective learning outcome. The structure of ODL provided by FET facilitates the learner community with the greatest possible control over time, place and pace of engineering education. Thereby, FET could reach the industry personnel who are experienced but lack the theoretical background in various areas of engineering. Keeping par with the technological developments, FET provides students with learner support via modern day technologies such as online support through the “OUSL Learner Management System”, video conferencing by linking the main campus to number of regional and study centres, conducting online examinations, utilizing contemporary laboratories, etc.

Although FET has taken maximum effort to deliver the programmes in a competitive way, it has been observed that the students following bachelor’s degree programmes offered by the FET of the OUSL take extraordinarily longer period to complete their degrees. A significant number of students have taken more than 10-15 years to complete the four- and five-year degree programmes. The problem of late completion of programmes in distance education has been subjected to considerable investigation (Musingafi et al., 2015; Berge et al., 2002). Late completion of the programmes is due to the underlying challenges faced by the ODL students. Berge et al. (2002) classified challenges to distance learners as situational-, epistemological-, philosophical-, psychological-, pedagogical-, technical-, social- and cultural-related challenges. Kember (1989) suggested that poor time management leads to challenges such as learners’ inability to integrate the demands of off-campus study with family, work and social commitments. According to Zirkle (2001), the barriers that an ODL learner faces are programme costs, lack of equipment and infrastructure, instructional concerns, poor technical assistance, inadequate feedback and poor teacher contact, alienation and isolation and poor student support services. Mossberger et al. (2003) was of the view that technical competence needed in order to have an effective access to contemporary ICT is a challenge to a distance learner.

In recent years, discussions have taken place in the FET of the OUSL on the prolonged time taken for the completion of the degrees offered by the faculty. This research was conducted primarily to identify the institutional barrier, student-related personal barrier and psychological barrier behind the prolonged duration for the completion of the said degrees. As a secondary goal, remedial measures that can be used to improve the duration of the degree programmes have been identified.

Degree programmes
Bachelor of Technology (Engineering) (BTech) and Bachelor of Industrial Studies (BIS) are the two degree programmes offered by the FET. These degrees are designed in accordance with the requirements of the Sri Lanka Qualification Framework and are
recognized both academically as well as professionally. The BTech (Engineering) degree of the OUSL is recognized by the Institution of Engineers Sri Lanka as a fulfilling academic qualification for associate membership. Furthermore, the BTech (Engineering) degree is equivalent to the engineering degrees offered by other national universities (Student Guide Book, 2014).

**Entry requirement**

Three passes in the General Certificate in Education (Advanced Level) in the physical science stream is the basic entry requirement for the BTech (Engineering) degree programme. Anyone who possesses three passes in the General Certificate in Education (Advanced Level) in any stream is allowed to join for the BIS degree programme. Students with higher qualifications in technology are entered to the programmes in relevant intake points.

**The study system**

The central component of the study system by the FET is the printed course material prepared by the relevant academics of the OUSL that offers the students information equivalent to lectures in a conventional university. They also provide a series of carefully designed activities and self-assessment questions, which help the student to develop analytical skills and independent thought. Printed material is supplemented by audio-visual material, online classes, face-to-face discussions/clarification classes (day schools), tutor clinics, laboratory work, mini projects (MP), fieldwork, field visits, viva voce examinations and seminars. Laboratory work and fieldwork form an integral part of most courses in technology and are compulsory. By offering FET programmes via the OUSL centre network that is spread all over the island, the barrier of distance is thought to be greatly reduced.

**Assessment criteria**

Each course in a programme of study is assessed separately. Assessment consists of two components, namely, continuous assessment (CA) and final examination (FE). CA is not merely a means of assessment, it is one of the significant means of facilitating learning. Activities such as laboratory work, field classes, tutor marked assignments, presentations, MP and CA tests are integral part of learning and assessment. A student is required to obtain a minimum of 40 per cent marks in CA of a particular course to be eligible to sit for the FE. If this minimum mark is not obtained, the student is considered to have failed in that course and has to re-register in a subsequent year. In this event, the student can obtain only a simple pass (C grade) for the course after successful completion.

A student gaining eligibility in a particular course is expected to sit the FE in the same year. However, facing the FE may be postponed to a subsequent year, within the valid period of eligibility of up to a maximum of three academic years including the year the student obtained the eligibility. Final assessment mark of any course depends on the performance at both the CA and the FE. For the courses offered by the Faculty, these components carry equal weight. Therefore, students must practice continuous learning throughout the academic year in order to attain success. Since a fair proportion of the activities used to impart knowledge in distance education have to be carried out by the student, success is possible only if he/she is motivated to learn by himself/herself. A student failing to obtain eligibility to sit the FE for any course will have to re-register for that course in a subsequent year by re-paying the tuition fee.
Such a student will be considered as a repeat student for that particular course. Such students will not be eligible for a grade higher than C grade for the repeat course, depending on the programme (Student Guide Book, 2014).

Counsellors at the time of registration strongly recommend that a student only register for the number of courses which they can manage within their respective time availability. A student who obtains the eligibility for a particular course but fails to obtain the minimum pass mark at the FE will be considered as a re-sit student. Re-sit students are not required to re-register for that particular course; however it is important that such students sit the FE before the eligibility period expires. Re-sit students will also not be eligible to obtain a higher grade than a mere pass grade (grade C).

Requirements for the award of degrees
Both study programmes in technology and industrial studies consist of four academic levels where the students are expected to enrol for courses from different categories. The course categories included in the technology curriculum are engineering, engineering projects, mathematics, general, management, industrial training, English language and computer literacy. The industrial studies programme consists of courses from categories such as industrial, management, general, mathematics, projects, English language, industrial training and computer literacy. The students are allowed to register for a maximum of 45 credits per academic year which is equivalent to 1,125 notional learning hours. The total course credit requirements for the award of BTech (Engineering) and BIS degrees are 177 and 150, respectively. The credit requirement is subjected to certain conditions so that a pre-determined minimum should be obtained from different categories and levels. In addition, the students need to complete industrial training modules equivalent to 30 weeks of duration according to the respective field of specialization (Student Guide Book, 2014).

Methodology
The research design involved extracting a sample of graduates from FET and distribution of a structured questionnaire among them. Exploratory interviews with the easily contactable graduates from FET were conducted before developing the questionnaire.

Exploratory interviews
The interviews were conducted individually and in groups of two based on the preference of the participants and their time constraints. A total of seven interviews were conducted with 17 graduates, ensuring participation from both BTech and BIS graduates.

The interviews addressed issues related to challenges associated with ODL, barriers arising due to quality of learner support, learners scholarly abilities, required academic skills, time and motivation factors and personal and psychological barriers faced by each individual.

Questionnaire
A structured questionnaire was developed using the data gathered during exploratory interviews and observations made by the first author who has served as a Senior Lecturer at the FET for a period of 13 years. The questionnaire included open-ended questions, yes or no questions and questions and statements with five-point Likert scale.
The questionnaire assessed the perceptions of the graduates of FET regarding their prolonged duration for the completion of the said degrees on the following points:

(1) Institutional barriers:
   - poor academic counselling and guidance;
   - inappropriateness of course material/course material being not updated;
   - laboratory sessions being inappropriate/not sufficient to understand course material;
   - inadequate resources and facilities such as library resources, computer and internet facilities, poor teaching and learning environments;
   - lack of laboratory facilities at the regional/study centre network;
   - high standard expected for the final-year project;
   - timely conveyance of eligibility expired in three years;
   - timely conveyance of registration information, course offerings, changes to course schedules and examination schedules; and
   - quality of instruction and effectiveness of day schools.

(2) Student-related personal barriers:
   - work-related challenges;
   - travelling time and cost of commuting to the main centre of the centre network where most of the activities are carried out;
   - inability to spend the required time expected of the programme;
   - lack of time due to family commitments;
   - cost of tuition fees;
   - frustrated with the personal life which led to poor concentration on the programme;
   - the living (home) environment was not suitable for studies;
   - parallel registration with another degree/diploma programme;
   - inability to add/drop courses during the given period; and
   - difficulty in familiarizing with the new course delivery system using Moodle.

(3) Psychological barriers:
   - possessing a limited repertoire of study strategies;
   - lack of understanding of ODL methods;
   - deficiency of constant motivation throughout the study period;
   - lack of independent learning skills;
   - lack of mathematical skills required by the programme; and
   - knowledge of English was not up to the standard required by the programme.
Remedial measures that can be adopted to improve the time taken to complete the degree programmes

The questionnaire also evaluated the observations of the graduates of FET regarding five remedial measures to improve the time taken to complete the said degree programmes. The suggested remedial measures can be listed as follows:

- shorten the duration of the degree programmes;
- adopt a semester system;
- conduct repeat examinations;
- adopt a methodology to re-correct FE papers; and
- equip regional centres with all necessary facilities.

The questionnaire was pilot tested, revised and administered among the selected sample of graduates.

Selecting the sample respondents

A sample of 284 respondents was drawn with the use of stratified random sampling method using the full sample frame of 956 graduates who have graduated during the period from 1986 to 2014 from FET.

Data collection

The questionnaires were posted/hand delivered to the selected sample of graduates and 166 responded.

Results and discussion

The duration for the completion of the degree programmes by the respondents was analysed, and after removing the outliers, it was found that more than 90 per cent of the students have taken 6-15 years to complete the four- and five-year degree programmes (Figure 1).

The results are presented under the following sub-sections: institutional barriers, student-related personal barriers and psychological barriers.

Institutional barriers

Results illustrated in Figure 2 indicate that 77 per cent of the respondents thought poor academic counselling and guidance have contributed immensely to their
prolonged duration to complete the degrees. Most students do not receive proper counselling at the time of registration as most registration activities are carried out by the clerical staff of the OUSL. Selecting unsuitable courses and inappropriate course loads can eventually lead to lengthening of the time duration. Of the respondents, 56 per cent were of the view that the laboratory sessions were inappropriate/not sufficient to understand the course material. In most laboratory sessions, the instruction sheets are given at the beginning of the laboratory session, where the students find it difficult to understand/correlate with the course materials. Among the respondents, 67 per cent are of the view that inadequate resources and facilities such as library resources, computer and internet facilities and poor teaching and learning environments have contributed much to the lengthy duration of the degree programmes. From the respondents, 78 per cent believed that the lack of laboratory facilities at the regional/study centres has contributed greatly to the prolonged duration taken to complete the degrees. Laboratory facilities for higher level courses are available only in the Colombo Regional Centre (Aluwihare and Manoshika, 2013). Learners from other regions have to travel to Colombo and find accommodation to participate in the laboratory classes, and thus many employed students give up the laboratory component of the courses (which is compulsory) as they cannot spend the time needed for the above venture.

Other factors tested under “institutional barriers” such as inappropriateness of course material, high standard expected for the final-year project, poor quality of instruction and effectiveness of day schools and delayed conveyance of eligibility expired in three years were found to be less important issues for the prolonged completion of the degree programmes as shown in Figure 3.

**Student-related personal barriers**

As illustrated in Figure 4, personal factors such as work-related challenges have hindered the on-time completion for more than 60 per cent of the graduates. The flexibility in the programme structure provides learners to be employed while studying in the OUSL – FET. Therefore, most students are found to be employed at the time of graduation. Employed students find it difficult to obtain leave for some of the compulsory activities and find it hard to concentrate fully on the programme due to the duties vested on them. Work-related challenges are more on students working...
in the private sector than in government institutions (Dedigamuwa and Senanayake, 2012). It is apparent from Figure 3 that 64 per cent of the respondents considered the travelling time and cost of commuting to the main centre located in Colombo have contributed hugely to the prolonged duration for the completion of the degree programme. This factor plays a major role for students living away from the main centre. For example, a student living in Kandy who wishes to attend a day school of a duration of two hours should spend at least eight hours of travel time to Colombo and back home in Kandy. Therefore, most students from regions other than Colombo do not attend the face-to-face sessions conducted by the OUSL teachers. Of the respondents, 57 per cent have reported that their inability to spend the required time expected of the programme has lengthened the duration of the programme whereas 40 per cent of the respondents rated against it. Mainly employed students failed to allocate the time required to follow the course effectively. On the other hand, unemployed young students with successful secondary education are able to spend plenty of time on the degree programmes for on-time completion (Hill, 2009). For 63 per cent of the respondents, the cost of tuition is not a major barrier for on-time completion.

Other personal factors such as family commitments, frustration which led to poor concentration on the programme, the living (home) environment not suitable for studies, parallel registration with another degree/diploma programme, inability to
add/drop courses during the given period, difficulty in familiarizing with the new
course delivery system using Moodle, etc., were ranked as less important issues when it
came to on-time completion of the degree programmes as shown in Figure 5.

**Psychological barriers**
According to Figure 6, 58 per cent agreed that possessing a limited repertoire of study
strategies have lengthened their degree programme. Most learners use primitive
strategies to help them remember course material but not to understand them (Hill,
2009). Most use crash lessons called “kuppi” classes conducted by one of the peers just
before the examinations to remember the important course content. About 86 per cent
of the learners agreed that lack of understanding of ODL methods has contributed
immensely to the increased time duration for their degree programmes. The learners do
not understand the difference between a conventional lecture and a day school. Most
learners turn up for day schools with minimal preparation which reflects a lack of
understanding of ODL objectives rather than lack of effort. The learners overall
attitude towards ODL was poor as they always compare it with conventional system
of course delivery. Most learners do not understand that the main medium of bridging
the gap between the teacher and the student is the printed course materials. Among
the learners, 66 per cent were of the idea that the deficiency of constant motivation

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**Figure 5.**
Student-related personal barriers rated as insignificant for on-time completion of the degree programmes

**Figure 6.**
Psychological barriers rated as significant for on-time completion of the degree programmes
throughout the study period had a tremendous impact on the delayed graduation. Degree programmes offered by FET need more learner commitment and self-motivation as the learner is not always in an academic environment compared to conventional universities.

Other psychological barriers such as lack of independent learning skills, lack of mathematical skills required by the programme and knowledge of English not up to the standard required by the programme had less impact on the prolonged duration taken to complete the degrees as shown in Figure 7.

Although inadequate knowledge in English and mathematical skills should have been a strong factor for the lengthy time duration to complete the degrees, majority of respondents considered them as less important issues.

*Tools used in delivering the degree programmes*

High satisfaction rate of nearly 80 per cent was observed regarding the ODL tools that were used within the programmes and the formative and summative evaluation criteria, which are shown in Figure 8.

*Graduates perspective on the remedial measures that can be used to improve the duration of the degree programmes*

More than 80 per cent of the sample approved the suggested remedial measures of adopting a semester system (Figure 9), conducting repeat examinations (Figure 10) and shortening the duration of the completion of the degree programmes (Figure 11). More than 64 per cent approved the adoption of a methodology to re-correct FE papers (Figure 12) and equipping regional centres with all necessary facilities (Figure 13).
Conclusions and recommendations

Findings of this study provide some insights for shortening the duration of the BTech and BIS degree programmes offered by the OUSL. Institutional barriers such as poor academic counselling and guidance, laboratory sessions being inappropriate/not sufficient to understand the course material, inadequate resources and facilities such as library resources and computer and internet facilities, poor teaching and learning
environments and lack of laboratory facilities at the regional/study centres have contributed immensely to the lengthy duration taken to complete the degrees. But the institutional barriers can be easily overcome by strengthening the centre network that will enhance learner support and updating and upgrading of laboratory facilities. Counselling at the time of registration for each academic year should be carried out by the teachers of FET, and proper guidance should be given in selecting appropriate course loads. Personal factors such as work-related challenges, travelling time and cost of commuting to the main centre located in Colombo and inability to spend the required time expected of the programme have played major roles on the prolonged completion of the degree. Results indicate that the cost of tuition is not a major barrier for on-time completion. Psychological barriers such as possessing a limited repertoire of study strategies, lack of understanding of ODL methods and deficiency of constant motivation throughout the study period had a tremendous impact on the delayed graduation. Personal barriers can be alleviated by molding the learners to be good time managers and independent learners with strong focus. Providing the learner with a greater repertoire of study strategies may remove physiological barriers. All these can be achieved via “Student Orientations” which should be conducted with a strong focus on time management, developing academic skills and ODL methods. The remedies suggested for external means of shortening the duration of the degree programmes were well accepted by the respondents.
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Transforming future public health professionals through open and distance learning (ODeL)

Case study of UPOU’s International Health Program in the Philippines

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Abstract

Purpose – Open and distance e-learning (ODeL) practices have substantial contributions to make in achieving societal development goals. The challenge however remains with enhancing skilling, training and educating professionals who will contribute to this progress. The purpose of this paper is to illustrate how transformative education and training in global health can be undertaken through ODeL in increasing the quality, quantity and relevance of health professional education and training.

Design/methodology/approach – This paper is based on a descriptive qualitative case study of the International Health and Development Course offered by the University of the Philippines Open University and is thus limited in its scope from other courses in the program.

Findings – Transformative education and training through ODeL has the potential of increasing the quality, quantity and relevance of health professionals training. However more critical assessment of transformative learning outcomes is needed via rigorous methods of objectifying such outcomes. Achieving transformative health education and training requires rigorous engagement in constructivist-oriented experiential learning that allow learners to be accustomed to significant interactions achieved by involvement in problem-based methods accomplished through small group e-tivities in order to demonstrate applicability in the real work context.

Originality/value – The outcome of this paper is relevant to institutions in Asia that offer ODeL-based global health programs through open knowledge systems in order to produce graduates who are more responsive to the evolving health needs amid twenty-first century global health challenges.

Keywords Public health, The Philippines, Constructivist pedagogy, ODeL, Transformation and scaling up training

Paper type Research paper

Introduction: the “crisis in health human resources” and need for new professional education and training

The World Health Organization (WHO) warns that the world is short of 7.2 million health care workers and where this is expected to rise to 12.9 million by 2035 (World Health Organization (WHO), 2014). In this regard, a basic threshold of 23 skilled health...
professionals per 100,000 people is required. Many countries are steadily progressing toward this target though approximately 83 countries are still lagging behind (WHO, 2014). As a result, the WHO warns of a looming crisis in human health resources in countries below the prescribed threshold given that an estimate 8.9 million health professionals are serving a population of 4.7 billion, translating to a global deficit of 7.2 million skilled professionals (WHO, 2014). Several key causes of this deficit are attributed to an aging health workforce, staff retirements and not enough young people entering the profession or being adequately trained (WHO, 2014). Increasing demands are also being put on the health sector from a growing world population and that of increasing risks of non-communicable diseases. Internal and international migration of health workers is also exacerbating regional imbalances (WHO, 2014, p. 35). Asia records the largest shortages in health care workers in numerical terms. This deficit is smallest in the European regions pegged at 0.07 million or 1 percent of the total deficit and acutely high I Sub-Saharan Africa (WHO, 2014, p. 36). Southeast Asia which has 27 percent of the world’s population, accounts for nearly half of this deficit, amounting to 3.4 million (47 percent). Aluttis et al. (2014, pp. 1-3) describe this crisis in the health sector as “one of the most pressing global health issues where the shortage of health workers has the greatest impact in low-income countries characterized by insufficient public investment resulting in too few people being trained and further exacerbated by migration of health care workers from low and middle income counties to high income ones.” Frenk et al. (2010, p. 1923) note in this regard that professional education has not kept pace with the evolving challenges in healthcare training and education due to their “fragmented, outdated and static curricula which tends to produce ill-equipped graduates.” The causes of such low level of education and training are attributed to systemic problems attributed to the “mismatch of competencies to patient and population needs, poor teamwork, persistent gender stratification of professional status, narrow technical focus without broader contextual understanding, episodic encounters rather than continuous care, predominant hospital orientation at the expense of primary care, quantitative and qualitative imbalances in the professional labor market, and weak leadership to improve health-system performance” (Frenk et al., 2010, p. 1923). Ergo, without substantial interventions, such trends will create severe implications for the global population health in that “a global under-supply threatens the quality and sustainability of health systems worldwide” (Frenk et al., 2010, p. 1923).

In the age of globalization and international migration, distance learning, especially web and internet based, offers an opportunity for students to scale up their knowledge and skills. E-learning is now regarded as an effective tool in healthcare workforce training and development (Safie and Aljunid, 2013, p. 590). It has in some way positive effect on the learning process by providing the learner with supplementary and updated knowledge that may not otherwise be acquired in a traditional classroom-based instruction. Through e-learning, Safie and Aljunid (2013, p. 590) opine that “healthcare workforce can easily access, monitor and record their learning progress and where if properly executed, the method can be an effective tool to support learning as a collaborative, collective and social experience.” In their review of numerous articles about distance learning in healthcare, Knebel (2001) highlighted the major benefits of such approaches to education notably its convenience to both faculty and students alike and in the accessibility of training. The importance of improving accessibility to such learning and knowledge transfer would in effect address issues pertaining to the expertise in the healthcare sector of those developing countries experiencing “crisis in
health human resources” given evidences on the effective use of e-learning in healthcare education in such contexts (Chhibber, 2004). Allegrante et al. (2009, p. 427) therefore posit that “the increasing prevalence of infectious and chronic diseases, as well as the deteriorating public health infrastructure in many settings in the world in part requires for renewed interest in the professional preparation and training of the public health workforce.” This is because health has become the center of many important global issues, including economic development, global security, effective governance and human rights promotion (Frenk, 2010, p. 1). Frenk et al. (2010, p. 5) therefore recommend for a “a redesign of professional health education as necessary and timely in view of the opportunities for mutual learning and joint solutions offered by global interdependence due to acceleration of flows of knowledge, technologies, and financing across borders, and the migration of both professionals and patients.” Such efforts can then be geared toward the transformational scaling up of health professionals’ education and training in order “to increase the quantity, quality and relevance of health professionals, and in so doing strengthen the country health systems and improve population health outcomes” (WHO, 2014, p. 11).

Ergo, this paper provides a discussion on international health programs in Asia with respect to transforming and scaling up health professionals’ education and training aimed at developing more responsive health practitioners in the face of twenty-first century global health challenges. The paper is informed by a descriptive qualitative case study of the University of the Philippines Open University’s (UPOU) International Health Program, by assessing the International Health and Development (IH 201) Module. The purpose of this paper is to critically illustrate how transformative education and training through ODeL can aid in increasing the quality, quantity and relevance of health professionals. The outcome of this paper is relevant to institutions in Asia in particular that offer ODeL-based international public health programs which through open knowledge systems can produce graduates who are more responsive to the evolving health care needs of both local and global populations amid twenty-first century global health challenges.

Theoretical framework
According to Swan (2005, p. 4), learning theories are referred to social constructivist when “their main concern is with knowledge construction through social interactions. This theory is drawn from the work of Lev Vygotsky (1978) who opined that all learning is a result from social interaction where meaning becomes socially constructed through communication, activity and interactions with others (Swan, 2005, p. 4). As such, meanings are learned collectively and later internalized individually and where the latter in turn guides social interactions. This schema of learning formed the basis of Piaget’s (1952) concept of cognitive construction, an epistemology that attempts to locate individual learning as an outcome of mental construction liked to interactions with the environment (Swan, 2005). According to Gold (2001, p. 37), “constructivism is an alternative epistemology [to objectivism] of how people learn and assimilate new knowledge” through a process that produces “cognitive structures that are similar to the experiences of those who are engaged.” Gold (2001, p. 38) contends that from this perspective, interpretation constructivism can include different types of knowledge construction where the goal is for the learner “to build, or re-invent knowledge.” Learning by the student is therefore gained through the ability of focusing “on concrete situations and understand not only the facts but also the context in which these facts are placed)” (Gold, 2001). A constructivist approach is therefore one that is learner-centered and based
on “authentic learning” in which problems and scenarios reflect student’s lives (Gold, 2001; Carwile, 2007). In the online platform, Thorman et al. (2013, p. 297) posit that online constructivist learning requires students to critically engage with new information through problem solving, analysis and the interpretation of new information through prior beliefs, experiences and perspectives where the role of the instructor is de-centered as a facilitator whose essence is to guide learners toward critically engaging with the material and collaborate with peers while rarely imparting knowledge directly (Carwile, 2007). This process of collaborative learning and its ultimate outcome aligns with Bloom’s (1956) taxonomy of cognitive learning which starts from general knowledge acquisition to a higher order critical evaluation of synthesized knowledge, a process described as one of “deeper learning and a greater degree of cognitive processing” (Adams, 2015, p. 152). Bloom’s (1956) taxonomy was later revised where the level of “synthesis” was placed above that of “evaluation” to become the highest level of cognitive learning a la Anderson and Krathwohl (2001).

It is the contention of Adams (2015, p. 153) that the alteration of Bloom’s (1956) original model adds a new dimension across all six cognitive processes where learning activities become specified by four types of knowledge, namely, factual (terminology ad discrete facts); conceptual (categories, theories, principles and models); procedural (knowledge of a technique, process or methodologies); and metacognitive (self-assessment ability and knowledge of various larding skills and techniques). These four cognitive knowledge types aligns with that by Gold (2001) who equally used four components of the constructivist approach, namely, assimilation, accommodation, equilibrium and disequilibrium, originating in Piaget’s (1977) theory on knowledge construction, to analyze online education and student learning outcome. The stage of assimilation involves a process by which one associates new events with existing knowledge and prior conceptions, usually done through reviews of empirical literature, the stage of accommodation that involves changing existing structures to new information. According to Hughes et al. (2004, p. 264), these two levels of Piaget’s cognitive learning relates to Bloom et al.’s (1964) lower levels. The intention at the higher levels is to develop student’s abilities to analyze their conceptual construct of a subject. Piaget (1977) in this regard adds the following two levels: equilibrium involving the balancing of one’s understands with that of others, and disequilibrium, which involves experiencing a new event without necessarily achieving equilibrium (Piaget, 1977). As such, the achievement of disequilibrium as the highest order of cognitive learning relates to both Salmon’s (2002, p. 10) “Self-reflection Stage” and Bloom’s revised taxonomy placing “synthesis” at the top of the learning order (Anderson and Krathwohl, 2001; Krathwohl, 2002). Salmon’s five stages model outlines means by which online learning can be achieved and the role of e-moderators in this process (Salmon, 2003). According to Gash (2012, p. 233), Salmon’s pedagogical model adopts a social constructivist perspective in describing the steps through which learners, while aided by their e-moderators, can become acclimatized to their class environment (access and motivation), become acquainted with their peers (socialization), research and share information (information exchange), deliberate on meaning and co-construction of knowledge (knowledge construction) and lastly to condense newly gained knowledge and understanding through self-refection (development). The ultimate outcome is for individuals to become sophisticated in their ability to reflect on and transfer knowledge gained through integration of their online experience (Salmon et al., 2010).

Emphasizing contextual relevance of constructivist models of learning has witnessed other conceptual frameworks such as Wenger’s (1998) theory to online
learning context that seeks toward the building of a “Community of Practice”, and Moule’s (2007) e-learning ladder approach that aims at enhancing Wenger’s “Community of Practice” in determining student’s ability to interact among peers in “joint enterprise and shared repertoire with knowledge and learning gained within the community” (p. 43). According to Moule (2007), Wenger’s (1998) theory has been applied in a number of studies such as that in the evaluation of a virtual learning environment to build support for an undergraduate medical course (Ellaway et al., 2004) to that of analyzing electronic interactions among researchers for a project that sought to consider children’s representation of information and communications technology (Somekh and Pearson, 2000). Moule’s (2007) e-learning ladder model on the other hand acknowledges a range of learning approaches, “starting at the bottom ‘rung’ that might be termed as instructivist, and moving through the ‘rungs’ ending with constructivist, or interactive learning approaches” (Moule, 2007, p. 42). Such pedagogical approaches can therefore be adopted in the online platform in efforts geared toward the transformational scaling up of health professionals’ education and training as called for by the WHO (2014).

Methodology
The study seeks to describe means by which transformative learning via a constructivist approach to knowledge construction occurs in the IH 201 Course. This paper is based on a descriptive qualitative case study (Baxter and Jack, 2008; Yin, 2003) of the IH 201 course offered under the DIH program at the UPOU which the author has been the faculty-in-charge (FIC) for the past three years. The paper acknowledges its limitation in its scope by assessing only this particular course in the overall International Health Program offered at UPOU. The course takes into cognizance developments in recent discourse in international health (Appendix 1) and is delivered entirely through e-learning platform via virtual classrooms run in MyPortal, a Moodle-based online learning management system of UPOU (Faculty of Management and Development Studies, 2015). Students have access to open educational resources (OERs) to aide in their learning experience. OER and Open educational practices are strongly fronted and used to train and support professionals in situations where funding and resources are scarce (Coughlan and Perryman, 2015). There were a total of 91 enrolled students in the course but where only 40 who actually took and completed the course. Data for the study were collected principally from student feedback (qualitative), student evaluation of teacher (SET) survey, and from the course guide highlighting samples of tasks done. Data were also gathered from the SET survey received from 14 students (35 percent of the total who completed the course). These scores were based on a Likert scale where 1 is ranked as “strongly agree” and 5 as “strongly disagree” on the following sections: course guide, learning resources, learning activities, discussion forums, student learning, student support, course site and on the FIC. Faculty feedback was however not solicited in informing the study and one that is recommended in future studies in order to add to rigor.

The analytical framework of this case is guided by Piaget’s (1977) learning concepts of assimilation, accommodation, equilibrium and disequilibrium which Gold (2001) equates to a process of transformative learning as pedagogically rooted in Mezirow’s (1991) transformative learning theory, the latter which views learning as a collaborative process in critical reflection to develop new perspectives, skills and behaviors (Cranton, 2006). According to Wittich et al. (2010, p. 1791) in reference to Piaget’s (1977) constructs, the transformative learning process begins with experiencing a
“disorientating dilemma”, like a life event, which causes the learner to pause and question underlying beliefs and assumptions and ends with critical reflection on the “disorientating dilemma” to expose the learner’s limitation and areas for improvement (Piaget, 1977). Beckman and Lee (2009) contend that the learner can in such a process address these limitations by acquiring new knowledge, skills and or attitudes. Transformation therefore occurs when learners are provided with fresh perspectives and powerful means for enacting improvement (Wittich et al., 2010, p. 1791).

**Results**

To aid students in constructive learning in an enquiry-based manner, the IH 201 course generally comprises of student-led discussion forums complemented by self-gauging multiple-choice quizzes. Further discussions are aided by faculty moderated discussions. Timed online multiple-choice midterm and final exams also constitute part of overall student assessment evaluation of student learning is done by gauging their development of critical viewpoints on topical issues as drawn from both personal experiences and from reading the literature. Table I aligns with Piaget’s (1977) learning concepts notably: assimilation, accommodation, equilibrium and disequilibrium and their respective instructional principles with module tasks in order to illustrate the constructivist component in the IH 201 course. According to Gold (2001, p. 39), the aim of a constructivist approach to learning is not outcome *per se*, but rather aiding students in their own ability to acquire knowledge.

**Discussion**

*The transformative learning process in the IH 201 course*

In an ODeL context, a constructivist syllabus or curriculum is what Gold (2001, p. 36) opines as being “less content-oriented and more learner-centered where the designer goal is to create an information-object rich, and socially meaningful (i.e. communication and collaboration filled) learning environment.” The role of the instructor is one of a facilitator (Salmon, 2002) in aiding the learner understand multiple perspectives through reflection of authentic tasks (Flavell, 1993). In such a setting as highlighted in Table I, the learning environment allows to students to start with observations within a world of authentic artifacts rooted in authentic (professional practice) situations. Students while in the process of accessing various OERs, construct ongoing interpretations of their readings and experiences, and collaborate interactively with their peers via student-led discussions. Small group case-based discussions (SGDs) can aide in this learning process as attested by the work of Hilvano et al. (2014). The authors (Hilvano et al., 2014, p. 29) empirically validate that SGDs based on case-based problems can enhance critical thinking skills, improve self-esteem, cultivate a positive attitude toward learning, increase motivation and improve interpersonal skills. In such a structure, the iteration rate is usually set by the students themselves and where the “freedom of this situation can lead to much deeper and wider debate” (Cartwright, 2000; Dysthe, 2002). As such, an increase in the level of deliberations presupposes that the student will be active in their engagement since students are believed to be “capable of assessing their own learning needs and will learn best when given the autonomy to meet them in their own way” (Rogers, 1983) especially when students are allowed to serve as coaches and teachers to each other in order to show mastery of what they learned (Gold, 2001, p. 38).

For illustrative purposes and in light of the case study in discussion in this paper, students were tasked for their first student-led discussion activity (SLDF) (out of six such tasks in the entire course) to undertake a problem solving activity on...
<table>
<thead>
<tr>
<th>Module sessions</th>
<th>Instructional principles</th>
<th>Cognitive learning concepts and indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Introduction</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Post your self-introduction in the course site in MyPortal</td>
<td>Orientate the learner to their online learning environment</td>
<td>Assimilation</td>
</tr>
<tr>
<td>Introduce yourself, your institutional affiliation, professional background, and your expectations from the course</td>
<td>Assess the learner’s prior knowledge and experience</td>
<td>Assimilation</td>
</tr>
<tr>
<td>Read the course guide</td>
<td>Solicit problems from the learner and to use these as stimulus for learning activities as an end of program project</td>
<td>Assimilation</td>
</tr>
<tr>
<td>Explore the course site</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seek clarification on the content of the course</td>
<td></td>
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</tr>
<tr>
<td><strong>Weeks 2-3 Unit I. Overview of international health and development</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Read assigned readings</td>
<td>Anchoring all learning activities to a larger task (DF and FMA) so that the learner can perceive and accept the relevance of the specific activities in relation to the larger tasks</td>
<td>Assimilation</td>
</tr>
<tr>
<td>Answer the study guide questions and discuss the answers in the forums</td>
<td>Learning environment is designed to support and facilitate critical thinking</td>
<td>Accommodation</td>
</tr>
<tr>
<td>Participate in faculty moderated discussion forum (DF)</td>
<td>Encourage testing ideas in discussions against alternative viewpoints and contexts</td>
<td>Accommodation</td>
</tr>
<tr>
<td>Prepare for faculty marked assignments (FMA)</td>
<td>Opportunities provided to reflect on both the learning content and process of the unit</td>
<td>Equilibrium</td>
</tr>
<tr>
<td><strong>Submit FMA</strong></td>
<td><strong>Challenging misconceptions</strong></td>
<td><strong>Disequilibrium</strong></td>
</tr>
<tr>
<td></td>
<td>Test for reinforcement</td>
<td>Accommodation</td>
</tr>
<tr>
<td><strong>Weeks 4-7 Unit II. Major global health issues</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Read assigned readings</td>
<td>Learning environment designed to support and facilitates critical thinking</td>
<td>Accommodation</td>
</tr>
<tr>
<td>Answer the study guide questions and discuss the answers in the forums</td>
<td>Encourage testing ideas in discussions against alternative viewpoints and contexts</td>
<td>Accommodation</td>
</tr>
<tr>
<td>Take self-gauging quiz</td>
<td>Designing a student-led task where cognition is consistent with professional practice in the field</td>
<td>Equilibrium</td>
</tr>
<tr>
<td>Participate in Student-led discussion forums and production of group projects (reports, policy briefs, proposals, action plans and iterative essays)</td>
<td>Opportunities provided to reflect on both the learning content and process of the unit</td>
<td>Equilibrium</td>
</tr>
<tr>
<td>Provide group summaries on the module content vis-a-vis practice</td>
<td><strong>Challenging misconceptions</strong></td>
<td><strong>Disequilibrium</strong></td>
</tr>
<tr>
<td><strong>Submit FMA 2</strong></td>
<td>Test for reinforcement</td>
<td>Accommodation</td>
</tr>
<tr>
<td><strong>Week 8</strong></td>
<td></td>
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<tr>
<td>Mid-term exam</td>
<td>Test for reinforcement</td>
<td>Accommodation</td>
</tr>
</tbody>
</table>

**Table I. Constructivist component of modules in IH 201 (continued)**

**Open and distance learning**
Module sessions | Instructional principles | Cognitive learning concepts and indicators
---|---|---
**Weeks 9-11 Unit III. Health and development**  
Read assigned readings  
Answer the Study guide questions and discuss the answers in the forums  
Take self-gauging quiz  
Participate in student-led discussion forums and production of group projects (reports, policy briefs, proposals, action plans and iterative essays)  
Provide group summaries on the module content *vis-à-vis* practice  
Submit FMA 3  
**Weeks 12-14 Unit IV. Strategies for addressing international health challenges**  
Read assigned readings  
Answer the study guide questions and discuss the answers in the forums  
Take self-gauging quiz  
Participate in student-led discussion forums and production of group projects (reports, policy briefs, proposals, action plans and iterative essays)  
Provide group summaries on the module content *vis-à-vis* practice  
**International cooperation and partnerships**  
Read assigned readings  
Answer the study guide questions and discuss the answers in the forums  
Participate in discussion forum 4  
Prepare and submit FMA 4  
Prepare for final exam  

Table I. (continued)
communicable and non-communicable disease burdens in low and middle income countries. The task required students to deliberate as a group (eight members per group out of five groups) in selecting a particular country that is experiencing a “double burden of disease” and produce a health policy paper highlighting the emerging health issue in a country of choice (Week 4, September 19- September 25, 2015). Presented in Figure 1 are the frequencies of appearance of Group A members who chose the topic on malnutrition among women and children in Bangladesh. This figure does not factor in the time spent doing the activity online or if the deliberations were done external of the

<table>
<thead>
<tr>
<th>Module sessions</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Opportunities provided to reflect on both the learning content and process of the unit</td>
<td>Equilibrium</td>
</tr>
<tr>
<td>FMA 4</td>
<td>Test for reinforcement</td>
<td>Accommodation</td>
</tr>
<tr>
<td>WEEK 14</td>
<td>Test for reinforcement</td>
<td>Accommodation</td>
</tr>
<tr>
<td>Final exam</td>
<td></td>
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<tr>
<td><strong>Course evaluation</strong></td>
<td></td>
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</tr>
<tr>
<td>Complete student evaluation of teacher SET) survey (quantitative component)a</td>
<td>Providing an opportunity for altering, modifying and enhancing course content and delivery vis-à-vis professional practice requirements</td>
<td>Disequilibrium</td>
</tr>
<tr>
<td><strong>Instructor evaluation</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Complete student evaluation of teacher survey (qualitative component)b</td>
<td>Providing an opportunity for altering, modifying and enhancing Course content and delivery vis-à-vis professional practice requirements</td>
<td>Disequilibrium</td>
</tr>
</tbody>
</table>

Notes: a Refer to Appendix 2 IH 201 SY 2015-2016 SET survey; b refer to Appendix 3 on qualitative student feedback

Table I.

- Open and distance learning

Figure 1.
Frequency of appearance by date, Group A
virtual class. It therefore highlights only the frequency of appearance of students in the virtual classroom on various dates in September, 2015.

From the data presented in Figure 1, students tend to appear more frequently toward the middle and end of the set date for the task. This indicates consistency in undertaking the task assigned collectively. Assessment of students learning outcomes and critical thought in this and other SLDF e-tivities were primarily gauged on the following criteria; that posts provide an engaging basis for further dialogue; that the initial post is made early in the discussion forum to allow for sufficient time for further deliberations from colleagues; submission and additional posts shows the ability of the student to consistently extend dialogues in multiple ways by encouraging and contributing well-supported new/alternative viewpoints, and through the use of probing questions, constructive arguments and critique in response to others’ postings and providing relevant additional empirical resources. A separate Forum was created where all the group output was posted to allow for further discussions among students as a peer-review process (equilibrium and disequilibrium). Qualitative comments as highlighted below therefore attest to Gold's (2001) and Roger's (1983) contentions on the abilities of students to assess their own learning needs as peers and where such learning is done best when students are given autonomy:

Re: Assignment
by RO- Friday, 25 September 2015, 1:11 PM
Hi Vic, I am not the group leader. Mam Weng already assigned Kath to put our inputs as a draft. Kindly help her. Coordinate nalang po sa kanya [with them]. Please consolidate all comments of our groupmates. You can post it in the forum as a word format so that everybody can have the access to edit it. For now, I still have important obligations to do, sorry but I will get back later in the evening and let’s finish our assignment before 12mn 😊

RO

Re: Policy Brief_Group 1a
by GB- Saturday, 24 October 2015, 9:04 PM
Congratulations Group 1A for coming up with a very good policy brief. I was observing how you interacted with each other and how you exchanged ideas among yourselves. That was wonderful. Though not everyone participated in the discussion, some of you stood out in the discussions and some showed great leadership. Nice work.

Anecdotally as presented in the data above, engaging in the SLDFs in the IH 201 course aligns with Piaget’s (1977) cognitive knowledge category of equilibrium. This form of interactive, collaborative and multidisciplinary learning experience is necessary for transformative learning in line with the following espoused World Health Organisation (WHO) (2013, p. 45) principles deemed important in the design of any inter professional education (IPE)-oriented curricula:

1. Has relevance to learners’ current or future practices.
2. Uses typical, priority health problems that require inter-professional approaches for their solution.
3. Inter-professional learning based on work practice.
4. Learning methods that facilitate interaction between learners from different professions including small group learning. Formats such as case-based and problem-based learning have been shown to be particularly effective.
Student evaluation of the IH 201 course indicates a general agreement that the Course meets their learning expectations (Appendices 2 and 3). From these responses, it comes out that much of the learning a la Piaget’s (1977) analytical framework on processes of knowledge production was, or should be, gained through interactive deliberations. From the student feedback, it is subjectively evident that an essence of transformative learning was gained in meeting the above listed WHO recommended IPE principles where learners are able to “construct meaning through sustained communication” through inter-professional learning (Garrison et al., 2001, p. 11). As this was a descriptive qualitative study, there is need for further research to quantitatively assess learning outcomes, e.g. comparative studies such to gauge the effectiveness of enquiry-based transformative learning experiences using small group discussions such as that by Hilvano et al. (2014). Doing this may empirically highlight how ODeL-based courses aimed at transformative learning can illuminate student problem solving abilities and critical thinking skills through group tasks (Hilvano et al., 2014).

From a constructivist pedagogical perspective, curriculum or syllabus should be geared toward “solving problems within the context of a person’s previous knowledge” (Gold, 2001, p. 40). This is achieved in the online environment by engaging learners in experiential learning with peers and instructors via actual project-based learning accomplished through e-tivities in order to demonstrate applicability in practice (Hilvano et al., 2014; Mastilak, 2012). For the IH 201 course in discussion, the core e-tivities employed included reports, policy briefs, proposals, action plans and iterative essays. A number of studies (Le’gare et al., 2015, Blanco et al., 2014) however raise concern over learning objectives in many training programs and curricula that focus overwhelmingly on the lower levels of the taxonomy of cognitive learning, knowledge and comprehension. Ergo, innovative processes to online learning necessitates a pedagogical shift in perspective during which habits of mind become more open, more permeable and better justified (Cranton and Taylor, 2012, p. 3). This I argue is best done “constructively” where transformative learning is achieved through a process of scaffolding (Kass, 2013; Salmon et al., 2010; Salmon, 2002) involving movement from an instructional to constructivist approach via e-tivities or what the WHO recommends, case-based and problem-based learning (WHO, 2013). This form of learning is guided by a pedagogical philosophy that “involves interaction between neutral, cognitive, motivational, affective and social processes” (Azevedo, 2002, p. 31). These occurs when a person, group or larger social unit encounters a perspective that is at odds with the prevailing perspective (Cranton, 2006, p. 2) or disequilibrium as per Piaget’s (1977) concept. Indeed the WHO (2013, p. 21) guidelines on transformation and scaling up of health professionals’ education and training makes a call “for new approaches in health professionals’ education that transform systems and encourage the move away from the traditional focus on tertiary care hospitals and toward initiatives that foster community engagement.” I thus reiterate Blanco et al.’s (2014) call for health educators to consider such shortcomings if health professionals are to achieve increasing level of skill and function. Doing this requires more critical assessments of transformative learning taxonomies that will in effect enhance the potential of ODeL-based healthcare education and training in offering an alternative approach to health care professionals’ education and training through open knowledge systems and thus produce graduates who are more responsive to the evolving health care needs of both local and global populations amid twenty-first century global health challenges.
Conclusion
This paper sought to qualitatively discuss, via a descriptive case study of the course in IH 201 of the International Health Program of UPOU, the means by which transformative education and training in global health can be undertaken through ODeL in the quest for increasing the quality, quantity and relevance of health professionals in the twenty-first century. E-learning is an affordable and credible means to reduce the growing disparity in health between developing and developed countries and, as such, “may offer a means of extending public health education in deprived areas and developing countries, where access to public health education is limited by lack of teaching facilities and resources” (Angell et al., 2011, p. 552). Ergo, the design, delivery and transformative learner outcomes as illustrated in this case analysis of the IH 201 course aligns with the general literature regarding the alternative solution ODE, and ODeL in particular, offers as “a viable method for increasing the skills of health care workers in low-resource settings. While acknowledging the limitation in the scope of the study, this paper’s discussion while supported by empirical literature shows relevance on the transformative learning process in health education and training which can be achieved by engaging students in constructive experiential learning via project-based learning. However more critical assessment of transformative learning outcomes are needed in order to enhance the potential of ODeL-based healthcare education and training in Asia and thus produce graduates who are more responsive to ever growing public health care needs. For future research, there is need to take on board Hilvano et al. (2014) proposition for the need to gauge the effectiveness of enquiry-based transformative learning experiences on the following variables: group selection processes, group size, group composition, amount of instructor intervention or consultation and student preferences as to learning styles. Doing this may help in highlighting how online courses aimed at transformative learning can illuminate student understanding and analysis of problem solving, learn critical thinking skills, and in ensuring group tasks of learners (Hilvano et al., 2014).

References


Rogers, C. (1983), *Freedom to Learn for the 80s*, Columbus, OH.


Appendix 1. IH 201 International Health and Development Course Syllabus, UPOU

Course outline
Unit 1: Overview of International Health and Development
  Module 1: The Context of International health
  Module 2: The Alma Ata Declaration and social determinants of health
Unit 2: Major Global Health Issues
  Module 3: Non-communicable diseases
  Module 4: Emerging and re-emerging communicable diseases
  Module 5: Women’s and Children’s Health
  Module 6: Adolescent Health
  Module 7: Aging and Global Health
Unit 3: Health and Development
  Module 8: Health Inequalities and Inequities: a Development Agenda
  Module 9: The Economics of International Health
  Module 10: Health in the post-2015 UN development agenda
Unit 4: Strategies for Addressing International Health Challenges
  Module 11: International health policies and systems
  Module 12: International cooperation and partnerships
Appendix 2. Student evaluation of teacher (SET) Semester 1, 2015-2016

Course code: IH 201
Number of students: 91
No of respondents: 14

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<td>Overall Mean</td>
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</table>

Overall Mean 1.928

Appendix 3. Student qualitative feedback

For the course in International Health and Development, there were 91 enrolled students, all who were Filipinos. A relatively low rate of student feedback (~8 percent) was received on the course as posted in the main course site as an end of module reflection. These are presented below where initials at the end of statements indicate the coded identities of respondents followed by their occupation and location:

I am very grateful that I enrolled in this course! I learned a lot and had an amazing learning experience with my classmates especially my groupmates! Thank you Sir Rehal for being a great teacher! D.C. (Filipino Medical Technologist – Al Jubail, Saudi Arabia).

All good things will come to an end. Indeed, this course has brought me a lot of good things and we already have reached the end of this course. But I learned a lot of new things, interacted with a lot of people from different places, shared a lot of insights and gained a whole lot new of experiences. Thank you Sir for imparting your wisdom to us and for letting us also share the lessons we gained through our discussion forum. I also want to thank my groupmates for the camaraderie we have slowly built through the interactions we have had in our forums. Looking forward to work together with you in the next courses we will have S.L. (Medical Technologist-Philippines).

I would like to express my sincerest thanks to Prof Rehal and Dr Gen David for the valuable learnings we gained from the course. With all the challenges that I encounter in this course, it added all to my professional growth as health care worker. And to my groupmates, thanks for the great discussion and support for each other. Till the next course! P.C. (Filipino Nurse Inspector-Bahrain School of Royal Medical Services).

I just want to say that I really enjoyed this course though I must say it is tough. Thank you for all of your experiences and knowledge shared through our discussion I’ve learned a lot from you guys and I hope to hear from you again next semester. Good luck to all of us and God bless! J.A. (Administrative Staff-East Avenue Medical Centre Philippines).

I love this course. International health has been my passion along with supportive, hospice, and palliative care medicine. It has been my dream to join international health organizations when I was but a child. I promised myself to apply in one of the international health organizations after my residency training, subspecialty training, and masteral course. All in all, I’ve learned a lot knowledge-wise and attitude-wise in this course E.B.G. (Physician-Philippines).

At first, I thought I could not make it to the end but I was able to finish the course because I was motivated by you and my classmates, especially my groupmates. They were all great and I learned a lot from them and that’s more important to me W.S. (Medical Doctor-Philippines).
Overall, Sir Rehal makes the course interesting with lots of activities such as DF and SLDF making all students interact/debate and in the same time make friends B.R. (Nurse-Jeddah, Saudi Arabia)

I do appreciate that the modules in this course are also related with other DIH subjects that I enrolled in – where supplemental ideas could be learned further R.O. (Inspector for Pharmaceutical manufactures-Philippines).

I think additional FIC, tutor or moderators are needed in order to reduce the number of students in the groupings so that discussions are well-facilitated. Furthermore, other strategies maybe needed to encourage all students to participate in the SLDF (student led discussion forum) so that more learning is gained S.T. (Medical Technologist-Doha, Qatar).

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Blended learning for building student-teachers’ capacity to learn and teach science-related interdisciplinary subjects

The case of Hong Kong

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Abstract

Purpose – The purpose of this paper is to report the design and evaluation of an inter-university collaborative project entitled “Blended learning for building student-teachers’ capacity to learn and teach science-related interdisciplinary subjects.” The project is a response of the science education faculty of three Hong Kong tertiary institutes to the challenge of catering to the diversity of academic backgrounds among student-teachers.

Design/methodology/approach – E-learning modules have been produced covering four content domains of science. These modules are designed based on the 5E learning model and are delivered to students using the learning management system provided by Moodle. The design of the modules is iterative, based on the evaluation of three consecutive rounds of trials through student surveys, and focus group interviews with students and course lecturers.

Findings – The evaluation findings indicate positive outcomes for certain attributes such as conceptual understanding, eagerness and confidence in learning science, and metacognitive reflection on students’ own learning. There are challenges to be met in relation to instructional design to cater for the diversity of student abilities, and enhance motivation in self-directed learning.

Practical implications – The project indicates the ways to develop students’ basic science knowledge in a mixed-ability setting through the design of self-directed e-learning modules blended with their major courses and possible measures to address the limitations of such design.

Originality/value – The study represents a conscious effort for the science teacher education faculty of different universities to pull together to tackle a perennial teaching and learning problem.

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This project was funded by the Hong Kong University Grants Committee under the Funding Scheme for Teaching and Learning Related Proposals.
The findings provide important insights into possible ways to blend e-learning with face-to-face learning approaches to better cater to the needs of science learners with mixed abilities to prepare them for interdisciplinary teaching.

**Keywords** Science teacher education, Blended learning, E-learning, Instructional design, Mixed-ability teaching

**Paper type** Research paper

**Background of the project**
The project addresses the problems that science teachers face in Hong Kong. At the primary level, science is not taught as an independent subject; it is integrated with social studies and health education to form an interdisciplinary subject, general studies. The implication for teacher education is that general studies teachers may have varied backgrounds in science. At present, many teachers are drawn from non-science streams. These teachers lack the essential science background to teach science concepts and process skills. The problem of differing levels of competence of primary teachers in science is likely to be exacerbated by the recent implementation of the new senior secondary curriculum in Hong Kong, which provides students with even greater flexibility in their choice of subjects. Students now may or may not opt for any single science subject, such as physics, chemistry, or biology, making the background of prospective student-teachers in science even more diverse than ever.

Science teacher education at the secondary level may also experience problems for two reasons. First, science teachers, regardless of the pure science disciplines they majored in at university, must teach junior secondary science to students aged 12-15; this course integrates physics, chemistry, and biology. Second, a new senior secondary subject, liberal studies (LS), was implemented in Hong Kong several years ago; this course focuses on developing secondary students’ critical thinking skills through an issue-based approach applied to various contexts, including public health, energy, and the environment. LS teachers thus have the implied need to have a basic mastery of science concepts and scientific reasoning, which many non-science teachers are likely to lack.

**Inadequacy of current provisions to address the learning issue**
Program evaluations by both students and tutors at the Education University of Hong Kong have consistently indicated that the courses on science for student-teachers are pitched at too high a level for those with little background knowledge in science. These student-teachers often have difficulty understanding the more advanced science concepts taught in science-related courses. Apart from their lack of basic science knowledge due to their choice of non-science subjects at the senior secondary level, there are other cultural factors such as self-image that impinge on their alienation from science (Wegerif et al., 2013). This inevitably influences their confidence to teach science-related topics. Research on science teachers’ performance in teaching secondary science subjects outside their specialization indicates that such teachers generally have less confidence than when they are teaching their specialist subjects (e.g. Dillon et al., 2000), have more misconceptions about subjects outside their specializations (e.g. Kind and Kind, 2010), and are less capable of handling students’ conceptual problems (e.g. Käpylä et al., 2009). The inadequacy of scientific knowledge, particularly among primary and junior secondary teachers, has been a cause for concern in both Hong Kong and the USA (So et al., 1998; National Research Council, 2007). Research has demonstrated that teachers’ intentions to teach science through inquiry, an approach highly recommended for teaching science, and their self-efficacy (Liang and
Richardson, 2009) are determined at least partially by their perceived level of mastery of content knowledge (Luera et al., 2005). Moreover, teachers’ previous learning experience in science, their perceptions of the nature of science and inquiry, and their understanding of the process of learning science by inquiry may all affect their ability to teach science through inquiry (Avraamidou, 2012; Liang and Richardson, 2009; Varma et al., 2009; National Research Council, 2007).

Existing practices in the Institute to address student diversity often involve the inclusion of supplementary science content pitched at a more foundational level. However, this has not solved the problem because of insufficient contact time and the wide diversity of students’ understanding of science. Some students have difficulty in catching up, while others with stronger backgrounds in particular areas of science find the content not challenging enough and become demotivated. Some lecturers have resorted to face-to-face coaching and tutorials for students in need on an ad hoc basis, but these measures are usually not well structured and organized and often do not have a significant effect on students’ learning. Such problems are more acute for postgraduate student-teachers, whose programs are often too short to focus on subject content knowledge in addition to pedagogy, and for part-time in-service postgraduate student-teachers, who spend only limited time on campus.

**Theoretical underpinnings and paradigm shifts in learning**

Blended learning approaches have become increasingly common in tertiary education around the world. These approaches often involve the use of self-directed learning materials delivered through a learning management system (LMS) to supplement face-to-face teaching. Learning management tools include blogs, quizzes, journals, online discussions, virtual lectures and activities, e-portfolios, and feedback. The advantages of blended learning are increasingly being recognized; these include the provision of new learning environments, more opportunities for learning, less dependence on teachers, the facilitation of cooperation among students, and the recognition and reinforcement of students’ efforts (Gil and Garcia, 2011). Blended learning fits with the constructivist approach to learning, which recognizes the role of the learner in constructing knowledge rather than receiving knowledge passively from the teacher. This approach entails the provision of a learning environment that is conducive to self-directed learning to fit with the learner’s own experience and cognitive ability (Condie and Livingston, 2007). Even for those that have studied science at senior secondary levels, they are not necessarily familiar with different areas of science or do not have experiences in interdisciplinary learning that are necessary for teaching socioscientific issues (Thomson and Tippins, 2013). Fensham (2012) points out that addressing this type of complex issues entails the application of multi-disciplinary knowledge and scientific reasoning, a process that obviously requires broader and deeper understanding of science. It is also essential that a constructivist learning environment can facilitate the development of metacognitive skills to enable learners to reflect on the efficacy of their learning processes and regulate their own learning strategies to achieve their desired learning outcomes (Thomas, 2012). In short, in such a learning environment, the learner is expected to be self-regulated, with learning becoming internally rather than externally controlled (De Kock et al., 2004).

Latchem and Jung (2010) argue that blended learning helps to motivate student learning and make the purposes of learning more explicit and clear to the learner. By blending e-learning with conventional classroom learning, students could “take advantage of much of the flexibility and convenience of an online course while retaining
the benefits of the face-to-face classroom experience” (Dziuban et al., 2011, p. 17). Moreover, blending the two different learning modes is highly flexible and can be tailored to the specific needs of different learning or subject contexts such that learners can take control and personalize their learning (Condie and Livingston, 2007) in an environment also oriented toward developing their self-regulation and metacognition. For science learning, different strategies can be embedded in blended learning, including virtual lectures (Gosper et al., 2008), virtual lectures followed by group-based problem-solving activities in the classroom (flipped classroom), interactive simulations (e.g. University of Colorado Boulder, 2013), and technology-assisted investigation activities such as a remote-controlled laboratory (Gröber et al., 2007). Thus, blended learning constitutes a paradigm shift toward more diversified goal-oriented and personalized pedagogies.

The main thrust of the project is to design a series of basic science modules to provide student-teachers with the necessary foundation for acquiring more advanced content knowledge from their major courses. These modules are designed together by three institutions, namely, the Education University of Hong Kong, the University of Hong Kong, and the Chinese University of Hong Kong for integration into existing courses in a flexible way to meet different course requirements. The pedagogical design of these modules is based on a blended learning mode that combines the advantages of e-learning and face-to-face contact. The e-learning component is delivered through Moodle (2.7), a LMS, which will be used as the major learning platform. An advantage of this kind of LMS is that it is familiar to students and contains a wide array of e-learning tools, such as quizzes, journals, blogs, and discussion forums. This learning environment allows self-pacing by students under the guidance of the course tutor. It is also intended to provide role models for student-teachers who have already obtained a science degree on the use of interactive e-learning strategies blended with traditional face-to-face teaching to extend their pedagogical repertoire in science teaching. It is hoped that this joint venture amongst the three universities will contribute to the building of the capacity of local science education faculties to design and implement creative and innovative teaching and learning strategies to address curriculum and learning issues in teacher education.

This project comprises four progressive stages of development. The first stage is the design of learning modules that can be integrated with existing teacher education courses to enhance student-teachers’ understanding of basic science. Such understanding constitutes the basis for their mastery of science-related content and pedagogical knowledge and skills. The second stage is the piloting of these modules in relevant courses. The third stage is the evaluation of the trials. The final stage is the revision of the module design for more effective learning and integration with existing courses. However, in actual implementation, these four stages are integrated to varying extents.

**Stages of Module Development**

**Stage 1: Design of Basic Science Learning Modules**

*Structure and organization of the learning modules.* The design of the foundational science modules forms the basis of this teaching and learning development project. These modules cover major areas or topics of science that are fundamental to teacher education courses across the three institutions. A detailed examination of the existing courses suggests that the proposed foundation science modules can best be organized into four content domains: “Nature of science and scientific inquiry,” “Life and health sciences,” “Energy and physical phenomena,” and “Materials in the environment.” The “Nature of science and scientific inquiry” domain provides the foundation for the study of science-related methods courses such as Teaching of Critical Thinking in
General Studies, LS and Methods of Inquiry, and Science and Technology in Society while also contributing to all science-related courses. The “Life and health sciences” domain is the foundation for the Natural World and Healthy Living, Biochemistry of Health and Disease, and Teaching of Junior Secondary Science courses. The “Energy and physical phenomena” domain supports The Technology and Usage of Energy, Forces of Nature, and Teaching of Junior Secondary Science courses. The “Materials in the environment” domain is fundamental to Environmental Studies, Introduction to Environmental Science, and major methods course: LS. The division of each module into different levels of complexity allows course lecturers greater flexibility in integrating appropriate topics into their courses and allows them to build students’ knowledge foundation before introducing more advanced and applied knowledge.

To capitalize on the expertise of individual team members and to enhance collaboration among the participating institutions, the project team is divided into different working groups, including the Steering Group, the LMS Development Group, and Module Development Groups under the four different domains.

The learning process and principles of instructional design. The learning process that underpins module design is based on the constructivist paradigm that recognizes learners’ active construction of meaning from educational and other life experiences. Student-teachers without formal training in basic sciences are prone to alternative conceptions arising from their own interpretations of science-related information encountered in their daily life. Thus, the recognition of these conceptions is instrumental in scaffolding conceptual change (National Research Council, 2007). To align with this paradigm, the 5E instructional model developed by the Biological Science Curriculum Study has been adopted as the framework for the design of the learning modules (Bybee et al., 2006). This instructional model consists of five phases of learning. In the engagement phase, students are engaged in short activities to motivate them and elicit their prior knowledge. In the exploration phase, they are presented with activities that help to identify misconceptions and facilitate conceptual change. The explanation phase allows students to explain their understanding of the concepts and receive input from teachers to guide them toward a deeper conceptual understanding. In the elaboration phase, students are challenged to extend and apply their concepts to develop a deeper understanding through additional activities. In the final or evaluation phase, students and their teachers evaluate their own progress toward achieving the educational objectives. Research findings on science learning have consistently pointed to the instrumental role of inquiry-based approaches that encompass asking and defining questions, planning and carrying out investigations, analyzing and interpreting data, and constructing explanations in developing students’ conceptual and procedural understanding (National Research Council, 2012). Thus, inquiry activities will be used as appropriate in the exploration through the elaboration phases to facilitate learning.

Integration and articulation with existing courses. Because of the interdisciplinary nature of most of the existing courses, it is envisaged that a single module may support one or more courses and, conversely, that a single course may be supported by two or more modules/topics. Students may be assigned to visit relevant topics in a foundation module and complete the activities before the course lecturer introduces them to more advanced scientific or interdisciplinary concepts in the course. Alternatively, students may visit specific topics in a module (e.g. “Viruses and micro-organisms”) to understand or consolidate their understanding of the basic concepts that they need to draw upon in subsequent discussions on related interdisciplinary topics (e.g. the
prevention of infectious diseases in a public health course) or on the choice of pedagogy in teaching those concepts in methods courses.

**Instructional design.** The foundation modules/topics are designed for different degrees of blended learning, from a high degree of self-directed learning to a relatively high degree of integration with face-to-face lectures. Law et al. (2000) suggested a range of teaching and learning strategies into which ICT can be infused to support students’ learning. These strategies include exposition, induction for seeking explanations, task-based learning that situates learning in interesting and engaging tasks, problem-based learning for identifying problems and developing knowledge for problem-solving, and social constructivist learning that encourages collaboration. Hence, our instructional design extends beyond the virtual lectures or tele-lectures commonly employed in Asian e-learning programs (Latchem and Jung, 2010) to include these various strategies. Students are guided through a series of learning activities in the LMS that are designed and presented at progressive levels of complexity. In studying the module/topic assigned by the course lecturer, students can skip certain parts of the module according to their science background and focus on those parts that are new or not so familiar to them on the condition that they satisfactorily complete the relevant assessment tasks. Students are required to complete a pre-test specific to each topic to assess their prior understanding and a post-test to allow them and their course lecturer to assess their learning after the completion of a module. The course lecturer may also assess students’ performance by tracking the quality of their work as recorded by the LMS. Those who are not able to meet the learning goals will be asked to revisit the topic or to consult with the course lecturer/tutor. Students’ performance in the blended learning modules may contribute to their final grade in any course in which these modules/topics are embedded at the discretion of the course lecturer.

Although a computer-based learning environment facilitates self-paced learning, its freedom of navigation and loose sequencing may not be conducive to effective learning (Greene and Land, 2000; Jacobson and Archodidou, 2000; Jonassen, 1996) or match with the learning style of individual students. To address these potential problems, discussion forums were built into the platform where students can post their queries. Moreover, the course lecturer can check their progress via the tracking mechanism available in the LMS. To help students reflect on their own learning after the completion of the module, three questions are posed to students: “What have you learned from this part/module?” “What do you think the module writer could have done to help you learn better?” and “After studying this part/module, what would you like to learn more about this topic?” This kind of reflection fits with the constructivist paradigm of learning whereby students are led to think metacognitively about their own learning and how it could be further improved. Research has shown that such metacognitive monitoring and control is important for the development of self-regulatory processes and is a predictor of achievement in an e-learning environment (Azevedo et al., 2004; Greene and Azevedo, 2009). More importantly, e-learning on a self-directed basis will be blended with face-to-face contact with the course lecturer. Face-to-face contact serves various purposes, including introducing students to the e-learning environment and the associated e-learning tools, explaining the operations of online individual and group activities, following upon online activities, and providing consultation to student groups that need further conceptual clarification.
Transforming the instructional design into a learning flow using LMS. Based on the 5E instructional model, the blended learning process involves the following steps, although these steps were integrated to meet the needs of individual courses:

- Step 1: learners' self-analysis of needs based on their understanding of the topics as revealed by diagnostic tests.
- Step 2: presentation of triggers/scenarios to motivate students to investigate the underlying scientific concepts (engagement).
- Step 3: inquiry into the topics through learner-centered individual or group activities supplemented with systematic inputs such as animated PowerPoints and computer simulations and modeling (exploration).
- Step 4: development of explanations relevant to the inquiry with the support of online and face-to-face tutorials (explanation).
- Step 5: application of scientific concepts/skills to wider contexts to facilitate deeper learning (elaboration).
- Step 6: self-assessment with outcomes feeding back to the student and tutor (evaluation).
- Step 7: self-reflection to review personal learning progress (evaluation).

Stage 2: piloting the foundational science modules
The pilot testing of the foundational science modules was conducted in three rounds. In each round of trial, each participating institution selected courses in which particular modules will be tested. The course lecturers and the project team members discussed how these modules could best be integrated into the course to achieve the intended learning outcomes. The course lecturer could carefully monitor students’ progress and performance in various assessment tasks as recorded by the LMS (e.g. quizzes) to evaluate their achievement. The second and third rounds of the trial involved re-trial of modules revised after the first round if the teaching timetable allowed so that the module design could be improved in an iterative manner. Before each trial round, professional development workshops were provided to the course lecturers to familiarize them with the e-learning platform, the associated e-learning tools, and the various technology-assisted tools for learning science. The course lecturers also carefully recorded the ways in which they used the modules in the trial to provide essential background information for evaluation.

A wide range of approaches were adopted by individual course lecturers in using the modules. These are summarized below:

- The module was assigned to students before teaching the course/topic for self-directed learning.
- The module was divided into parts, each of which was integrated with different topic areas of the course as basic reading materials or contextual issues for discussion.
- The module was assigned to students to complete before a lecture. Students were asked to use the following week to go through it by themselves. A quiz was then administered to the students in class a week later to test their understanding of the concepts covered by the module. The lecturer then summarized the main concepts designed to build a foundation for the students to learn subsequent topics.
The module was integrated extensively with the course content (in the case of modules on scientific inquiry). The module, a series of inquiry activities, was uploaded to Moodle for students to work on in class. Before conducting the activities, students were required to go through specially designed textual materials to learn the concepts involved in the activities if they had not learned them before. After the students had completed the activities in groups, they were asked to upload their activity outcomes in the form of video clips to the Web for sharing and discussion with the rest of the class under the guidance of the lecturer.

Stage 3: evaluation of the trials
Upon completion of each pilot phase, the project team conducted rigorous evaluations of the effectiveness of the modules and the problems encountered. The evaluation was based on data collected through pre- and post-tests to assess students’ conceptual understanding, pre- and post-surveys of students’ attitudes toward science learning, focus group interviews with students and lecturers, and students’ reflections after studying the modules.

Stage 4: revision of the module design
The evaluation outcomes were used to inform further revision to the modules to improve their effectiveness and integration with existing courses. The end-products in this stage are a set of blended learning module kits for use in future course implementation.

Evaluation of the project
In view of the limitation of space in this paper, only some of the evaluation findings are reported in this section. Care should be exercised in interpreting these outcomes in light of the broad range of courses in which the modules were blended with conventional learning modes. Only the major findings based on the data gathered from the third module trial round in the chemistry and physics domain are presented. Despite this, we hope that these data reflect to a certain extent the effects of the project and the issues that have implications for the further development of blended learning in science in tertiary education.

Domain: materials in the environment
In this domain, two modules were trialed in the third round: “Basic chemistry for environmental studies” and “Environmental and health impacts.” A total of 119 students completed both modules. Table I shows the results of the survey administered to the students before and after they completed the two modules. The results in general suggest positive effects on students’ attitudes toward science learning, with statistically significant gains in self-confidence in learning science. However, when taking the students’ science background into consideration, among the four groups of students (chemistry, non-chemistry, science, and non-science), the results of the paired t-test reveal that respondents with a background in chemistry or any science subject showed a greater tendency to avoid learning science after completing the modules. In contrast, the non-chemistry students showed a statistically significant gain not only in their confidence in learning science but also in their eagerness to learn science. A probable conjecture is that as those students with chemistry or science backgrounds
Table 1. Students’ attitudes toward science learning before and after completion of the modules in the “materials in the environment” domain.

<table>
<thead>
<tr>
<th>Science background</th>
<th>No. of respondents</th>
<th>I am interested in science-related knowledge</th>
<th>I am eager to learn science-related knowledge</th>
<th>I was confident in learning science-related knowledge</th>
<th>I would avoid learning science-related contents</th>
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<tr>
<td></td>
<td></td>
<td>Pre</td>
<td>Post</td>
<td>Difference</td>
<td>Pre</td>
</tr>
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<td>Chemistry</td>
<td>25</td>
<td>0.84</td>
<td>0.84</td>
<td>0.00</td>
<td>0.92</td>
</tr>
<tr>
<td>Non-chemistry</td>
<td>94</td>
<td>0.06</td>
<td>0.30</td>
<td>0.23</td>
<td>0.26</td>
</tr>
<tr>
<td>Sciencea</td>
<td>53</td>
<td>0.58</td>
<td>0.74</td>
<td>0.15</td>
<td>0.62</td>
</tr>
<tr>
<td>Non-science</td>
<td>66</td>
<td>-0.06</td>
<td>0.31</td>
<td>0.21</td>
<td>0.21</td>
</tr>
<tr>
<td>All</td>
<td>119</td>
<td>0.23</td>
<td>0.41</td>
<td>0.18</td>
<td>0.39</td>
</tr>
</tbody>
</table>

Notes: *Science students refer to students that have studied at least one science subject at the senior secondary level, which may include chemistry. 
*p < 0.05; **p < 0.01
might have learned similar concepts before, they might be less motivated to study basic science. However, further study is needed to substantiate this hypothesis.

Students’ changes in conceptual understanding with respect to each of the two modules were gauged through specially designed pre- and post-tests. There were variations in the effects of the two modules. For the module “Basic chemistry for environmental science,” there was a statistically significant increase in students’ scores after they studied the module, regardless of their science background (Table II). However, for the module “Environmental and health impacts,” there was a significant decrease in students’ performance across all groups (Table III). This anomalous result might be attributable to the difference in assessment items between the pre- and post-test for the module. In the post-test of both modules, new items were added to those in the pre-test. However, for the module “Environmental and health aspects,” the MC items were mostly replaced with written-response items. We hypothesize that the students were reluctant or had little motivation to answer this type of item because they were used to the multiple-choice type or because these items were too difficult for them.

Students provided insightful responses to the three questions to elicit self-reflection after completing each module. Most were able to cite specific concepts they had learned from the modules, such as various types of pollutants and their effects, the phenomenon of eutrophication and algal bloom, biological oxygen demand, and PM10. Many students wanted to learn more about the solutions to the pollution problems, and some wanted to gain deeper knowledge on the topics. The respondents suggested a wide range of methods to improve their learning, including more visual content, extra information, explanations of vocabulary, more readings, and more interactive activities. Only two students said they preferred face-to-face lessons to e-learning.

### Table II.
Pre-test and post-test scores on students’ conceptual understanding of the module “basic chemistry for environmental studies” by students’ science background

<table>
<thead>
<tr>
<th>Science background</th>
<th>No. of respondents</th>
<th>Pre-test</th>
<th>Post-test</th>
<th>Difference</th>
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<tbody>
<tr>
<td>Chemistry</td>
<td>12</td>
<td>42.16</td>
<td>58.33</td>
<td>16.18*</td>
</tr>
<tr>
<td>Non-chemistry</td>
<td>53</td>
<td>44.73</td>
<td>54.72</td>
<td>9.99**</td>
</tr>
<tr>
<td>Science</td>
<td>28</td>
<td>46.01</td>
<td>57.86</td>
<td>11.85**</td>
</tr>
<tr>
<td>Non-Science</td>
<td>37</td>
<td>42.93</td>
<td>53.51</td>
<td>10.59*</td>
</tr>
<tr>
<td>All</td>
<td>65</td>
<td>44.25</td>
<td>55.38</td>
<td>11.13**</td>
</tr>
</tbody>
</table>

Notes: *p < 0.05; **p < 0.01

### Table III.
Pre-test and post-test scores on students’ conceptual understanding of the module “environmental and health” by students’ science background

<table>
<thead>
<tr>
<th>Science background</th>
<th>No. of respondents</th>
<th>Pre-test</th>
<th>Post-test</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemistry</td>
<td>12</td>
<td>61.86</td>
<td>40.47</td>
<td>−21.39**</td>
</tr>
<tr>
<td>Non-chemistry</td>
<td>47</td>
<td>60.73</td>
<td>48.94</td>
<td>−11.78**</td>
</tr>
<tr>
<td>Science</td>
<td>27</td>
<td>61.61</td>
<td>46.56</td>
<td>−15.05**</td>
</tr>
<tr>
<td>Non-science</td>
<td>32</td>
<td>60.41</td>
<td>47.78</td>
<td>−12.63**</td>
</tr>
<tr>
<td>All</td>
<td>59</td>
<td>60.96</td>
<td>47.22</td>
<td>−13.74**</td>
</tr>
</tbody>
</table>

Note: **p < 0.01
Domain: energy and physical phenomena

In this domain, five modules were trialed in the third round, including “Transfer of thermal energy,” “Force,” “Machine,” “Electricity,” and “Introduction to waves.” A total of 138 students completed these modules. The overall results of the pre- and post-surveys are shown in Table IV with a breakdown by students’ science backgrounds. The results in general suggest positive effects on students’ attitudes toward learning science. Considering the modules as a whole, there was improvement in students’ attitudes for all items, with statistically significant gains in eagerness to learn science. The gain in confidence in learning science was statistically significant for non-physics students and for the whole group. Non-physics students gained greater confidence than the other students, probably because they lacked basic knowledge about physics but had attained a level of scientific understanding from other subjects that enabled them to benefit more from the modules than the non-science students that had not taken any senior secondary science subjects.

As fewer than 20 students participated in the modules trialed in this round (except for the module “Introduction to waves”), a paired t-test was only applied to this module to compare the students’ level of conceptual understanding before and after studying the module. Statistically significant gains were obtained for the “non-physics” and “science” students, implying that the module was more effective for students who lacked a physics background but had some background in science subjects outside physics (Table V).

In their self-reflection on learning the modules, students cited a variety of topics and concepts that they had learned from the modules, with detailed examples provided by some respondents, such as “how to catch a fish underwater” for the “waves” module. As to the content that students wanted to learn more about, students’ responses fell into two categories: more detailed theories and principles and more applications of theories. Again, the students made a variety of suggestions on how to improve their learning of the module content. These include more examples to illustrate the concepts, more learning materials in the form of animations and videos, deeper knowledge, more questions raised for thought with hints provided, and more support from tutors.

Lecturers’ feedback on the trial. Several focus groups were arranged with the lecturers who participated in the trial to gauge their feedback. Most of them used the modules as self-directed learning materials in addition to their regular course materials. They normally assigned a particular module or part of a module to their students either before or in the middle of the course. Judging from the pre-/post-test comparison, they thought the module materials were useful, but much depends on whether the students went through the materials seriously or merely to pass the tests. It seems that students were better motivated when they completed quizzes in class than when allowed to work on them in their own time. Students’ participation can be guaranteed only if the module is made compulsory by allocating participation marks upon satisfactory completion. The lecturers also noted that students participated more enthusiastically if the content of the module was included in the end-of-term examination.

The lecturers made the following specific suggestions after completing the first trial:

- it is more useful to emphasize the objectives of a module (e.g. self-directed learning) at the start of using the module;
- it is better to provide students with a summary when they complete a module;
- a problem-based approach could be adopted in designing the modules in which students are required to answer questions to facilitate more active learning;
I am interested in science.
I am eager to learn science-related knowledge.
I was confident in learning science.
I would avoid learning science-related contents.

<table>
<thead>
<tr>
<th>Science background</th>
<th>No. of respondents</th>
<th>Pre</th>
<th>Post</th>
<th>Difference</th>
<th>Pre</th>
<th>Post</th>
<th>Difference</th>
<th>Pre</th>
<th>Post</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physics</td>
<td>19</td>
<td>1.00</td>
<td>1.21</td>
<td>0.21</td>
<td>1.00</td>
<td>1.42</td>
<td>0.42</td>
<td>0.68</td>
<td>0.89</td>
<td>0.21</td>
</tr>
<tr>
<td>Non-physics</td>
<td>27</td>
<td>0.93</td>
<td>1.07</td>
<td>0.15</td>
<td>1.00</td>
<td>1.22</td>
<td>0.22</td>
<td>0.33</td>
<td>0.70</td>
<td>0.37*</td>
</tr>
<tr>
<td>Science*</td>
<td>32</td>
<td>1.25</td>
<td>1.31</td>
<td>0.06</td>
<td>1.13</td>
<td>1.44</td>
<td>0.31</td>
<td>0.63</td>
<td>0.88</td>
<td>0.25</td>
</tr>
<tr>
<td>Non-science</td>
<td>14</td>
<td>0.29</td>
<td>0.71</td>
<td>0.43</td>
<td>0.71</td>
<td>1.00</td>
<td>0.29</td>
<td>0.14</td>
<td>0.57</td>
<td>0.43</td>
</tr>
<tr>
<td>All</td>
<td>46</td>
<td>0.96</td>
<td>1.13</td>
<td>0.17</td>
<td>1.00</td>
<td>1.30</td>
<td>0.30*</td>
<td>0.48</td>
<td>0.78</td>
<td>0.30*</td>
</tr>
</tbody>
</table>

Notes: *Science students refer to students that have studied at least one science subject at the senior secondary level, which may include physics.
*p < 0.05
each module could be designed in such a way that component parts can be used separately, thereby increasing the flexibility in blending the module materials with the course content;

• students’ performance on the post-test could be counted toward the overall grade of the course or the e-module content could be assessed in the end-of-course examination;

• the approach used by the e-module should preferably be consistent with that employed by the course in which the e-module is used;

• additional modules could be designed to introduce other basic concepts such as radiation, bonding structure, molecular interactions, and redox reactions;

• an e-learning week could be incorporated into the course to allow time for students to complete the self-directed learning activities in the relevant modules;

• in-class quizzes could be used to monitor students’ progress and check their misconceptions after the completion of a module; and

• students should be allowed to skip certain parts of a module if they are able to gain a certain score on the pre-test.

Conclusion and implications
As judged from the evidence reported herein, we consider the outcomes to be positive and encouraging. The objectives have been achieved to a certain degree with respect to the successful development of foundational science e-learning modules to improve students’ basic science knowledge and increase their confidence in learning science, particularly for those without strong science backgrounds. Students’ development of metacognitive skills was demonstrated by their reflections on their own learning in terms of the knowledge gained, further knowledge they wish to gain, and suggestions for further improvement. Students were generally receptive to this kind of self-directed e-learning approach, which was blended to varying degrees with more conventional approaches, although a small proportion of students preferred conventional modes of learning. In designing and trialing e-learning materials, we experienced the capacity-building process most needed to address our concern: developing non-science students’ foundation in science as a prerequisite for learning more advanced science concepts in their undergraduate programs. We also recognized the synergy generated by drawing together the expertise of the three partner institutes in creating a variety of modules and suitable Moodle tools that could be applied to a wide range of courses in a flexible way.

Table V.
Pre-test and post-test scores on students’ conceptual understanding of the module “introduction to wave” by students’ science background

<table>
<thead>
<tr>
<th>Science background</th>
<th>No. of respondents</th>
<th>Pre</th>
<th>Post</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physics</td>
<td>19</td>
<td>89.50</td>
<td>98.70</td>
<td>9.21</td>
</tr>
<tr>
<td>Non-Physics</td>
<td>15</td>
<td>76.70</td>
<td>98.30</td>
<td>21.67*</td>
</tr>
<tr>
<td>Science</td>
<td>31</td>
<td>83.90</td>
<td>98.40</td>
<td>14.52**</td>
</tr>
<tr>
<td>Non-Science</td>
<td>3</td>
<td>83.30</td>
<td>100.00</td>
<td>16.67</td>
</tr>
<tr>
<td>All</td>
<td>34</td>
<td>83.80</td>
<td>98.50</td>
<td>14.71**</td>
</tr>
</tbody>
</table>

Notes: *p < 0.05; **p < 0.01
However, as revealed in the evaluations of both students and lecturers, there remain a number of challenges to be met to fully achieve our objectives. These challenges are not solely technical ones in terms of transforming teaching content into digital forms delivered through the LMS; they also involve applying sound pedagogical designs underpinned by evidence-based learning theories to facilitate students’ construction of foundational science knowledge in a progressive and self-directed way. Hungwe and Dagada (2013) have argued that blended learning will not be successful if the lecturers involved fail to integrate “technological content knowledge” with “pedagogical knowledge” (p. 1). Another important issue to address is the motivation of students to learn science content in a self-directed way. Students’ recognition of their own difficulties in learning undergraduate science does not necessarily lead to increased motivation to engage in the self-directed learning of more basic science. Our experience from the trials shows that students’ motivation in engaging in self-directed learning could be enhanced by pegging it to the formal assessment of the course with which the module is blended. Both the lecturers and the students suggested measures for the more effective blending of the self-directed and face-to-face learning approaches such that more effective learning could take place by lowering the cognitive barrier for students to overcome. This echoes the findings of Condie and Livingston (2007) that the effect of blended learning on students’ achievement could be increased if lecturers actively engage students in the learning process.

Apart from an increased degree of blending of self-directed e-learning and face-to-face lectures, the effectiveness of student learning can be improved by pitching the module content at a level of complexity appropriate to different target groups, identifying and supporting students in need, using a broader range of e-learning tools to cater to diverse abilities and learning styles, making learning activities more interactive and interesting, incorporating more inquiry activities to enhance students’ understanding of concepts and their capacity for scientific thinking, encouraging students to reflect on their learning and learning difficulties, strengthening the provision of feedback and support to students in need, and enhancing the integration of the e-learning modules into the courses. The last point could possibly be addressed by setting aside class time for e-learning, holding quizzes in class to assess self-directed learning, and having the course lecturer provide a greater degree of facilitation to guide students through concepts that are difficult to master.

In summary, this project is challenging in that it applies blended learning approaches to solve a perennial teaching and learning problem facing both student-teachers and teacher educators arising from the unique school curriculum context in Hong Kong. The success of the project hinges on whether student-teachers can be motivated to learn basic science content in addition to the content covered by their major courses and whether more effective blended learning approaches can be designed to boost students’ confidence in learning science, a subject which most of them had opted out of in their senior secondary school years. It is thus important to develop more creative and innovative learning approaches to exploit the possible resources available to address the learning problem, which is difficult to resolve solely by conventional means.

References


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Hybrid online/offline mobile solutions for accessing open educational resources in areas with poor internet connectivity

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Abstract
Purpose – The purpose of this paper is to present mobile solutions that aid in accessing open educational resources (OERs) in areas that have limited bandwidth resulting in poor internet connectivity and a gap between those with ready access to the online OERs and those without such access.

Design/methodology/approach – A system architecture was designed to support the repository-based, mobile-friendly, and hybrid online/offline characteristics of OERs. In a hybrid online/offline setup, the learner connects to the internet to obtain OERs from the repository via a process called syncing. Afterward, he may view any OER content regardless of whether he is online or offline. Mobile solutions based on Browser-Like Android App (BLAP)/HTTrack and Worona/Corona approaches were successfully implemented and evaluated by 139 respondents using the System Usability Scale.

Findings – BLAP/HTTrack and Worona/Corona solutions were well received. These were found to be both relatively usable, acquiring above-average usability scores of 73.2374 and 71.6546, respectively.

Research limitations/implications – The findings of this study aim to contribute to the literature of hybrid online/offline model that addresses low bandwidth access of OERs in developing countries, which is not historically well provided.

Originality/value – The mobile solutions were designed to help those learners who experience internet connectivity difficulties in accessing OERs efficiently and updating them conveniently.

Keywords Usability, Mobile learning, Hybrid online/offline model, Open educational resources, Syncing

Paper type Research paper
Introduction

Nowadays, the market for smart devices has seen a rapid growth due to massive consumer interest around the globe that resulted in a shift from using desktop computers to mobile devices for mobility (Miguel et al., 2015). In the Philippines, there is a growing smartphone ownership; in 2013, there were 14.5 million smartphone users, and by the end of 2016, the number of users is projected to reach 29.9 million (eMarketer, 2015). This presents opportunities to use mobile devices in facilitating learning, including open and distance e-learning, in new and innovative ways (Tuliao et al., 2015). One possible example is by enabling learners to use their mobile devices to view learning materials such as open educational resources (OERs).

At present, repository-based OERs are increasingly established (De Vries and Thuss, 2013). The materials and files associated with each OER are stored in a repository, a storage area in the cloud. Whereas before, OERs and mobile devices have nothing to do with each other, storing OERs in repositories allows learners to access them using mobile technology (Ally and Samaka, 2013; De Vries and Thuss, 2013). Ally and Tsinakos (2014) also argued that combining OERs and mobile learning will revolutionize education, especially in developing countries where the use of mobile technology is increasing at an astounding rate.

However, issues remain for providing repository-based OERs. One issue is that many OERs are not suitable for mobile consumption since most commonly used authoring tools lack mobile support (De Vries and Thuss, 2013). Without proper mobile support, users may encounter the following: texts are too small and unreadable; zooming in and zooming out need to be done countless times; and elements and formats are missing due to incompatibility (Pugoy and Figueroa, 2012). In this regard, responsive web design (RWD), a revolutionary web design trend, may address these. RWD is a set of techniques for enabling websites to automatically adjust based on screen sizes and resolutions, ranging from widescreen desktops to tiny smartphones (Hussain and Mkpojiogu, 2015). RWD allows the development and access of mobile-friendly OERs to be less complicated and more convenient.

Another significant issue is poor internet connectivity resulting from limited bandwidth due to the absence of appropriate infrastructure to deliver quality mobile services in developing countries (Shrestha et al., 2010). Austin and Bradley (2005) indicated that accessing and utilizing information and communication technology (ICT) is technically much easier when one has a broadband internet connection. Developing and viewing online OERs would then depend on this factor. However, Shrestha et al. stated that internet connectivity is little to none in remote rural areas, where a significant number of educational institutions are located. They further added that even though internet connectivity is present in urban areas, it is inferior to the service provided in developed countries. Moreover, the Philippines is considered to have the second slowest internet connection in Asia, and broadband internet subscriptions in the country are expensive (Gonzales, 2015). Consequently, according to Hassler and Jackson (2010), this limitation affects the users in accessing the internet effectively and satisfactorily. This, in turn, may influence the learning experience. Therefore, as they have noted, a gap exists between those with ready access to the online OERs and those without such access.

A hybrid online/offline model is a possible strategy that can provide OERs in bandwidth-challenged countries (Hassler and Jackson, 2010). In a hybrid setup, the learner connects to the internet to obtain OERs from the repository via syncing. Syncing is a process that only copies new and updated files from the repository to the
mobile device, and this prevents copying the same files that are already copied before (De Leon, n.d.). After syncing, the learner may readily view an OER with or without an internet connection. Hassler and Jackson noted that this kind of solution, most suitable in leading to improvements in low bandwidth OER access, has not been historically well provided. They urged to address this with high priority. They also stated that due to the use of mobile devices for internet access, the hybrid model might finally be confronted after years of technology models changing from offline to online modes and vice versa. Furthermore, hybrid online/offline OERs are more advantageous than completely offline OERs. The former are more appropriate for OERs that are regularly updated. Users would need not to manually download and organize OERs on their mobile devices that may be cumbersome and time consuming.

Hence, this study aims to answer the following research question:

RQ1. What are the possible designs and implementations of acceptable mobile-friendly solutions for repository-based OERs that adopt the hybrid online/offline model?

Objectives of the study
The general objective of this study is to design and implement mobile solutions, including the generation of Android apps, that support the following features:

- OERs that are repository based and mobile friendly.
- Whenever the user is connected to the internet, new and updated OERs are fetched and synchronized from the repository to the mobile device. Syncing is limited to text and images only.
- Regardless of whether the user is connected to the internet or not, he can view and access OERs using the provided mobile apps.

Another objective is to determine whether these mobile solutions are found acceptable by the users, using a survey based on the System Usability Scale (SUS).

Significance of the study
The mobile solutions implemented in this study shall help learners who experience slow and intermittent internet connection. These solutions shall allow them to browse OERs efficiently, and to update them conveniently on their respective mobile devices. Moreover, the findings of this study aim to contribute to the literature of the emerging trend on hybrid online/offline model that addresses low bandwidth access of OERs in developing countries.

Review of related works
As far as hybrid online/offline OERs are concerned, the literature is limited. Nevertheless, related works on offline mobile learning and its use in developing countries, and RWD were examined.

In 2010, Hassler and Jackson listed some initiatives that have partially implemented the hybrid model. These include the MIT OpenCourseWare and the eGranary, both which made a range of educational resources available offline.

In 2012, Menon reported an initiative taken by the Wawasan Open University (WOU) in the development of a course on ICT in Education in the Master of Education degree program. WOU developed a workable model for using, remixing, repurposing, and redistributing OERs. OERs employed in the course were identified and selected
using Google search and advanced search. A study package was developed using eXe, an open source authoring application. The entire course was made available offline on a compact disc (CD), using Hypertext Markup Language or HTML as its base format.

In 2013, Imtinan et al. proposed a research project on offline mobile learning to aid in the promotion of literacy in the underprivileged rural areas of Pakistan. Their research objectives include the investigation of mobile learning options on low-cost mobile devices for the underserved and the development of an offline mobile learning framework for developing countries.

In 2015, Figueroa et al. created OERs for Philippine biodiversity to promote its protection and conservation. Relevant OERs were curated and later stored in a WordPress-powered repository. OER materials were then organized in a platform that employed the Multiple Paths Approach and RWD principles. Their proposed OER platform acquired a usability score of 72.08.

In 2016, Awodiji and Ogbudinkpa looked into exploring offline and online OERs for primary school instruction in Nigeria. Pupils can access these educational resources with the aid of electronic devices. Their instructors facilitated offline education using presentation tools such as Microsoft PowerPoint. The learning process was delivered using digital video disc, CD, videotape, and over a television channel.

Theoretical framework
OER content and the hybrid online/offline model
According to Hassler and Jackson (2010), there are certain requirements for providing OERs using the hybrid setup. First, any OER provider should be able to easily produce OERs as hybrid online/offline content. Second, any OER consumer, such as the learners or the users, should be able to easily obtain any OER content. Third, any OER content needs to be updatable, i.e. updates are automatic, and these respect the available bandwidth.

One-way file synchronization
De Leon (n.d.) described one-way file synchronization, also known as syncing and mirroring, as a process where files are anticipated to change in one location, and copying occurs in one direction only. One location is considered the source (such as a server, a cloud storage, and a repository), and the other location is called the target (examples include computers, mobile devices, and another server). It is an automatic process that exclusively pushes new and updated files from the source to the target, thereby creating an exact 1:1 replica of the source to the target. As a consequence of this behavior, it prevents copying same old files that are already copied before. Thus, this is more advantageous than manual copying, as it saves time and is less prone to errors (Tridgell, 1999).

Concept of usability
Measuring the usability of a particular system or application is an imperative step to determine the perceptions of its users. According to ISO 9241-11, usability is the extent to which an application can be used with effectiveness, efficiency, and satisfaction by specified users to achieve specified goals in a specified use context (Baharuddin et al., 2013). ISO 9126 also defines usability as the capability of a particular software to be understood, learned, and appealing to users when used under certain conditions (Yen and Bakken, 2012).
Users appear to have a good sense in identifying whether a system is usable or not (Lund, 2001). According to Spencer (2004), if a system is usable, users can accomplish tasks easily. On the other hand, if a system is unusable, users will find it hard to use, and they will not use it. To determine usability, users are asked to evaluate a particular system through a usability test. Spencer added that a usability test is an instrument that collects quantitative measures of efficiency, effectiveness, and satisfaction.

**Methodology**

*System architecture*

Figure 1 illustrates the architecture designed to support the repository-based, mobile-friendly, and hybrid online/offline characteristics of OERs. On the server side, the OER repository allows OERs to be organized, created, and modified. WordPress, a content management system (CMS), was used as the repository. The CMS allows OER providers to efficiently manage content without being required to possess prior web programming competencies. Categories were utilized to organize the resources, and tags were employed to make searching easy. For this study, the Philippine biodiversity OERs were used as the content source of the repository. The Philippine biodiversity OERs were developed in a prior research, and its primary purpose is to promote the communication, education, and public awareness on Philippine flora and fauna among various individuals, communities, and institutions (Figueroa *et al.*, 2015). Its repository is accessible via this web address: www.learnbiodiversity.com (Figure 2). Furthermore, the server side contains another component called the mobile enabler, a small program or plugin that ensures that the OERs are mobile friendly.

Conversely, the mobile phone side consists of the viewer and the syncer. The viewer is an app utilized by the user to browse any OER content, regardless of the mobile enabler.
his internet connectivity state. Likewise, the syncer, when triggered, automatically fetches updates from the OER repository. Then, it downloads and synchronizes them with the viewer.

**Browser-Like Android App (BLAP)/HTTrack approach**

In this method, the mobile enabler is the Responsive Theme by CyberChimps. The Responsive Theme was installed in the WordPress-based repository due to its built-in RWD support (Rawlins, 2016). For the viewer, BLAP was developed using the Android Software Development Kit. This native app behaves similarly to a web browser. It can also be set to exclusively access and render the materials from a specified OER repository. BLAP utilizes the WebView class to observe the browser-like behavior. Figure 3 displays a code snippet used to implement BLAP.

Figure 4 shows the app’s main page resulting from the code in Figure 3. BLAP resembles a miniature version of the repository website so that its content can fit on mobile device screens. Figure 5 displays a list of all available OERs after the user selects the Resources button in Figure 4. Figure 6 presents an example of an OER content.

For the syncer, an app called HTTrack was installed. HTTrack, widely used and easy to configure, allows downloading of web content for local hosting and viewing (Marill et al., 2004). In effect, it can copy any OER content from the repository to the mobile device. Figure 7 shows the instructions for syncing provided on BLAP.

**Worona/Corona approach**

In this method, the mobile enabler is a WordPress plugin called Worona, which enables the conversion of a WordPress site to an Android app (Chauhan, 2015). The native app was generated using the Corona Software Development Kit. Unlike the previous

![Code snippet used to implement the BLAP viewer](image-url)
approach, the said app integrates both the features of the viewer and the syncer. Figure 8 presents a configuration file provided by Corona that can be customized according to the needs of the OER providers. An example of this customization is fixing the web address of the OER repository.

Figure 9 shows the app's main page that enumerates all available OERs. The user interface is minimalist and simpler than BLAP's. Moreover, the sync icon can be selected on the upper right portion of the app to initiate the syncing process. Figure 10 displays an example of an OER content.

Usability evaluation
To evaluate the implemented mobile solutions, 139 respondents were chosen. Respondents are current students of the University of the Philippines Open University under the Faculty of Information and Communication Studies, where open and distance e-learning is being used as the mode of learning. Respondents were asked to each test BLAP/HTTrack and Worona/Corona. Afterward, a survey based on the SUS was given to assess the usability and acceptability of each of the mobile solutions.
The SUS is a widely recognized industry standard that serves as a quick and reliable tool for measuring usability (Brooke, 2013). Formulated by Brooke (1996), the SUS consists of ten items, which the respondents can rate on a five-point Likert scale, ranging from strongly disagree (1 point) to strongly agree (5 points). The list below shows the survey items:

1. I think that I would like to use the system frequently.
2. I found the system unnecessarily complex.
3. I thought the system was easy to use.
4. I think that I would need the support of a technical person to be able to use the system.
5. I found the various functions in the system were well-integrated.
6. I thought there was too much inconsistency in the system.
7. I would imagine that most people would learn to use the system very quickly.
8. I found the system very cumbersome to use.
(9) I felt very confident using the system.

(10) I needed to learn a lot of things before I could get going with the system.

The usability score from each respondent is derived by applying the following steps:

1. For odd-numbered items: subtract 1 from the response;
2. For even-numbered items: subtract the response from 5; and
3. Get the sum of the converted responses and multiply that total by 2.5.

The overall usability score is then computed from the average of the respondents’ given usability scores. If the usability score is greater than the global mean score of 68, the solution being evaluated is considered to be relatively usable (Sauro, 2011). The SUS adjective scale, as described in Table I, is used to interpret SUS scores (Bangor et al., 2009).

Furthermore, to compare the mobile solutions, two-tailed paired t-test was performed. This is appropriate when the same respondents are asked to evaluate both systems (Sauro and Lewis, 2016). The mean and the standard deviation of the solutions’ difference scores are first calculated. Then, obtaining a p-value of 0.05 or less implies that the difference in their usability scores is statistically significant.
Aside from the SUS survey, the following questions were also given to the respondents:

1. Would you recommend using a mobile device for OER access?
2. Which of the two solutions did you prefer?
3. Was syncing relevant to your situation?
Figure 9. List of all available OERs on the Corona viewer.

Figure 10. Sample OER content on the Corona viewer.

Common name: Rufous-headed Hornbill
Local name: Dulungan
Distribution: Guimaras, Negros and Panay
Conservation status: Critically Endangered
Population trend: Decreasing
Results and discussion

Results of the SUS survey
Results showed that BLAP/HTTrack and Worona/Corona obtained overall usability scores of 73.2374 and 71.6546, respectively. Both scores are above the global mean score of 68, implying that the respondents found both solutions to be relatively usable. Based on the SUS adjective scale, BLAP/HTTrack is considered to be an excellent solution, and Worona/Corona is deemed to be a good solution (Table II).

Moreover, notwithstanding the distinct approaches used in implementing the mobile solutions, t-test results revealed that there is no significant difference in their usability scores ($M = 1.5827$, $SD = 16.1826$, $p = 0.2509$). Though BLAP/HTTrack has a higher usability score than Worona/Corona, there is no sufficient evidence to state that the former is easier to use than the latter. It could mean that the solutions are indistinguishable from the perspectives of the respondents, or less likely, Worona/Corona is more usable.

Results of the other survey items
On recommending the use of mobile devices to access OERs, 88 percent of the respondents said that they would support it while the other 12 percent said otherwise. Figure 11 illustrates that a majority of the respondents prefer BLAP/HTTrack over Worona/Corona: 56 percent preferred BLAP/HTTrack, 35 percent preferred Worona/Corona, and 9 percent preferred neither. According to them, BLAP’s advantages include better user interface, better organization, and easier navigation. On the other hand, Worona/Corona has an easier syncing process, but the look and feel is too dull.

Lastly, 77 percent of the respondents agreed that syncing was relevant to their situation while 23 percent disagreed. Those who agreed noted that syncing is practical and helpful to keep materials available even when offline. They do not have constant internet access, and they occasionally visit places where it is not available. On the contrary, those who disagreed said that they always have a good internet connection.

Conclusion and future works
The proposed architecture integrates four essential components: OER repository, mobile enabler, viewer, and syncer. Hence, this allows hybrid online/offline OERs to be usable in areas with poor internet connectivity.
successfully implemented using the BLAP/HTTrack and Worona/Corona mobile solutions. Both solutions were well received and considered to be relevant, as evidenced by the above-average usability scores and feedback from the respondents. Furthermore, the architecture and the mobile solutions developed in this study may serve as starting points to assist in open and distance e-learning in areas with poor internet connectivity.

In the future, the enhancement of the syncing process can be considered. Syncing OER materials in other formats such as videos and audios can be included. Syncing can be further optimized to respect the limited bandwidth, considering the varying OER file sizes. Also, the effect of utilizing these mobile solutions on the learners’ cognitive experiences can be examined and analyzed as well.

References


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Clustering of online learning resources via minimum spanning tree

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Abstract

Purpose – The quick growth of web-based and mobile e-learning applications such as massive open online courses have created a large volume of online learning resources. Confronting such a large amount of learning data, it is important to develop effective clustering approaches for user group modeling and intelligent tutoring. The paper aims to discuss these issues.

Design/methodology/approach – In this paper, a minimum spanning tree based approach is proposed for clustering of online learning resources. The novel clustering approach has two main stages, namely, elimination stage and construction stage. During the elimination stage, the Euclidean distance is adopted as a metrics formula to measure density of learning resources. Resources with quite low densities are identified as outliers and therefore removed. During the construction stage, a minimum spanning tree is built by initializing the centroids according to the degree of freedom of the resources. Online learning resources are subsequently partitioned into clusters by exploiting the structure of minimum spanning tree.

Findings – Conventional clustering algorithms have a number of shortcomings such that they cannot handle online learning resources effectively. On the one hand, extant partitional clustering methods use a randomly assigned centroid for each cluster, which usually cause the problem of ineffective clustering results. On the other hand, classical density-based clustering methods are very computationally expensive and time-consuming. Experimental results indicate that the algorithm proposed outperforms the traditional clustering algorithms for online learning resources.

Originality/value – The effectiveness of the proposed algorithms has been validated by using several data sets. Moreover, the proposed clustering algorithm has great potential in e-learning applications. It has been demonstrated how the novel technique can be integrated in various e-learning systems. For example, the clustering technique can classify learners into groups so that homogeneous grouping can improve the effectiveness of learning. Moreover, clustering of...
online learning resources is valuable to decision making in terms of tutorial strategies and instructional design for intelligent tutoring. Lastly, a number of directions for future research have been identified in the study.

Keywords: Clustering, E-learning, Density based, Minimum spanning tree, Online learning resources

Paper type: Research paper

1. Introduction

E-learning is a means of education that incorporates self-motivation, communication, efficiency, and technology (Phobun and Vicheanpanya, 2010; Woldab, 2014). As a general tendency in intelligent tutoring and learning, e-learning has attracted an increasing amount of attention from researchers in the fields of computer science, pedagogy, and praxeology. With the rapid growth of e-learning resources, including content delivered through the internet, intranet/extranet, CD-ROM, audio or video tape, and satellite TV, the selection and organization of these materials is very time-consuming and challenging to users. Thus, it is necessary to cluster learning resources and subsequently recommend personalized resources to both teachers and learners. Clustering is the process of assigning class labels to objects based on the principle of minimizing the interclass similarity and maximizing the intraclass similarity (Li et al., 2013), which is widely used in various scientific areas (Ben et al., 2011). For instance, taxonomists, social scientists, psychologists, biologists, statisticians, mathematicians, engineers, computer scientists, medical researchers, and others who collect and process real-world data have all contributed to clustering methodology (Jain, 2010; Mimaroglu and Erdil, 2011). At the same time, a recent trend in e-learning is the development of massive open online courses (MOOCs) and micro-courses. With the help of numerous teachers, MOOCs provide unlimited participation and open access via the internet to learners worldwide. It is not rare that tens of thousands of students from around the world enroll in a single course. As more and more learning resources are generated due to the explosion of MOOCs, it is hard to apply traditional clustering algorithms to analyze online learning resources.

Outliers or noise objects are very common in real-world data sets, especially for user-generated content. This brings new challenges to existing clustering methods. On the one hand, most of traditional partitional clustering algorithms (e.g. K-means, bisecting K-means, and K-medoids) randomly assign objects as initial centroids of the clusters. Outliers may be chosen as the initial centroids of clusters. It will then converge to an unstable result (i.e. instability issue). On the other hand, the performance of classical density-based clustering methods (e.g. density-based spatial clustering of applications with noise (DBSCAN)) will be computationally expensive and time-consuming when they are facing those noise objects.

In this paper, a novel scheme is proposed to resolve the problem of instability and inefficiency for clustering of online learning resources. Outliers are first eliminated based on the density of each resource. Then, a minimum spanning tree is constructed based on the distances among resources. The degree of freedom for each resource is subsequently calculated based on the structure of the minimum spanning tree. The resource with the largest value of degree of freedom will be considered as the initial centroid. In comparison with the previous work (Wang et al., 2015), a number of enhancements have been made: a more comprehensive literature review has been conducted in Section 2; the effectiveness of the proposed algorithm together with other clustering algorithms are evaluated with two additional data sets including a two-dimensional data set (Section 4.3) and a real-world e-learning data set (Section 4.4) to improve the generalization of results; one classical density-based clustering method (i.e. DBSCAN) is implemented for comparison, and the experimental results are
analyzed in more detail; and more detailed information and in-depth discussion is provided in the introduction, experiments, conclusion, and future research directions.

The rest of the paper is organized as follows. Section 2 describes related work on e-learning systems and clustering of online learning resources. Section 3 presents a novel clustering algorithm based on minimum spanning tree. Section 4 evaluates clustering algorithms with four data sets. Section 5 discusses the directions of incorporating the proposed clustering algorithm into e-learning systems. Finally, Section 6 provides concluding remarks.

2. Related works

2.1 E-learning systems

E-learning is valuable to educational institutions, corporations and all types of learners as it eliminates distances and subsequent commutes (Phobun and Vicheanpanya, 2010). It is affordable and time-saving because a wide range of online learning resources can be accessed from properly equipped computer terminals. Thus, the development of e-learning systems is one of the fastest growing trends in educational uses of technology (Li et al., 2009). Applications and components of e-learning systems include construction of learning models, prediction of learners’ learning behavior, development of mobile application, and so forth. For instance, Zou et al. (2014) proposed an incidental word learning model for e-learning. In particular, they measured the load of various incidental word learning tasks so as to construct load-based learner profiles. A task generation method was further developed based on the learner profile to increase the effectiveness of various word learning activities. Boyer and Veeramachaneni (2015) designed a set of processes which take the advantage of knowledge from both previous courses and previous weeks of the same course to make real-time prediction on learners’ behavior. Ferschke et al. (2015) implemented a Lobby program that students can be connected via a live link at any time. Zbick (2013) presented a web-based approach to provide an authoring tool for creation of mobile applications with data collection purposes.

2.2 Clustering of learning resources

It is believed that e-learning systems should provide a variety of learning resources to satisfy need of different learners (Sabitha et al., 2016). With the rapid growth of online learning resources, learners are facing a serious problem of information overload. A tool is urgently required to assist the learners to get the similar learning materials efficiently. The clustering algorithms are extensively employed for discovery of community (Xie et al., 2012, 2014) and event detection (Rao and Li, 2012), which are important research topics in e-learning. Sabitha et al. (2016) employed fuzzy clustering technique to combine learning and knowledge resources based on attributes of metadata. Mansur and Yusof (2013) tried to reveal the behavior of students from all activities in Moodle e-learning system by using ontology clustering techniques. In their ontology model, the forum, quiz, assignment, and many other activities were placed as clustering parameters. Govindarajan et al. (2013) employed particle swarm optimization algorithm to analyze and cluster continuously captured data from students’ learning interactions. However, some useless resources may exist in e-learning systems.

It is important to remove the noise objects before clustering. Mimaroglu and Erdil (2011) defined two variables named weight and attachment to address the issue of noise object. The first one (i.e. weight) measures the similarity between two objects, and the second one (i.e. attachment) ranks the quality of each candidate centroid. Noise objects are removed based on their measurement of weight and attachment. Luo et al. (2010) proposed another
method to exclude the “fake” centroid based on the notion of density, as follows: let $X = \{x_1, x_2, \ldots, x_n\}$ be the set of objects. $DEN(x_i)$ is the density of object $x_i$. A small value of $DEN(x_i)$ indicates that $x_i$ locates at a relative high-density location, or vice versa. The density of $x_i$ is compared with the average density $ADEN$. If an object has density higher than the average density, it will be considered as a “fake” centroid and therefore eliminated.

3. Clustering of online learning resources

3.1 The overall framework

The increasing availability of digital educational materials on the internet, called online learning resources, has been followed by the definition of indexing standards. However, the selection process of these elements is challenging to learners because of the diversity of metadata approaches, in addition to the lack of consensus about the definition of learning resources (Silva and Mustaro, 2009). In light of these considerations, learners need effective and efficient clustering methods to organize and manage such large volume of online learning resources. The objective of clustering of online learning resources in this study is to assign class labels to various learning resources by eliminating outliers, and to improve the accuracy of clustering algorithm based on the minimum spanning tree as well as procedures of merging learning resources and small clusters.

As illustrated in Figure 1, a clustering framework for online learning resources with four key steps is proposed as follows:

1. The density of each instance of online learning resource is measured in order to identify and eliminate outliers. Learning resources that are few and scattered in their areas will be removed in this step.

2. A minimum spanning tree is constructed to create a link of all learning resources. The minimum spanning tree is helpful to detect clusters of different shapes and sizes (Päivinen, 2005).

3. A partitioning method based on the structure of minimum spanning tree is employed to merge learning resources into clusters.

4. The small clusters that contain only a few learning resources are also merged into large ones.

The density-based clustering algorithm proposed in this paper can be applied to a number of areas in e-learning, for example, classification of learner, discovery of learning path, recommendation of learning resource, and intelligent tutoring.

On the other hand, the key parameters of the proposed approach are explained below in the context of online learning resources for better understanding of the paper:

- distance between two online learning resources measures the dissimilarity between the contents of two resources;
- density of an online learning resource measures number of learning resources which are similar as the resource, i.e., their distances to the learning resource are less than a threshold value;
- outlier or noise learning resource is a learning resource which is very different from the others; and
- usefulness of learning resource refers to the relevancy of the learning resource to the learner’s study or learning interest.

Mathematical definitions of the parameters can be found in the following subsection.


### 3.2 Elimination of outliers

The existence of outliers will produce useless learning resources in e-learning, and disturb the effect of clustering. In order to solve this problem, the method proposed by Luo et al. (2010) is incorporated in the algorithm proposed. The related definitions are shown below:

**Definition 1.** The density of an object (i.e. an online learning resource) is:

\[
\text{DEN}(x_i) = \frac{1}{m} \sum_{y_j \in \varphi(x_i)} d(x_i, y_j),
\]

where \(\varphi(x_i)\) is the set of \(m\) nearest online learning resources of \(x_i\), \(d(x_i, y_j)\) is the Euclidean distance (Deza and Deza, 2016) between \(x_i\) and \(y_j\).

**Definition 2.** The average density of online learning resources is:

\[
\text{ADEN} = \frac{1}{p} \sum_{i=1}^{p} \text{DEN}(x_i),
\]

where \(p\) is the number of online learning resources.

**Lemma 1.** The density \(\text{DEN}\) of some normal online learning resources is larger than the average density \(\text{ADEN}\).

Proof 1: if all online learning resources are normal, i.e., no outliers, the value of \(\text{ADEN}\) must between \(\text{DEN}_{\text{max}}\) and \(\text{DEN}_{\text{min}}\). Thus, the density \(\text{DEN}\) of some normal online learning resources must be larger than then average distance \(\text{ADEN}\). □

According to Lemma 1, a constant \(\text{DEV}\) is added to the average distance \(\text{ADEN}\). If \(\text{DEN}(x_i)\) is larger than the sum of \(\text{ADEN}\) and \(\text{DEV}\), it will be considered as an outlier and removed from the data set.

### 3.3 Generation of minimum spanning tree

After the elimination of noise resources, there are still a huge number of online learning resources. As a result, an efficient clustering technique is required to group similar learning resources together as clusters. The distance between each pair of remaining objects is first calculated, and then the minimum spanning tree of remaining learning resources is built accordingly by using the Prim’s (1957) algorithm. A minimum spanning tree is constructed to create a link of all remaining objects (Algorithm 1).

![Figure 1. Framework of online learning resource clustering](image_url)
Algorithm 1. Algorithm of generating the minimum spanning tree.

**Input:** A weighted connected graph, with a vertex set $V$ and an edge set $E$;

**Output:** A set $V_{new}$ and a set $E_{new}$ by which the minimum spanning tree is described

1: initialization: $V_{new} = \{x\}$ ($x$ is the starting point chosen from $V$), $E_{new} = \emptyset$;
2: while $V_{new} \neq V$ do
3: choose edge $u,v \in E$ ($u \in V_{new}$, $v \notin V_{new}$ and $v \in V$);
4: add $v$ into $V_{new}$ and add $u,v$ into $E_{new}$;
5: end while

3.4 Merging learning resources into clusters

In the previous subsection, a minimum spanning tree is generated. The degree of freedom of each instance of learning resources can be obtained by using Definition 3:

**Definition 3.** The degree of freedom of an object (i.e. online learning resource) $x_i$ is:

$$df(x_i) = |\{x_j | (x_i,x_j) \in E\}|,$$

where $E$ denotes the edges that $x_i$ belongs to.

It is believed that an object with a large value of degree of freedom means that it has a large number of neighbors. The object therefore may be a centroid (Mimaroglu and Erdil, 2011). Thus the learning resources are sorted according to their degree of freedom. Subsequently, the learning resources are partitioned into clusters based on the structure of minimum spanning tree and their degree of freedom (Algorithm 2).

Figure 2 provides an example to demonstrate the operation of Algorithm 2. Table I shows the Euclidean distance between all pairs of objects.

This algorithm is illustrated as follows:

1. Six objects $v_1, v_2, \ldots, v_6$ are used as an example (Figure 2). The parameters $DEV$ and $m$ are set as 0.5 and 2, respectively. The values of density $DEN$ of each object are shown in Table II. Because there is no noise object, all objects are hence reserved.

2. A minimum spanning tree for the objects is generated by using the Prim’s algorithm. The resulting edges of the tree are $(v_1, v_2), (v_2, v_3), (v_1, v_4), (v_4, v_5), (v_5, v_6)$.

3. Table II shows the degree of freedom of each object. The objects are sorted in reverse order of their degree of freedom. The order of the objects after sorting is $v_1, v_2, v_4, v_5, v_3, v_6$. Thus, object $v_1$ is put into the first cluster, i.e., Cluster 1.

4. The immediate neighboring objects of $v_1$ are $v_2$ and $v_4$. Object $v_2$ is put into Cluster 1 because $d(v_1, v_2) < d(v_2, v_3)$. Object $v_4$ is not included in Cluster 1 because $d(v_1, v_4) > d(v_4, v_3)$.

5. The neighboring objects of the newly added object are subsequently considered. Because object $v_2$ is the newly added object, object $v_3$ which is the immediate neighbor of object $v_2$ is considered. Object $v_3$ is put into Cluster 1 because $v_3$ have no other neighboring objects and the minimum distance between object $v_3$ and its neighboring objects is $d(v_2, v_3)$. Now, Cluster 1 has three objects, i.e., $\{v_1, v_2, v_3\}$.

6. The object with the largest value of degree of freedom is first chosen among remaining objects. Among the three objects $v_4, v_5,$ and $v_6$, object $v_4$ has the
The neighboring objects of $v_4$ are $v_1$ and $v_5$. As object $v_1$ has been put into Cluster 1, it is not considered here. Object $v_5$ is put into Cluster 2 because $d(v_4, v_5) = d(v_5, v_6)$. After that, the neighboring objects of the object which is newly added are considered, i.e., object $v_6$. Object $v_6$ is also added into Cluster 2 because it has no other neighboring objects, and the minimum distance between object $v_5$ and its neighboring objects is $d(v_5, v_6)$. At last, all objects have been put into clusters and two clusters are generated by the algorithm, i.e., Cluster 1 = \{v_1, v_2, v_3\} and Cluster 2 = \{v_4, v_5, v_6\} (Figure 3).

Algorithm 2. A partitioning method based on minimum spanning tree.

**Input**: $D$: Date Set  
**Output**: C: Clusters  
1: Calculate the Euclidean distance between each pair of objects;  
2: Calculate the Density $DEN$ based on the Euclidean distance;  
3: Calculate the average density $ADEN$;  
4: for all objects do  
5: if $DEN > ADEN + DEV$ then  
6: Elimination of outlier  
7: end if  
8: end for

<table>
<thead>
<tr>
<th>Object</th>
<th>$v_1$</th>
<th>$v_2$</th>
<th>$v_3$</th>
<th>$v_4$</th>
<th>$v_5$</th>
<th>$v_6$</th>
</tr>
</thead>
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<td>$v_1$</td>
<td>~</td>
<td>1.000</td>
<td>1.414</td>
<td>2.828</td>
<td>3.606</td>
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<td>1.000</td>
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<td>~</td>
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<td>5.000</td>
<td>4.243</td>
<td>2.000</td>
<td>1.000</td>
<td>~</td>
</tr>
</tbody>
</table>

$DEN = 1.207$  
$df = 2$  

Table I: The Euclidean distance between objects

Table II: The value of every object

largest value of degree of freedom. The neighboring objects of $v_4$ are $v_1$ and $v_5$. As object $v_1$ has been put into Cluster 1, it is not considered here. Object $v_5$ is put into Cluster 2 because $d(v_4, v_5) = d(v_5, v_6)$. After that, the neighboring objects of the object which is newly added are considered, i.e., object $v_6$. Object $v_6$ is also added into Cluster 2 because it has no other neighboring objects, and the minimum distance between object $v_5$ and its neighboring objects is $d(v_5, v_6)$. At last, all objects have been put into clusters and two clusters are generated by the algorithm, i.e., Cluster 1 = \{v_1, v_2, v_3\} and Cluster 2 = \{v_4, v_5, v_6\} (Figure 3).
9: Construct a minimum spanning tree for remaining objects by using the Prim’s algorithm;
10: Calculate and sort the degree of freedom of each vertex in the tree;
11: $\text{cluster} = 1$;
12: while there are unmarked objects do
13: Add unmarked object with the highest value of degree of freedom to an empty queue;
14: while queue is not empty do
15: $V = \text{dequeue}();$
16: Add $V$ to the present cluster;
17: Mark $V$;
18: for all edge $<v,w>$ do
19: if $w$ is unmarked then
20: $\text{weight} = \text{weight}(v,w);$ 
21: end if 
22: for all edge $<w,t>$ do 
23: if $\text{weight}(w,t) \leq \text{weight}$ then 
24: $\text{ismax} = \text{false};$
25: break;
26: end if 
27: end for 
28: if $\text{ismax} = \text{true}$ then
29: Enqueue($w$);
30: end if 
31: end for 
32: end while 
33: $\text{cluster}++;$
34: end while 
35: for every cluster obtained above do 
36: if the number of objects in the cluster $< \text{minNum}$ then 
37: if distance between the cluster and neighboring cluster $< \text{minDis}$ then 
38: merge the cluster into the neighboring cluster; 
39: end if 
40: end if 
41: end for
3.5 Merging small clusters by the distance

Based on the minimum spanning tree generated, an initial clustering result is obtained by using Algorithm 2. However, there may be a large number of small clusters which only contain a few learning resources. To save computational resources, the small clusters will be further merged into large clusters. Algorithm 3 details the merging of small clusters into large clusters, where \( \text{minNum} \) indicates the minimum number of objects required for a cluster, \( \text{minDis} \) represents the minimum distance between clusters. If the number of objects in one cluster is less than \( \text{minNum} \) and the distance between the cluster and its closest neighboring cluster is less than \( \text{minDis} \), the cluster is merged into its closest neighboring.

Algorithm 3. Merging small clusters based on the distance.
1: for every cluster obtained above do
2: if the number of objects in cluster < \( \text{minNum} \) then
3: if distance between the cluster and its closest neighboring cluster < \( \text{minDis} \) then
4: merge the cluster into its closest neighboring cluster;
5: end if
6: end if
7: end for

3.6 Comparison with technique proposed with density-based clustering methods

Clustering approaches are very popular for understanding the natural grouping or structure in a data set. There are various clustering algorithms such as K-means, bisecting K-means, K-medoids, and fuzzy-means clustering. The main drawback of those approaches is the random selection of initial centroids (i.e. instability issue). In addition, the traditional clustering approaches can find only spherical-shaped clusters (Govindarajan et al., 2013). Other clustering methods have been developed for non-spherical cluster shape based on the notion of density. Density-based clustering can be used to filter out noise objects (outliers) and discover clusters of arbitrary shape effectively (Duan et al., 2006).

DBSCAN is one of the most widely used density-based clustering algorithms, which can discover clusters of arbitrary shape in spatial databases with noise objects (Ester et al., 1996). The general idea of DBSCAN is that for each instance of a cluster, the neighborhood of a given radius (\( \epsilon \)) has to contain at least a minimum number of points (\( \text{MinPts} \)), where \( \epsilon \) and \( \text{MinPts} \) are parameters set by users manually. If a spatial index is used, the computational complexity of DBSCAN is \( O(n \log n) \), where \( n \) is the number of objects. Otherwise, its computational complexity is \( O(n^2) \).

In this paper, a novel clustering technique is proposed based minimum spanning tree. Because the minimum spanning tree is built by using the Prim’s algorithm and the running time of Prim’s algorithm is \( O(n^2) \), the overall running time for the technique proposed is also \( O(n^2) \). In this regard, the computational complexity of the technique proposed is comparable with DBSCAN. The efficiency of DBSCAN is highly dependent on appropriate settings of the user-defined parameters \( \epsilon \) and \( \text{MinPts} \). The performance of DBSCAN will be computationally expensive and time-consuming when they are facing noise objects. The proposed technique is free of the problem of noise objects, because they are removed at the early stage.

4. Experiments

In this section, the clustering technique proposed is evaluated by using four different data sets. First, we employ three data sets (i.e. “Smileface,” “Aggregation,” and “Jain”
data sets) to test the effectiveness of our method and standard clustering algorithms, because these data sets have quite different densities, scales, and shapes. Second, a large-scale discussion threads from the forums of Coursera MOOCs is used for real-world validation. Specifically, the “Smileface” data set contains clusters with both uniform and uneven densities, which is suitable to evaluate the effectiveness of density-based clustering algorithms. The “Aggregation” data set has seven clusters with different scales, and the “Jain” data set contains two clusters with ambiguous boundaries. The above features may be presented in online learning resources and will bring challenges to clustering approaches. The classical K-means clustering, average-link hierarchical clustering, complete-link hierarchical clustering, and DBSCAN method are implemented in this study for comparison.

4.1 Results of different clustering algorithms on the “Smileface” data set
The algorithm proposed is first evaluated with the data set named “Smileface.” The “Smileface” data set contains a total of 644 points which belong to four different clusters.

The K-means clustering performs very well with data points in globular shaped clusters. However, clusters in the “Smileface” data set are not in the globular shape. Figure 4 shows the result of K-means clustering with $K$ equals to 4. Figures 5 and 6 show the results of average-link hierarchical clustering algorithm and complete-link hierarchical clustering algorithm, respectively. It is observed that the four clusters are not separated very well by three baseline algorithms.
Figure 7 shows the result of the proposed algorithm with parameters shown in Table III. As shown in Figure 7, our clustering scheme is robust and it can handle the outliers very well. The result of clusters produced by our algorithm is more satisfactory than three baseline algorithms.

4.2 Results of different clustering algorithms on the “aggregation” data set

Similarly, all clustering algorithms are also evaluated with the data set named “Aggregation.” The “Aggregation” data set contains a total of 788 points, which belong to seven different clusters. In comparison with the “Smileface” data set, the “Aggregation” data set is more complex.

Figure 8 shows the result of $K$-means clustering. It is observed that the red cluster contains points which belong to three different clusters. Furthermore, two clusters in the right hand side with internal touch are separated into three clusters. Figures 9 and 10 show the results of average-link hierarchical clustering and complete-link hierarchical clustering algorithms, respectively. The result of the average-link

<table>
<thead>
<tr>
<th>Point</th>
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<th>$DEV$</th>
<th>$minNum$</th>
<th>$minDis$</th>
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<tbody>
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<td>80</td>
<td>0.5</td>
</tr>
<tr>
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<td>0.5</td>
<td>70</td>
<td>2</td>
</tr>
</tbody>
</table>
hierarchical clustering is good. However, the complete-link hierarchical algorithm performs very poorly on the “Aggregation” data set.

Figure 11 shows the experimental result of our algorithm. It exactly separates two clusters in the right hand side which are wrongly separated by $K$-means clustering. However, it groups the points which belong to three clusters in the lower left corner into two clusters. This problem will be further investigated in the future. It provides a research direction for enhancement of our algorithm proposed.
4.3 Results of different clustering algorithms on the “Jain” data set

A two-dimensional data set “Jain” is used for further evaluation of the robustness of the clustering algorithms over clusters with different densities. The “Jain” data set contains a total of 373 points, which belong to two clusters. Different from the aforementioned two data sets, the cluster densities of this data set are different with each other.

Figure 12 shows the result of $K$-means clustering. It is observed that the performance of $K$-means on “Jain” data set is poor since these two clusters are not in the globular shape. Figures 13 and 14 show the results of average-link hierarchical
clustering and complete-link clustering algorithms, respectively. In this case, it is observed that these two algorithms have the same experimental results. Figure 15 shows the result of our algorithm which treats the points with low density as noise points and eliminates them. This indicates that our algorithm is more suitable to identify dense resources than other baseline methods.

4.4 Results of different clustering algorithms on the e-learning data set

In this section, the proposed minimum spanning tree based clustering algorithm is compared with the classical density-based algorithm DBSCAN, and the best-performing baseline of average-link hierarchical clustering by using a real-world e-learning data set (Rossi and Gnawali, 2014). This data set is the anonymized version of the discussion threads from the forums of 60 Coursera MOOCs, for a total of about 100,000 threads. After removing the redundant items, 73,942 learning instances are used for evaluation. A total of 197 distinct courses are assigned to four clusters (i.e., automata-002, bigdata-edu-001, humankind-001, and gametheory-003).

The characteristics of the “MOOCs” data set are used as the density of DBSCAN, and the density of the object is used as the parameter of our minimum spanning tree algorithm.

The actual clusters of the MOOCs data set are shown in Figure 16. By tuning various combination of parameters, the best clustering result of DBSCAN is shown in Figure 17. The result of average-link hierarchical clustering, which performed well on the previous “Aggregation” data set, is shown in Figure 18. However, it is observed...
Clustering of online learning resources

Figure 16. Actual clusters of “MOOCs” data set

Figure 17. Result of DBSCAN on “MOOCs” data set

Figure 18. Result of average-link on “MOOCs” data set
that these two baselines both generated some errors on the e-learning data set. The clustering result of the algorithm proposed is shown in Figure 19, which is nearly the same with the grand truth (Figure 16).

On the one hand, the proposed minimum spanning tree based clustering algorithm shows higher accuracy, which can group the online courses into clusters effectively. On the other hand, our algorithm can find the appropriate parameters efficiently on the “MOOCs” data set, i.e., it is robust to make a correct distinction between the labeled and unlabeled e-learning data sets.

The experimental results also indicate that determination of parameters for different clustering algorithms on e-learning data sets is a critical factor which affects the effectiveness of the algorithms. This provides another direction for future research.

5. E-learning applications
This section will discuss briefly how to apply the novel clustering technique proposed in various e-learning systems. Generally, the algorithm proposed can be employed in the following four aspects.

5.1 Classification of learner
As there may be more than tens of thousands of learners enrolling in one single course in MOOCs, it is very important to cluster the learners into groups. The effectiveness of learning can be greatly improved by homogenous grouping. Because the learners in a group have common characteristics, so that learning material and teaching strategies can be adjusted accordingly. For instance, the MITx and HarvardX (2014) data set suggests that the learners with good academic results have similar pattern of playing of course video. These learners are quite close with each other if their attributes (e.g. frequency of playing video) are plotted in an $n$-dimensional graph. As a result, the clustering algorithm proposed can differentiate the learners and corresponding assistances can be offered subsequently.

5.2 Discovery of learning path
Discovery of learning path is a classical application in e-learning system. On the other hand, it is very time-consuming and extremely challenging for users to identify...
their optimized learning paths when they wish to acquire new knowledge in a specific topic. A key step in discovery of learning path is to identify whether there is a strong linkage between two knowledge units (Leung and Li, 2003). It can be easily determined whether two knowledge units are in the same cluster by using the clustering result produced by the method proposed. It is less time-consuming, because it is not required to compare all pairs of knowledge units.

5.3 Recommendation of learning resource
In web-based learning, learners are facing a problem of overloading of online learning resources. It is essential to identify suitable learning resources from a potentially overwhelming variety of choices (Manouselis et al., 2010). The algorithm proposed can discover the natural grouping of online learning resources effectively. The system can easily recommend both interesting and relevant learning resources to learners by using the clustering result.

5.4 Intelligent tutoring
Intelligent tutoring is a generation of learning oriented methodology that includes the individuality of the learner in the learning process. It is very similar to what happens in a traditional individualized lesson with one tutor and one learner. In the learning oriented approach, technology needs to be adapted to the needs of learners and tutors to create suitable methods for working with it (Aberšek et al., 2014). To this end, clustering of online learning resources is valuable to decision making in terms of tutorial strategies and instructional design.

6. Conclusions
A clustering algorithm for online learning resources is proposed based on the minimum spanning tree in this paper. Outliers are removed according to the density of resource which is measured by using Euclidean distance. A minimum spanning tree is generated to connect the neighboring online learning resources together by edges. The K-means clustering, average-link hierarchical clustering, complete-link hierarchical clustering algorithms and DBSCAN algorithm are tested with four data sets in order to evaluate the performance of different clustering techniques. Furthermore, it is elaborated how to apply the algorithm proposed in four different e-learning applications (i.e. classification of learner, discovery of learning path, recommendation of learning resource, and intelligent tutoring). The experimental results demonstrate the effectiveness of our algorithms proposed. Our technique will shed light on the real-world online learning, i.e., the minimum spanning tree based clustering algorithm can classify large amount of learning resources according to their characteristics. Such a kind of feature can reduce the time for searching of learning resources, alleviate the problem of ineffective studies, and improve the efficiency of online learners.

In the future, the density-based clustering method will be applied to choose the representative documents for sentiment analysis (Rao et al., 2014). Moreover, the algorithm proposed will be further evaluated by using a large and high-dimensional learning corpus, as well as more real-world data sets. On the other hand, it will be valuable to conduct a longitudinal study.


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Trends in open and distance
learning research: 2005 vs 2015

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Abstract
Purpose – The purpose of this paper is to analyse the research trends in the field of open and distance learning (ODL) as reflected in journal articles.
Design/methodology/approach – It compares research articles published in 2005 and 2015. Content analysis was conducted on a total of 288 research articles published in seven peer-reviewed journals on ODL. The study covers research areas and keywords, research methodology and participant types, and author collaboration.
Findings – The results show that macro-level research on areas such as globalization and cultural aspects of ODL remain relatively scarce, and international collaboration appear uncommon in both 2005 and 2015. However, there was an increasing amount of international collaboration in developing macro-level research. Empirical research studies, especially those using quantitative methods, have become the dominant methodology. The data sources have also been broadened. Several new keywords which did not exist or were rarely used (e.g. massive open online courses) have become common in 2015.
Originality/value – The analysis offers insights for researchers into how they can develop their research effectively in the field and enhance the chances of their research outputs being accepted. Recommendations are also made for ODL researchers on the types of research that tend to be accepted for publication and will have a high potential impact in the future.
Keywords Content analysis, Open and distance learning, Research trend

1. Introduction
Open and distance learning (ODL) practices have been evolving, in particular as educational technologies being applied to ODL are developing at an unprecedented pace. Research in the ODL field appears to have also been evolving. This paper attempts to investigate the changes that have taken place in the last decade by systematically comparing research publications.

For effective research in the field and enhancing the chances of their research outputs being accepted, it is important for researchers to be aware of trends in the field.

In order to facilitate healthy and sustainable development of ODL research, scholars in this area have suggested conducting empirical research to analyse, and monitor the changes over time (e.g. Bozkurt et al., 2015). To remain connected to the constant advances in technology that have been taking place at an increasingly fast pace, it is especially important to follow closely the trends in ODL research.

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The work described in this paper was partially supported by a grant from the Research Grants Council of the Hong Kong Special Administrative Region, China (UGC/IDS16/15).
This paper examines the changes that took place in ODL research in the last decade by comparing ODL research articles in 2005 with those in the most recent year, 2015. The research trends have been investigated, following the framework of research areas of Zawacki-Richter et al. (2009). Four aspects of research trends were analysed. The first aspect focusses on “what” ODL research has been done, and the other three aspects are devoted to “how” ODL research has been carried out, as follows: research issues and topics, including the research areas covered in published research work, and the keywords indicated by the author; the research methods used by ODL researchers; the patterns of authorship and ways of developing collaborative research; and the target group or population to whom the researchers address their research questions.

2. Previous related efforts and the light shed

The early attempts to study the trends in ODL research were mainly explorations of the research themes underlying it from the 1990s to the early 2000s. For example, Berge and Mrozowski (2001) examined the research issues in ODL literature sampled over a ten-year period from 1990 to 1999. Also, Lee et al. (2004) analysed the research topics, as well as methods, and citation trends, in ODL literature from 1997 to 2002.

In building on the groundwork to develop systematic classification rubrics of ODL research based mainly on thematic analyses of published research articles, Zawacki-Richter (2009) conducted an in-depth Delphi study to collect and analyse the opinions of ODL research experts, who were editorial board members of major ODL journals. The experts’ responses led to a classification system which divided ODL research areas into three levels, namely, the macro-level, meso-level, and micro-level. Macro-level research focusses on distance education systems and theories and includes a number of specific research areas covering access and equity issues; globalization and cross-cultural aspects, as well as distance teaching systems and institutions; and theories and research methods in distance education. Meso-level research involves a broad range of topics on the management and technology of distance education institutions, such as administration, organizational systems, costs and benefits, learner and faculty support, and quality assurance. Finally, micro-level research is mainly concerned with issues of teaching and learning in the distance education context, including instructional design, interaction and communication in learning communities, and learner characteristics.

Zawacki-Richter’s (2009) seminal work in developing a classification scheme for research areas then inspired a series of subsequent studies which examine empirically the trends in ODL research in more recent years.

Zawacki-Richter et al. (2009) reviewed 695 articles published in five prominent ODL journals between 2000 and 2008. They pointed out that several weaknesses in ODL research persisted, including a lack of both methodological and theoretical robustness, and a comprehensive coverage of research areas. Based on their classification scheme, they highlighted the fact that ODL research was largely dominated by micro-level research. In contrast, macro-level and meso-level research — including a number of important research areas from management, institutional organization to cross-cultural aspects of distance education — were largely neglected. Based on the same classification scheme, Bozkurt et al. (2015) reviewed 861 research articles published in seven ODL journals from 2009 to 2013 to examine more recent trends (see also Bozkurt et al., 2015 for analysis of dissertations from 1986 to 2014). Similar to Zawacki-Richter’s (2009) report, Bozkurt et al. (2015) found “a strong imbalance between research areas and high over-representation of the micro-level perspective” (p. 342).
3. Methodology

3.1 Research design

In this study, content analysis was employed to study the changes in ODL research as reflected in refereed journal articles published in 2005 and 2015. The aspects of change cover research areas, authorship patterns, research collaboration, methodology, target population and/or participant groups, and keywords.

The qualitative part of the content analysis involved labelling every article under each of the six variables above. After the qualitative coding procedures, the data were further submitted to quantitative analyses such as descriptive data analysis and categorical data analysis.

3.2 Sample

Articles from the seven journals were reviewed for the study, namely, The American Journal of Distance Education, Distance Education, the European Journal of Open, Distance and e-Learning (EURODL), The International Review of Research in Open and Distributed Learning, the Journal of Online Learning and Teaching, Open Learning: The Journal of Open, Distance and e-Learning (OL), and the Asian Association of Open Universities Journal (AAOU Journal).

These journals were selected based on four criteria. First, the journals focus specifically on distance education or ODL. Second, their papers are refereed, with a formal review process for paper selection. Third, they have a publication history of at least ten years which is necessary for the study. Fourth, they are published in English. Of the seven journals above, the first six were also chosen by Bozkurt et al. (2015), which also required the journals to have been indexed by prominent databases. The AAOU Journal, which publishes research articles relevant to ODL in the Asia-Pacific context, was first produced in 2005, and just met the time criterion for inclusion.

Of the seven journals chosen for the major part of the analysis of research areas, authorship and collaboration, methodology, and target population, only three journals had keywords indicated for all articles published in 2005 and 2015, and therefore only these three were selected for the analysis of keywords, namely, EURODL, OL, and the AAOU Journal.

From the seven journals published in 2005 and 2015, a total of 288 articles (106 in 2005 and 182 in 2015) were identified as research articles and therefore analysed for their purposes. Following Bozkurt et al’s (2015) criteria, other types of articles (e.g. book reviews, concept papers, editorials, field notes, interviews, position papers, reflection papers, and technical notes) were excluded from the analysis. From the three journals selected for keywords analysis, a total of 87 articles (42 in 2005 and 45 in 2015) were sampled.

3.3 Coding procedures

For the variables of number of authors and research collaboration, two raters were involved. One rater counted the number of authors for each article and coded the variable at five levels, i.e. “one author”, “two authors”, “three authors”, “four authors”, and “five author or above”. If there was more than one author, he then determined whether the authors were from the same institution (coded as “same institution” for the variable “research collaboration”); from different institutions, but the same region/country (coded as “cross-institution only”); or from different regions/countries (coded as “cross-border”). The other rater cross-checked the coding made by the first rater and ensured there were no mistakes in the coding.
For the variable of target population and/or participant group, two raters made a joint effort to search for the relevant information in each article and coded the variable into one of 12 categories, namely, bachelor’s/sub-degree students, postgraduate students, academician/teachers, students, document/data file, administrators, K-12 students, specialists, institutions, system/programme, multiple types, and other.

The two variables mentioned above were relatively straightforward to code with a little subjective judgement. The variables of research areas and research methodology involved much more subjective interpretation. Therefore, two raters made judgements on each article on these two variables independently to avoid bias in the coding results. For research areas, the classification scheme was based on the one developed in Zawacki-Richter et al.’s (2009, pp. 22-25) study. The two raters each assigned a category from a total of 15 research areas at three research levels to each article.

Research areas of ODL categorized by Zawacki-Richter and von Prümmer (2010):

1. Macro-level: distance education systems and theories:
   - access, equity, and ethics;
   - globalization of education and cross-cultural aspects;
   - distance teaching systems and institutions;
   - theories and models; and
   - research methods in distance education and knowledge transfer.
2. Meso-level: management, organization, and technology:
   - management and organization;
   - costs and benefits;
   - educational technology;
   - innovation and change;
   - professional development and faculty support;
   - learner support services; and
   - quality assurance.
3. Micro-level: teaching and learning in distance education:
   - instructional design;
   - interaction and communication in learning communities; and
   - learner characteristics.

The definitions and descriptions for each type of empirical research method – namely, quantitative, qualitative, and mixed method – were based on those specified in Creswell (2013). Two raters each judged whether the research article was empirical or non-empirical (i.e. a literature review or theoretical article in which the arguments were not supported by empirical data). For empirical research articles, each rater judged which type of methods was employed based on Creswell’s (2013) criteria.

An inter-rater reliability analysis using Cohen’s κ statistic was performed to determine the consistency of the judgements of the two raters on the research area and the research methodology of each article. For the research area, the inter-rater reliability was found to be \( \kappa = 0.73, p < 0.01 \), 95 per cent CI (0.68, 0.78); and for research methodology, the
inter-rater reliability was $\kappa = 0.77$, $p < 0.01$, 95 per cent CI (0.71, 0.83). According to Landis and Koch (1977), values of $\kappa$ from 0.40 to 0.59 can be considered moderate, 0.60 to 0.79 substantial, and 0.80 outstanding. Therefore, the $\kappa$ statistic showed that the two raters had reached a good level of agreement with each other on the research area and research methodology of the articles. For each article with inconsistent coding between the raters, a final consensus was reached through discussion.

For the keywords indicated in the research articles, 203 keywords from 42 articles in 2005, and 220 keywords from 45 articles in 2015 were extracted from all the articles. For accuracy and avoidance of duplication, a final list of 337 keywords was then employed. The frequency and proportion of articles containing each keyword in the list were counted for descriptive analysis.

4. Results
As noted earlier, the major part of the results was based on content analysis of 288 research articles sampled from all issues of seven ODL journals in 2005 and 2015, covering the aspects of research areas, authorship patterns, research collaboration, research methodology, target population, and/or participant groups. To analyse the trends reflected in the keywords in the research articles, we investigated a sample of 87 research articles from three ODL journals as specified above.

4.1 Research areas
Table I presents the percentage figures for each type of research article that was classified in one of the research areas categorized by Zawacki-Richter and von Prümmer (2010), as well as the total percentage figures for each level of research area. The three levels of research area (macro, meso, and micro-level) showed an imbalance in distribution among

<table>
<thead>
<tr>
<th>Research area</th>
<th>Percentage of articles</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2005 ($n = 106$)</td>
</tr>
<tr>
<td><strong>Macro-level: distance education systems and theories</strong></td>
<td>18.9</td>
</tr>
<tr>
<td>1. Access, equity, and ethics</td>
<td>4.7</td>
</tr>
<tr>
<td>2. Globalization of education and cross-cultural aspects</td>
<td>3.8</td>
</tr>
<tr>
<td>3. Distance teaching systems and institutions</td>
<td>6.6</td>
</tr>
<tr>
<td>4. Theories and models</td>
<td>1.9</td>
</tr>
<tr>
<td>5. Research methods in distance education and knowledge transfer</td>
<td>1.9</td>
</tr>
<tr>
<td><strong>Meso-level: management, organization, and technology</strong></td>
<td>35.8</td>
</tr>
<tr>
<td>6. Management and organization</td>
<td>8.5</td>
</tr>
<tr>
<td>7. Costs and benefits</td>
<td>1.9</td>
</tr>
<tr>
<td>8. Educational technology</td>
<td>5.7</td>
</tr>
<tr>
<td>9. Innovation and change</td>
<td>0.9</td>
</tr>
<tr>
<td>10. Professional development and faculty support</td>
<td>7.5</td>
</tr>
<tr>
<td>11. Learner support services</td>
<td>3.8</td>
</tr>
<tr>
<td>12. Quality assurance</td>
<td>8.5</td>
</tr>
<tr>
<td><strong>Micro-level: teaching and learning in distance education</strong></td>
<td>45.3</td>
</tr>
<tr>
<td>13. Instructional design</td>
<td>25.5</td>
</tr>
<tr>
<td>14. Interaction and communication in learning communities</td>
<td>13.2</td>
</tr>
<tr>
<td>15. Learner characteristics</td>
<td>5.7</td>
</tr>
</tbody>
</table>

*Note: *$p < 0.05$, two-tailed
the research articles published in both 2005 and 2015, in that the macro-level research was underrepresented. There was no significant difference between the percentage of each level of research area between 2005 and 2015, and macro-level research constituted less than 20 per cent of all articles in both years. Of the five categories in the macro-level research area, none had published over 10 per cent of all articles in both years. Such a pattern of results is consistent with previous findings (Bozkurt et al., 2015; Kanwar, 2014; Zawacki-Richter et al., 2009), which showed a persistent lack of attention to macro-level research in ODL research by the end of 2005.

In contrast, micro-level research, although with only three categories of research area, constituted the largest proportions of the three levels in both 2005 (45.3 per cent) and 2015 (44.0 per cent). Among the three micro-level research areas, “instructional design” had the largest group of research articles published in both 2005 (25.5 per cent) and 2015 (21.4 per cent). With the continuous technological progress in the past decade, especially related to digital learning environments (Bozkurt et al., 2015), utilising the new technology to enable better delivery of course materials, innovative teaching and learning approaches, and more effective assessment practices has remained an important research issue that has attracted a lot research effort. In addition, a significant increase in research articles published can be observed in the research area “learner characteristics” in 2015 (14.3 per cent) compared to 2005 (5.7 per cent). This difference indicates that there may have been a shifting focus on learner-centred approaches and an increasing amount of research on individual differences, e.g. motivational and behavioural patterns among learners who participated in ODL.

ODL research in 2015 also showed an increase in the percentage of research at the meso-level, although the change was not statistically significant. Of the seven categories of meso-level research areas, a notable increase in percentage was observed for “quality assurance”, from only 8.5 per cent in 2005 to 14.3 per cent in 2015, ranking the third highest among all 15 research areas. This trend may have been brought about by the emerging new technology and new modes of learning in the past decade (e.g. new massive open online courses (MOOCs) programmes), indicating that quality assurance has become an increasingly important issue for keeping up with the pace of technological innovation in ODL.

4.2 Authorship patterns and research collaborations

Table II presents the percentages of research articles with different numbers of authors in 2005 and 2015. A χ² test of independence was performed to examine the relation between the number of authors and the year of publication. The relation between the two categorical variables was significant (χ² (4, n = 288) = 13.53, p < 0.01), showing changes in authorship patterns from 2005 to 2015. The percentage of single author

<table>
<thead>
<tr>
<th>Number of authors</th>
<th>2005 (n = 106)</th>
<th>Percentage of articles</th>
<th>2015 (n = 182)</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>47.2</td>
<td>26.9</td>
<td>−20.3***</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>27.4</td>
<td>33.5</td>
<td>6.1</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>14.2</td>
<td>17.6</td>
<td>3.4</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>6.6</td>
<td>12.1</td>
<td>5.5</td>
<td></td>
</tr>
<tr>
<td>5 or above</td>
<td>4.7</td>
<td>9.9</td>
<td>5.2</td>
<td></td>
</tr>
</tbody>
</table>

Note: ***p < 0.001, two-tailed

Table II. Percentage of ODL journal articles by number of authors in 2005 and 2015
articles decreased in 2015 (26.9 per cent) compared with 2005 (47.2 per cent) at a statistically significant level. Multiple authorship had become the norm in 2015, with over 70 per cent of the sampled research articles having more than one author.

We further analysed how research collaboration was conducted in the multi-authored research. Table III presents the percentages of multi-authored research articles with different types of research collaboration, i.e. between authors from the same institution, authors from a different institution but from the same country or region, and authors from different countries or regions. A $\chi^2$ test of independence was performed to examine the relation between types of research collaboration and year, and the test revealed that the distribution of different types of research collaboration was not significant difference between 2005 and 2015 ($\chi^2 (2, n = 189) = 0.25, p = 0.88$). In the sampled research articles published in both 2005 and 2015, a majority of research collaboration was done between authors from the same institution.

4.3 Research collaborations by research area

To examine the trend in research collaboration at different levels of research area, we conducted a three-way cross-tabulation analysis on the relations between the level of research area, and the type of collaboration in the different years. Table IV presents the percentage of the three types of collaboration at each level of research area in 2005 and 2015. Because the breakdown of expected cell counts for the 2005 contingency table did not meet the assumptions for $\chi^2$ tests (Yates et al., 1999), the $\chi^2$ test was performed only for the 2015 data. The relation between the level of research area and the type of collaboration in 2015 was significant ($\chi^2 (4, n = 133) = 11.17, p < 0.05$), showing that the types of collaboration varied at different levels of research area. Specifically, although around 60 per cent of the research collaboration was done by authors from the same institutions at all three levels of research area, the breakdown of the research collaborations done by authors from different institutions differed across the

<table>
<thead>
<tr>
<th>Table III.</th>
<th>Percentage of ODL journal articles by type of collaboration in 2005 and 2015</th>
<th>Percentage of articles with multiple authors</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Type of collaboration</td>
<td>2005 ($n = 56$)</td>
<td>2015 ($n = 133$)</td>
</tr>
<tr>
<td>Same institution</td>
<td>58.9</td>
<td>56.4</td>
<td>−2.5</td>
</tr>
<tr>
<td>Cross-institution only</td>
<td>21.4</td>
<td>24.8</td>
<td>3.4</td>
</tr>
<tr>
<td>Cross-border</td>
<td>19.6</td>
<td>18.8</td>
<td>−0.8</td>
</tr>
</tbody>
</table>

| Table IV. | Percentage of ODL journal articles by research areas and type of collaboration in 2005 and 2015 | Percentage of each type of collaboration at each level of research areas |
|------------|----------------------------------|---------------------------------|-----------------|
| Level of research areas | Type of collaboration | 2005 | 2015 |
| Macro-level | Same institution | 83.3 | 60.9 |
| | Cross-institution only | 0.0 | 8.7 |
| | Cross-border | 16.7 | 30.4 |
| Meso-level | Same institution | 63.2 | 60.0 |
| | Cross-institution only | 26.3 | 32.7 |
| | Cross-border | 10.5 | 7.3 |
| Micro-level | Same institution | 51.6 | 56.4 |
| | Cross-institution only | 22.6 | 24.8 |
| | Cross-border | 25.8 | 18.8 |
three levels. Among studies from authors affiliated with different institutions, the collaborations for macro-level research were mainly cross-border, while those for meso-level and micro-level were mainly within border.

Compared with the data for 2005, the distribution of different types of collaboration at the meso and micro levels had not changed much statistically in 2015. However, for the research collaborations at the macro-level, a greater proportion of cross-border collaboration had been conducted in 2015 than in 2005. This results show that, although both macro-level research and cross-border collaboration remained underrepresented in ODL research in 2015, there was an encouraging trend of an increase in cross-border collaborations at the macro-level of research.

4.4 Research methodology

Table V presents the percentages of research articles with different types of research methodology in 2005 and 2015. A $\chi^2$ test of independence was performed to examine the relation between research methodology and year. The relation between the two categorical variables was significant ($\chi^2 (3, n = 288) = 23.95, p < 0.01$), showing changes in research methodology in 2015 compared with 2005. The percentage of non-empirical articles decreased in 2015 (12.9 per cent) compared with 2005 (34.0 per cent) at a statistically significant level. In contrast, the percentage of articles using quantitative methods increased significantly in 2015 (43.4 per cent) compared with 2005 (24.5 per cent). A higher percentage of empirical, especially quantitative, research had been done in 2015 than in 2005, revealing a shifting norm in ODL research that theoretical work had to be validated by empirical, especially quantitative, data in order to be published in good journals.

4.5 Research methodology by research areas

To examine whether the trend in research methodology found in Section 4.4 varied at different levels of research area, we conducted a three-way cross-tabulation analysis on the relations between research methodology, and type of collaboration in the different years. Table VI presents the percentage of the four types of research methodology at different levels of research area in 2005 and 2015. For all three levels of research, there were more non-empirical research articles published in 2005 than in 2015, although the difference was not significant at the meso-level. For all three levels of research, there were more quantitative research articles published in 2015 than in 2005. This trend in research methodology can be consistently found at all three levels of research area.

4.6 Target population and/or participant groups

Table VII shows the percentages of research articles with different types of target population and/or participant group in 2005 and 2015. Cross-year comparison of the proportion shows three notable changes in 2015. There were a higher percentage of
students at non-specific levels being recruited in 2015 than in 2005. These students included those who participated in online learning through various MOOCs platforms but did not register with higher education institutions as undergraduate or graduate students in a traditional way. There was a higher percentage of documents/data files, including the data collected from online platforms or social network service providers, such as Twitter and Facebook, in 2015 than in 2005. Also, there was a lower percentage of studies recruiting multiple types of participant groups, typically students, and instructors involved in traditional face-to-face programmes, in 2015 than in 2005. These three findings jointly uncover a trend that more research effort has been devoted to studying the emerging, innovative ways of learning, such as MOOCs, in which students were from various levels, communication was made online, and traditional face-to-face interactions between students and instructors were absent.

Table VI.
Percentage of ODL journal articles by research area and research methodology in 2005 and 2015

<table>
<thead>
<tr>
<th>Level of research areas</th>
<th>Research methodology</th>
<th>2005 (n = 106)</th>
<th>2015 (n = 182)</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Macro-level</td>
<td>Qualitative method</td>
<td>4.1</td>
<td>12.2</td>
<td>8.1*</td>
</tr>
<tr>
<td></td>
<td>Quantitative method</td>
<td>6.1</td>
<td>22.4</td>
<td>16.3***</td>
</tr>
<tr>
<td></td>
<td>Mixed method</td>
<td>0.0</td>
<td>6.1</td>
<td>6.1**</td>
</tr>
<tr>
<td></td>
<td>Non-empirical</td>
<td>30.6</td>
<td>18.4</td>
<td>−12.2*</td>
</tr>
<tr>
<td>Meso-level</td>
<td>Qualitative method</td>
<td>12.5</td>
<td>21.1</td>
<td>8.6</td>
</tr>
<tr>
<td></td>
<td>Quantitative method</td>
<td>12.5</td>
<td>32.8</td>
<td>20.3***</td>
</tr>
<tr>
<td></td>
<td>Mixed method</td>
<td>7.0</td>
<td>7.0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Non-empirical</td>
<td>5.5</td>
<td>1.6</td>
<td>−3.9</td>
</tr>
<tr>
<td>Micro-level</td>
<td>Qualitative method</td>
<td>9.4</td>
<td>20.1</td>
<td>10.7*</td>
</tr>
<tr>
<td></td>
<td>Quantitative method</td>
<td>9.0</td>
<td>27.4</td>
<td>18.4***</td>
</tr>
<tr>
<td></td>
<td>Mixed method</td>
<td>16.0</td>
<td>12.6</td>
<td>−3.4</td>
</tr>
<tr>
<td></td>
<td>Non-empirical</td>
<td>34.0</td>
<td>12.1</td>
<td>−21.9***</td>
</tr>
</tbody>
</table>

Notes: *, **, ***Significant at p < 0.05; p < 0.01; p < 0.001, two-tailed level, respectively

Table VII.
Percentage of ODL journal articles by type of target population/participant group in 2005 and 2015

<table>
<thead>
<tr>
<th>Type of target groups</th>
<th>2005 (n = 70)</th>
<th>2015 (n = 180)</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bachelor's/sub-degree students</td>
<td>22.9</td>
<td>16.3</td>
<td>−6.6</td>
</tr>
<tr>
<td>Postgraduate students</td>
<td>15.7</td>
<td>8.8</td>
<td>−6.9</td>
</tr>
<tr>
<td>Academician/teachers</td>
<td>8.6</td>
<td>13.1</td>
<td>4.5</td>
</tr>
<tr>
<td>Students\a</td>
<td>17.1</td>
<td>31.9</td>
<td>14.8*</td>
</tr>
<tr>
<td>Documents/data files\b</td>
<td>2.9</td>
<td>11.9</td>
<td>9.0*</td>
</tr>
<tr>
<td>Administrators</td>
<td>2.9</td>
<td>0.6</td>
<td>−2.3</td>
</tr>
<tr>
<td>K-12 students</td>
<td>1.4</td>
<td>0.0</td>
<td>−1.4</td>
</tr>
<tr>
<td>Specialists</td>
<td>1.4</td>
<td>1.3</td>
<td>−0.1</td>
</tr>
<tr>
<td>Institutions</td>
<td>1.4</td>
<td>1.3</td>
<td>−0.1</td>
</tr>
<tr>
<td>System/programme</td>
<td>1.4</td>
<td>2.5</td>
<td>1.1</td>
</tr>
<tr>
<td>Multiple types\c</td>
<td>22.9</td>
<td>11.9</td>
<td>−11.0*</td>
</tr>
<tr>
<td>Other\d</td>
<td>1.4</td>
<td>0.6</td>
<td>−0.8</td>
</tr>
</tbody>
</table>

Notes: \a Students include non-specific-level students, online learners, adult learners, etc.; \b documents/data files include university archives, research papers/dissertations, online platform archives, online activity log files, etc.; \c multiple types means more than one type from items one to ten, e.g., both students and instructors; \d other types means those categories not covered by items 1 to 10, e.g. community sample. *p < 0.05, two-tailed
4.7 Keywords
A descriptive analysis of the keywords indicated in the research articles sampled from three ODL journals was conducted on the assumption that keywords give a holistic reflection of the topics of the research papers.

Keywords from 42 journal articles in 2005 and 45 articles in 2015 were ranked in terms of their frequency of appearance in the articles in these two years. The results showed that “MOOCs”, coined in 2008, was the keyword indicated most frequently in 2015, appearing in 18 per cent of the selected articles; and “blended learning” ranked third. A possible reason is that from mid-2000 onwards, there have been more attempts to define the field of blended learning (Chew et al., 2010; Graham, 2006), attracting more researchers to investigate the related topics, resulting in an increasing number of publications devoted to this area.

Whereas some new keywords appeared in 2015, some keywords found in 2005 fell significantly in terms of their frequency. For example, “e-learning” appeared in 17 per cent of the articles in 2005, but only once in 2015. However, “online learning” was indicated relatively more frequently in 2015 (9 per cent), suggesting that in recent ODL research the term “e-learning” may have been redefined as this old term no longer fitted the developments in educational technology in the last decade. More specific keywords such as “online learning” may have become more useful for indicating the related research topics.

5. Discussion
The findings above are summarized below and their implications are highlighted. They are also compared with relevant findings from other studies:

(1) Micro-level research, especially instructional design, still dominated the ODL research sampled in both 2005 and 2015. This is consistent with what was observed from ODL research sampled until 2008 (Zawacki-Richter, 2009) and until 2013 (Bozkurt et al., 2015). An encouraging change noted in 2015 was that meso-level research accounted for a proportion of research articles similar to that of micro-level research. A number of important areas, such as quality assurance, attracted considerable attention. However, much work still remains to be done to facilitate macro-level research as it continued to be underrepresented in 2015.

(2) International collaboration appeared uncommon in both years, but seemed to have become more common in macro-level research in 2015 publication data. Since macro-level research frequently involves different perspectives and data sources from researchers around the world, rather than a localized setting, such international collaboration will be likely to foster high-quality macro-level research than other types of research collaboration.

(3) Quantitative methods were more frequently employed in 2015 than in 2005, while in both Zawacki-Richter et al. (2009) and Bozkurt et al. (2015) the largest proportion of research sampled employed qualitative research. Such results could reflect either journal editors’ preferences or a general tendency in researchers’ study approaches.

(4) The variety of sources for data collection has been broadened owing to recent advances in technology, especially the emergence and widespread application of social network services, and big data technology. A multitude of data resources
will benefit ODL research by reflecting multiple facets of students and teachers’ learning and teaching processes, especially in the interaction and communication domain. It seems desirable that a greater effort should be made to explore the potential usage of various types of data in addressing research topics apart from learning and teaching, particularly in macro-level research, such as how open educational resources or MOOCs penetrate the learning activities for global users of the internet, and mobile networks.

There are a number of limitations in the present research. The sample size in this study is relatively small compared to prior research with the same purpose; and our analyses, especially the analysis of keywords, were based on a small number of journal articles. Also, we conducted a relatively small-scale analysis, comparing only research published in two years. Therefore, only the differences between the beginning and the end of a ten-year period (2005 to 2015) were observed, but the changes in the years in between have not yet been uncovered. Since the trends in ODL research aspects were not necessarily linear (Zawacki-Richter et al., 2009), we could have missed important information about such changes, which might have taken place under the influence of a variety of contextual factors, such as the introduction of new technology or new local or global policies in certain years. In addition, the variables coded in our study may not be comprehensive enough to cover the various aspects of ODL research we were interested in. Future research should focus on improving these aspects through a more thorough sampling of ODL research journals and research articles, covering data in more years, and exploring and measuring more variables. This would give a deeper level of understanding of the research trends, and higher convergence validity in the ways employed to operationalize ODL research trends.

6. Conclusion remarks
The present study uncovered the evolutionary trends of research in the ODL field as reflected in refereed research journal articles. We observed changes in ODL research in 2015 compared with 2005. These trends are worthy of researchers’ attention and can facilitate their identification of study areas and approaches.

For conducting research and publishing a high-research output, this study points to the following recommendations for ODL scholars. Research publications on macro-level issues with the support of empirical, especially quantitative, results on innovative theoretical positions will be in greater demand. Research would be more promising if there is international collaboration or its scope is extended to incorporate multiple facets to cross-validate the initial conclusions, and conclusions made by others. In addition, the use of multiple types of sources for data collection should be explored, as such uses have been made possible largely by the exciting emerging technological advances.

References


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