Innovative Crowdsourcing Mobile app for Curriculum Design: specification for a prototype mobile application

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Abstract-There is a demand for curriculum design systems to support the representation, exchange, integration and sharing of curriculum data over the internet, especially for ubiquitous computing; the main aim of the research is to undertake a critical analysis of the practices of crowdsourcing in software, evaluating the procedures carried out in construction of pieces of software and assessing the crowdsourcing software features. This aim will be achieved by using crowdsourcing in higher education as a case study and a prototype app specification will be designed using the knowledge gained from the critical analysis.

Keywords-Crowdsourcing mobile app； Curriculum Design； Education;

I. INTRODUCTION

Nowadays, in response to the arrival of the new generation of Web/Internet environments, one of the most attractive challenges in current research is to exploit wireless computing technologies in the process of curriculum design, as well as sharing the information via mobile devices, which may help to build a ubiquitous mobile curriculum system and support collaborative works within a mobile environment. Crowdsourcing is on the cutting edge of research today and is of great interest in a growing number of fields, for example medicine, for helping doctors makes diagnoses [2] and navigation for collecting information for maps [3]. There has not been much research or investigation into crowdsourcing in a software sense, which is why this study can contribute knowledge to the field, but more importantly carrying out a systematic analysis will be of great help to people in the future interested in this topic and wanting to apply it to software.

The focus for the paper will be the use of crowdsourcing in higher education. Education has been slower than other industries to adopt crowdsourcing [4]. Solemon et al [5] published a review of crowdsourcing in higher education and student learning and student feedback come through strongly as important areas. It was concluded that crowdsourcing in higher education can benefit students, staff, researchers, lecturers and administrators and prepare them for the 'online world challenges' through soliciting 'ideas, reviews, and feedback, and to create on-campus support from the crowds[6]. The aim of this research is to design the architecture of a crowdsourcing mobile system to enhance the capability by employing a wide range of information technologies in Curriculum design.

The contributions of the paper are shown below:

- Analysis and design of the prototype Crowdsourcing mobile app: currently, mobile devices (such as pocket computers, wireless handheld devices, mobile phones, etc) are being used more often as personal tools in education. New system aimed at providing a collaborative work environment for the sharing of Curriculum information, data and knowledge among distributed team members through mobile devices.
- How to share and exchange data in different formats (databases, spreadsheets, Extensible Markup Language, etc.) within a distributed enterprise and its various partners, and return the related information back to the mobile users; and how to support the employer-led learner route plan – given a number of requirements, to find suitable course provisions.

II. LITERATURE REVIEW

A. Crowdsourcing background and classification

Mobile applications have become a significant part of human life, proved by the fact that there were 179,628 million app downloads in 2015 alone, and that number is set to increase by half in the next two years [6]. It is thought that the mobile application industry will be worth $77 billion by 2017 [7]; therefore this is a large and growing field to be researching in.

Crowdsourcing is a technique that has been used to develop mobile applications in recent years. It is not a developmental technique; it is more of an information gathering technique that can be used to great effect in creating a truly useful program. The term crowdsourcing was first coined in 2006 by Howe [8]. One of the earliest uses of crowdsourcing was something called fund-sourcing or crowd-funding where, in education terms, a 'crowd' would

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provide much needed funding for education projects, however crowd-funding was used in many other different fields [9]. Crowd-funding is only one aspect of crowdsourcing; according to Solemon et al there are four crowdsourcing techniques, as applied to education: collective intelligence or crowd wisdom; crowd creation; crowd funding; and crowd voting [9].

A big part of the success that crowdsourcing has had relates to the growth and use of Web 2.0 technologies. Web 2.0, being an improvement on 1.0, is simply "the second stage of development of the Internet, characterized especially by the change from static web pages to dynamic or user-generated content and the growth of social media" [10]. The key things about Web 2.0 are "greater user interactivity and collaboration, more persuasive network connectivity and enhanced communication channels" [11]. Also, one of the biggest differences between Web 1.0 and Web 2.0 is "the greater collaboration among Internet users, content providers and enterprises" [20]. An important feature of Web 2.0 is the social nature of it, "enabling community-based input, interaction, content-sharing and collaboration" [11].

B. Crowdsourcing as problem solving and crowdsourcing in education

Crowdsourcing has been heavily used in the field of problem solving. By definition, problem solving is a very broad term, meaning simply the process of finding solutions to difficult or complex issues [12]. A person may employ many different techniques in order to solve the problem that they wish to solve. The process of crowdsourcing requires that a company/organisation must set a task for a 'crowd' to contribute to, which can be considered as a problem to be solved.

As well as problem solving, crowdsourcing has been used a technique in education. The crowdsourcing technique 'crowd wisdom', detailed above can be used as a method to obtain student feedback, specifically in higher education [20]. In an article about the state of crowdfunding in higher education, Yen talks about how universities are starting to use crowdfunding and crowdvoting in order to empower students [13]. Weld et al talk about how, if the correct methods are applied, crowdsourcing can offer an improved education environment, increasing work-flows and optimizing personal curricula [14]. It is believed that the introduction of crowdsourcing in to higher education can also improve alumni performance [14]. A further idea, posed by Llorente, was that in a crowdlearning environment, students can bring different skills to a common project to solve a given problem [14].

Because of the strong application of crowdsourcing to problem solving and to higher education, specifically the point that was raised by Llorente [14] about students bringing different skills to a common project; there is very strong potential for using crowdsourcing, specifically crowd wisdom in the field of supporting employer engagement and workforce planning requirements. This was hoped to achieve by developing a software application that can provide an integrated view of curriculum provision from all types of providers such as employers (industrial) and the higher education sector of UK (universities).

There is a growing body of literature about what crowdsourcing can do in higher education, several papers have discussed the possibilities it can bring to the field and the usefulness it can have. However, despite all the discussion and speculation, nobody, as yet, has produced a piece of software that can encapsulate all the potential that has been written about. Therefore there is quite clearly a gap here for an application, or any piece of software, which can truly change the way curriculum design is approached.

C. Teaching and learning framework

A paper by Weld et al discusses how crowdsourcing can be used in education "We foresee exciting developments in crowdsourced methods for content creation & curation, personalization and generation of rich feedback for students" [15]. However, they do not go on to create something that proves their predictions, leaving opportunities open provided the higher education environment is ready to accept crowdsourcing as a legitimate learning and teaching technique. If a crowdsourcing application for curriculum design is to be produced, a teaching and learning underpinning is required.

The Higher Education Academy [16] is the national body which champions teaching quality. It focuses mainly on the contribution of teaching and lecturers, and also has recently published reports that focus more on the role of partnership and student engagement in enhancing learning [17]. Crowdsourcing has at its heart engagement, collaboration and collective wisdom [18] therefore the concept of bringing students and lecturers together as partners could underpin this crowdsourcing project from a theoretical teaching and learning point of view.

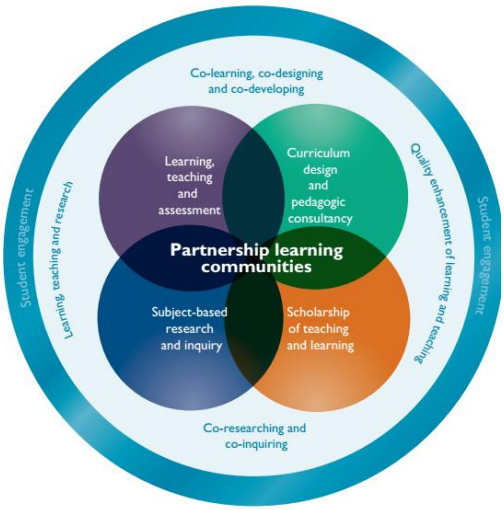

Figure 1 Ways of engaging students as partners in higher education from Healey et al page 24 [17]

Figure 1 shows a model of how, in a partnership approach, co-learning, co-designing, co-developing, co-researching and co-inquiring surround traditional models of learning, teaching and assessment, to create a new opportunity for students and lecturers to work together. Crowdsourcing as a technique could facilitate these activities to move teaching and learning into the 'new space' that Healey et al talk about [17]. In a literature review of Web 2.0 tools in higher education it was found that crowdsourcing practices have become more prevalent and are promoting innovative thinking and problem solving, where learners have "easier access to the expertise of others, to authentic environments and to distributed audiences" [19]. In some of the very early work on crowdsourcing it was said that "a group of people can be smarter than the smartest person in the group" [18]. However, according to Surowiecki this is only the case if four key elements exist:

- Diversity of opinion- where everyone has their own private information/knowledge.
- Independence – where opinions are not determined by those of others.
- Decentralisation – where people can draw on local and specialised knowledge.
- Aggregation – where a mechanism exists for turning private judgements into a collective decision. [18]

The second condition (number 2 above) may not always exist in higher education because of peer pressure and students being conscious of the opinions of others and the lecturer, but Llorente [14] argues that collaboration and collective actions to solve problems may lead to stronger solutions and better learning. They propose a 'crowd teaching' technique that promotes 'crowdlearning' and therefore application of crowdsourcing in higher education could achieve the following:

- Help student retention by aligning learner requirements with academic provision: one of the biggest challenges higher educational institutions are facing today is student retention. One reason for student dissatisfaction arises from their inability to select the programme best for them. Institutions can make use of the tool to help students select what is best for them and thus increase student retention.
- To align with employer's needs – Higher education is a competitive market today. Educational institutions need to be competitive in not only designing their programmes but also in the way they deliver them. Students also are much more demanding and aware of what exactly they want from their educational programmes. One way of developing competitiveness is by delivering skills and capabilities which are much more valuable to industry than those delivered elsewhere. The tool can be used to monitor skills required by employers. Universities can engage employers in a proactive manner when designing programmes.
- Agile programme development – quick response to market needs fast track validation process: every industry is in a very dynamically changing environment today, as is the higher education sector. Having the ability to pick modules which satisfy a particular set of requirements, the tool will facilitate more agile programme development.
- Keeping to quality standards: helps to eliminate delivery of a topic in several modules, thus leading to redundancy in programme delivery; making sure the equality between levels is less, e.g. when the same topic is delivered at both UG and PG level.

III. ARCHITECTURE OF MOBILE SYSTEM

In order to achieve the above goals, and by analysing the potential features of crowdsourcing application, the diagram below explains on a high level the architecture of the system, mainly detailing how the information will be shared between each user and its communication to the server/database.

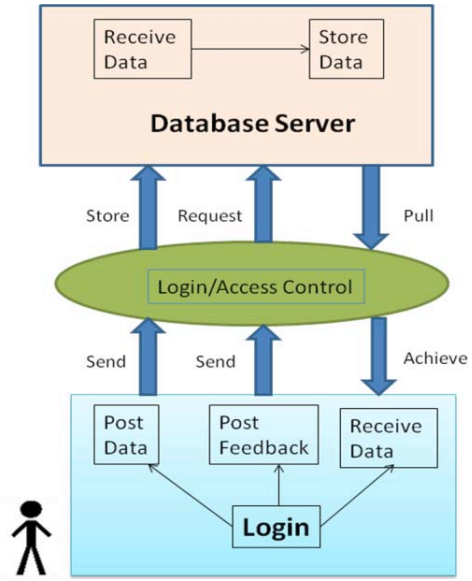

Figure 2: Architecture of the system

In order to complete any task on the application, the user must login with a verified university email, not only adding security to the system but also verification.

User tasks: (Login; Post course data; Read course information; Post suggestion; Read analysis results). All of these tasks require a connection to a database, which will simply receive and store data to be accessed at a later time. The connection to the database does need to be secured, as the database server will be located within the university network, which has its own firewalls that will block potential attacks. A further level of security is the fact that the user has to be logged in to the application in order to post something.

The majority of the functionality of the application will be based around communication between the user and the database, with relevant information being shown to the user as they request it. There will be no communication between the users (students/lecturers) themselves; everything will go through the database.

A. UI Design

All of the screen shots below were taken on a Moto phone and were designed with that particular phone in mind. The author is aware that these designs may look different if the code was loaded on to a different phone; this problem will be tackled later in development. As well as this, all of the UI designs below are subject to change throughout the course of the application development due to unforeseen changes and/or problems that may occur later on.

Material design elements have been used throughout the designing of this UI, for example using androids standard large, medium and small fonts. As well as this, material design icons have been used for the arrows shown below.

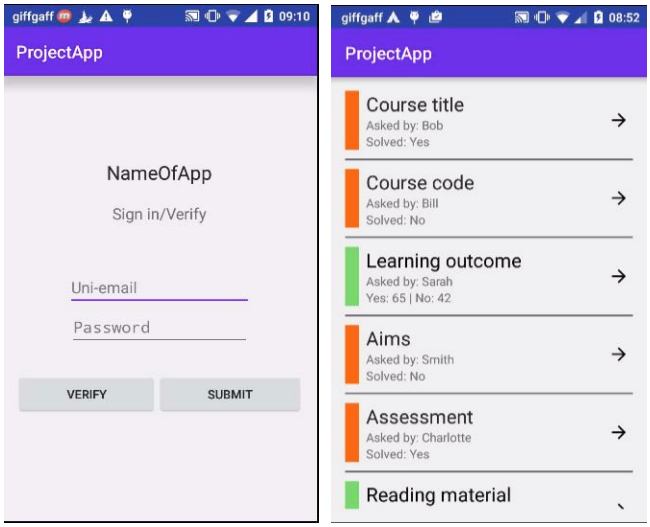

Figure 3: Mobile UI design (Example)

The screenshot above shows the login screen of the application, this will be presented to the user when they first load up the application.

- A standard login form contains: -
  - A field for the users email/username
  - A field for the users password
  - A submit button

The majority of the time, the layout for this form would be the email/username field on the top, with the password field being below. The submit button would be below the password field and to the right. The only difference between the login screen in this application and the standard login form is the 'Verify' button located to the left of the submit button, it would be unwise to have the verify button on the right side as this would go against convention.

The purpose of the 'Verify 'button is for verifying the users' email, the user have to do when they use the application for the first time. The system will not let the user login until they have verified the email; this is for the purpose of verifying the user and for security purposes. The user will be notified when the verification email has been sent.

This UI design above details what the user is welcomed with once they have logged in. It will show a list of submitted data uploaded by the users. The information will be ordered in chronological order, meaning the most recently uploaded data would be at the top.

When a user submits a course data they have to provide

the following information: (Their name, the title of the course and whether it is an open data or a poll (two option choices)). Once the information has been submitted it will appear in the list with all the other related data. Within the list, a little bit of information about the submitted data will be shown to the user; the course title, who provide it and whether it is stored.

The "Course information details" screen will detail the course information to the user, showing the course title, headline description, code if it is needed and a button to display the comments to the user. Below the description of the information will be a box of code if necessary, the grey box in the UI design above. This will be a scrollable text view that in final development will be a syntax highlighter that will reproduce the code coloring that the users are used to. Thus, pressing the 'Compare' button will bring up a fragment from the bottom of the screen (Figure 5), showing the user all of the courses anybody has made on this program. Again, like the list of the course title, the course data will be listed in chronological order. The user will also be able to add course information from this fragment as well as read the comparison.

IV. TECHNOLOGY UTILIZED FOR SYSTEM

By uploading the data/documents from mobile users, looking at program specifications from various universities, it was evident that several Universities followed certain templates that were not applicable to all disciplines. It was also difficult to identify the main reasons for the use of such templates and it emerged that certain quality concerns were the main focus rather than the design of a curriculum structure that could be used to describe the main elements of a programme.

A. Exchange of Course Related Information

To address the issues associated with the above course-related information system, several methods were used. The method which largely depends on the current system in place in the institutions relates to transforming course / curriculum information into the XCRI (Exchange of Course Related Information) format [1 and 21]. XCRI is the nationally acclaimed standard of representing course information in the United Kingdom. A major theme of XCRI is the development of an Extensible Mark-up Language (XML) specification. Learning providers can publish their course information in the standard XCRI-CAP format, so that it can be collected easily by organisations with course search services such as UCAS and Hotcourses etc.

For Bull [22], the method involves "parsing unstructured Word document, semi-structured HTML or a relational database", which is then converted to XCRI feeds. As stated by Taylor and Beal [23], the process involves outsourcing of course information database to a third party company that converts the course information to XML. For many institutions, the transformation process involves converting internal course information stored in more than two locations (usually database) and performing one transformation process or other. For [25], a coalition of several sources has to be done into one database, and for [24] a completely new database was developed because the information from the previous database system could not be easily harvested.

B. Course similarity and mapping/design

When the crowdsourcing system received the uploaded course data, comparison among different courses from different universities play the key role for Curriculum design. Semantic similarity takes into consideration the importance the end user puts on each keyword. This enabled us to take into consideration the individual user preferences. The semantic similarity between documents should not be focused on a simple text comparison but an intelligent mapping of curriculum components. Therefore, the semantic similarity is also filtered according different criteria that may affect the user preferences (e.g. which keywords are more important, the context of a keyword, the use of certain wording in the description of curriculum components).

But the XML (XCRI format) file was designed to carry data, not to display data. XML tags are not predefined, and XML is designed to be self-descriptive. Within this research field, Semantic Web Technology are utilized to captures and formalises knowledge by connecting the human understanding of symbols with their machine processing ability; and, through the introduction of ontological reasoning, the approach is suitable for flexibly discovering abilities in using information that were not specifically designed or intended for the particular case in use.

Semantic Web Technology performs major implications in the development of new information management system recently [26-28]; people were taking a variety of approaches to develop tools to extend the current Web into a true Semantic Web, for example, Protégé by Stanford Medical Informatics, Ontolingua by Knowledge Systems Laboratory of Stanford University, and OntoSaurus by University of South California. These tools consider the construction process as system engineering, and focus on coding the concepts into the ontology, which computers can understand [29-31]. By making the annotation machine readable, it becomes accessible to automatic processing, carrying out many routine tasks which consume people's time.

D. Ontology Construction and Modelling Technology

This server of mobile system will use Protégé by Stanford University for constructing the ontology, Ontology Web Language (OWL) is used to capture knowledge about some domain of interest, which describes the concepts in the domain and also the relationships hold between those concepts [32].

- **OWL Classes** are interpreted as sets that contain individuals. They are described using formal (mathematical) descriptions that state precisely the requirements for membership of the class.
- **Properties**: They are also known as relations in Unified Modelling Language (UML) and other object oriented notions. For example, the property "belong to" might link the individual "Learner 1" to the individual "Role". Properties can have inverses.
- **Individuals** represent objects in the domain. OWL does not use the Unique Name Assumption (UNA) that means two different names could actually refer to the same individual.

E. Semantic Similarity and its Calculation

By taking advantage of the ISA relationship of concepts in ontology modelling, several factors should be considered, and use the algorithm which have been presented in details [32]. Below is how the knowledge representation tool implemented within server, which has been adopted which accommodates semantic relationships and similarity of course data; and a mobile UI which utilize the information retrieval is presented in Figure 5.

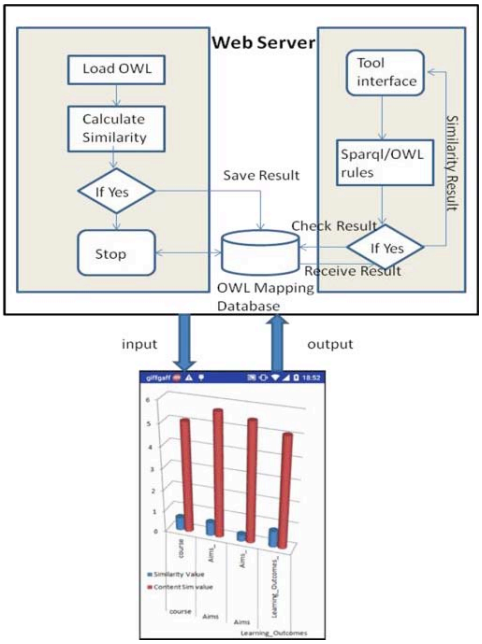

Figure 5: Semantic similarities and Mobile UI

With help of the similarity value among different course providers, the crowdsourcing mobile system allows non-technical specialists to import unstructured documents containing course descriptions, and that will also support employer-led learner route planning among ambient environment.

V. CONCLUSION

The crowdsourcing apps will enable employers and educational institutions to work together more effectively in a value adding manner. Employers are seeking quality of provision, relevance to business needs and a delivery method suited to the company rather than the Higher Education Institutions (HEIs). The need for improved communication between HEIs and employers is a desired feature highlighted by the government and many advisory agencies. The semantic similarity between programmes offered at universities and learner providers can assist this alignment. A different approach in using the semantic similarity is from a learner perspective that offers the means of searching curriculum documents for certain keywords. The learner could potentially assess a number of programmes against a number of keywords and search for the most suitable one according to certain criteria (e.g. a specific topic, key learning outcomes, reading list, placement opportunities).

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