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Mobile Technologies and Augmented Reality: Early Experiences in Helping Students Learn About Academic Integrity and Ethics

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Abstract: *Higher education institutions worldwide are facing a surge of academic dishonesty aided by advances in information technology. This project aims to help students develop academic integrity and ethics with the use of augmented reality (AR) and mobile technologies. We take the approach of an 'AR learning trail', in which students visit various locations around the university campus where ethical dilemmas may arise, make use of their mobile devices to retrieve details of different scenarios, and produce responses to these scenarios. This paper describes the design of a prototype AR TIE (Trail of Integrity and Ethics) and its associated learning activities, implemented at Hong Kong Baptist University in 2014. Students responded to a post-trail survey, which revealed a positive overall user experience and a high level of interest in the learning trail. Students' qualitative feedback also constituted input for improvements to the learning design.*

Keywords: *Mobile Learning Augmented Reality Blended Learning, Learning Trail.*

1. INTRODUCTION

Helping students understand the importance of behaving with integrity is one of the most important goals of tertiary education in the 21st century [1]. Higher education institutions worldwide are facing a surge of academic dishonesty. Advances in information technology (IT) have put students under pressure to perform quickly and at a high level, and act as a catalyst for unethical behaviour or low-integrity actions [2]. In light of this, this paper describes a project that makes use of IT to combat an issue made worse by IT. The project aims to help students develop their understanding of academic integrity and ethics as well as shifting their mindset and their behaviour, as necessary, so that they come to act ethically and with integrity.

Augmented reality (AR) lends itself to achieving this objective. Although the term 'AR' is sometimes used in the narrow, technocentric sense of an annotated viewfinder display, it has been suggested that a broad conceptual definition is more productive [3][4]. According to such a conceptual definition, AR entails 'dynamically overlaying contextually relevant digital information on a real-world environment' [5: p.78]. AR can allow students to learn in real-world settings with the support of digital information and communication channels, helping them to connect their learning with their everyday lives through a situated or embedded, learning approach [6]. The issue of transfer distance – that is, the need to transfer abstract learning from a formal setting to the real-world setting where it applies – is thus minimized, if not eliminated, since students are already learning in the real world [5]. Students are able to use their own mobile devices to participate in such AR experiences, allowing an element of personalization of the learning process.

This paper describes the first pilot of a project, 'Reinforcing the Importance of Academic Integrity and Ethics in Students through Blended Learning – A Deployment of Augmented Reality Applications'. The project makes innovative use of digital technologies, combining AR, mobile devices and a learning management system (LMS) in order to motivate students to learn in real-world settings supported by digital information, and to reflect on their learning through digital communication channels. It takes the approach of an AR learning trail, in which students visit various locations around the university campus and make use of their mobile devices to retrieve different

information, consider different ethical scenarios, and produce ethical responses under different circumstances. Interactive contents are retrieved using AR technologies. Students are also asked to complete a post-trail usage experience survey, and to respond to questions related to ethical matters within an LMS to reflect on what they have experienced on the learning trail. Qualitative data resulting from students' reflective responses becomes input for a learning analytics algorithm, which analyzes keywords and phrases to provide insights into students' levels of learning from taking the trail.

2. TRAIL OF INTEGRITY AND ETHICS (TIE)

2.1. Learning Trail Design

The prototype learning trail is named the Trail of Integrity and Ethics 1 (TIE-1); it consists of four checkpoints, which are physical locations within the campus of Hong Kong Baptist University (HKBU). Students activate learning activities at each checkpoint on their mobile phones using the Mobxz mobile application, which can retrieve digital mobile contents using AR technologies such as image recognition, geolocation mapping, and QR code scanning (details of the Mobxz platform will be described below). Upon activation, each learning activity presents a scenario centered on a set of fictitious student characters who have to confront issues related to academic integrity and ethics. Towards the end of each scenario, students are asked to make a choice about the issue involved, following which they learn about the consequences of their choice. The four checkpoints, the content activation methods, the issues explored, and the scenario descriptions are summarized in Table 1.

Table1. *Summary of content activation methods, issues explored, and scenario descriptions for checkpoints on the TIE-1*

Checkpoint	Content Activation Method	Issue Explored	Scenario Description
Recycling Bin	Image Recognition	Data Falsification	A student is conducting a survey about recycling habits. However, he cannot collect enough data, and is considering calling up relatives and friends to answer the survey, without reporting the change of data collection method in his final report.
Library Book Return Box	Image Recognition	Ethical Use of Library Resources	A student is considering hiding a sought-after library book on another shelf, so that he can use it for as long as he needs, while denying access to other students.
Dr. Sun Yat-sen Statue	Geolocation Mapping (GPS)	Citation and Common Knowledge	A student is considering using a famous Chinese quote (inscribed on the statue) in her assignment, and ponders whether citation is required.
Classroom	QR Code	Plagiarism	A student in the classroom discovers that she has insufficient time to complete an assignment, and is considering copying from a classmate.

Careful consideration must be given to the design of each checkpoint in terms of location, scenario description, and content activation. First, the scenario described at each checkpoint is carefully written based upon the setting or physical objects found at the checkpoint location. For instance, at the Recycling Bin checkpoint, the scenario reveals that a fictitious student character, Felix, is conducting a survey on the recycling habits of students on the HKBU campus (Fig. 1a). Each learning activity involves a digital overlay of information on top of the real-world setting, which is the essence of the conceptual definition of AR. The information is tailored to stimulate students to think about ethical scenarios in terms of the physical objects to which they might relate, and/or the physical settings in which they might occur. This situated learning approach should help students to link their learning with their everyday lives, with the learning being better embedded as transfer distance is reduced.

Second, the mobile contents at each checkpoint are tailored to engage students using elements that are closely related to their daily lives. Taking the Recycling Bin checkpoint as an example again, the scenario describes Felix's intention of data falsification through a series of fictitious WhatsApp

conversations with his friend. Students can easily relate to this style of content presentation: their familiarity with messaging app formats should help to increase the sense of authenticity, albeit simulated authenticity, and hence increase their engagement with the learning activities.

(a) Scenario description

(b) Ethical choices

(c) Explanation for a choice

(d) Code shown on completion of an activity

Fig1. *Sample screen captures of recycling bin checkpoint contents*

Third, the content activation method is carefully selected such that the choice of AR technology is suitable for the particular environment of each checkpoint. At locations where uniquely shaped objects are available, image recognition can be employed. For this activation method, students use their mobile phone to take a photo of a specific object; upon recognition of the object by the mobile application (through an image recognition algorithm), relevant mobile contents are retrieved. Alternatively, geolocation mapping can be used when the checkpoint is located in an open area with good GPS reception. Once students arrive in the vicinity of the checkpoint location, the mobile application recognizes their location through GPS and retrieves the relevant mobile contents. QR Codes can also be used, particularly in indoor areas where it is not feasible to employ GPS, and where there is no uniquely shaped object that lends itself to image recognition.

After becoming familiar with the scenarios, students are presented with a set of ethical choices (Fig. 1b). They must then make a choice, after which they will learn about the consequences of that choice (Fig. 1c). Upon selecting a non-optimal choice, students are given the option to go back and make a different choice. This way, they have the chance to explore a variety of ethical choices. Finally, students are presented with additional information related to ethical issues arising in the scenario, such as the University's policy on plagiarism, or the definition of common knowledge and its citation requirements in publications. This additional information helps add a layer of depth to the understanding of concepts of academic integrity and ethics presented in the respective learning activities.

At the end of the learning activities at each checkpoint, a 'checkpoint code' is displayed. Each checkpoint code represents a word forming part of a sentence (Fig. 1d). In the current learning trail design, the four checkpoint codes compose a four-word sentence: 'I must not copy'. This adds a

gaming dimension to TIE-1, similar to that found in a treasure hunt, which may help entice students to go through every checkpoint of the learning trail.

2.2. Mobile Application Platform

TIE-1 is deployed using a mobile application called *Mobxz*, produced by the Singaporean company BorderlessHealthLab Pte Limited. Mobxz is designed specifically for deployment of activity trails, and has been successfully used for a selection of heritage activity trails in Singapore. The Mobxz mobile application has built-in support for AR technologies (in particular, image recognition, geolocation mapping, and QR code scanning) that are used to activate mobile contents at each checkpoint; it is also available for both the iPhone and Android smartphones.

In terms of production, all mobile contents are authored using Microsoft PowerPoint and the iSpring Suite, and are converted into HTML5 files (such a file format ensures visual consistency of the contents across the iPhone and Android smartphones). The HTML5 files are then uploaded onto a web server (part of the Mobxz system) dedicated to serving the trails. When students activate a checkpoint on a learning trail, HTML5 contents are instantly retrieved from the web server and loaded onto their smartphones.

3. METHODOLOGY

The pilot trials of TIE-1 have been conducted as activities during classes on academic integrity and ethics. Students are first requested by the class instructor to download and install the Mobxz mobile application, which is freely available on Google Play and in Apple's iTunes App Store. The user interface and the operation of the Mobxz application are also explained by the instructor. Since the learning activities require a stable internet connection to operate smoothly, the instructor prompts students to turn on the Wi-Fi internet connection on their smartphones before they begin exploring the learning trail. The instructor also briefs students on the flow of the learning activities, and what they can expect to experience on the learning trail. Prior to taking the trail, the students are asked to log into the Blackboard LMS to individually answer the following question:

> *In your own words, what is your understanding of the words 'Plagiarism' and 'Citation'? (Within 100 words)*

The purpose of this question is to let instructors collect and analyze students' level of understanding of the concepts of plagiarism and citation before they start exploring the learning trail. The students are asked to answer a similar question again after taking the learning trail. The instructors can then compare the pre-trail and post-trail responses, in order to ascertain the effectiveness of the learning trail in increasing students' understanding and shifting their views of these two concepts.

Each student is provided with a map (Fig. 2) of TIE-1. The purpose of the map is to help students locate the four checkpoints on the HKBU campus, and to describe the content activation methods for each checkpoint, so that students can explore the learning trail with minimal help from the instructor. Spaces are also provided on the map for students to write down the checkpoint codes upon completing the respective learning activities.

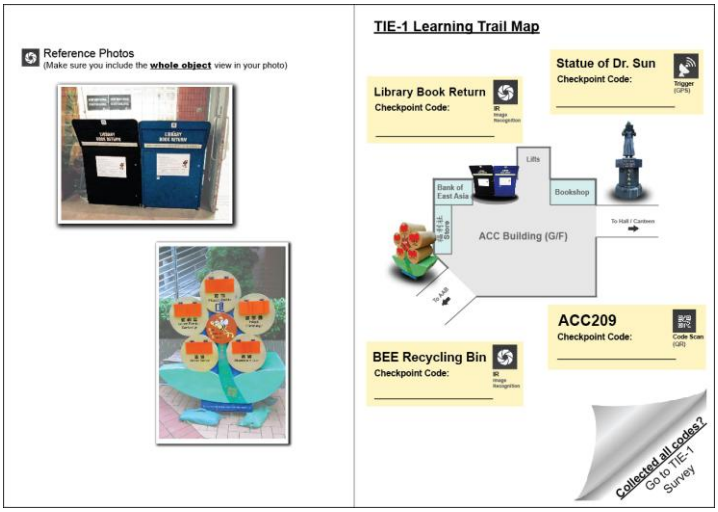

Fig2. *Map of TIE-1*

After the briefing, students exit the classroom, visit the four checkpoints on the learning trail, and use their smartphones to complete the learning activities. After completing all four checkpoints, students are prompted to fill in an online usage experience survey (adapted from Davis [7] and Venkatesh et al. [8]) in the Mobxz mobile application. The survey consists of the following six statements, which are rated on a five-point Likert scale (1=Strongly Disagree; 2=Disagree; 3=Neutral; 4=Agree; 5=Strongly Agree):

- I find this App easy to use.
- My interaction with this App is clear and understandable.
- This App makes learning about academic integrity and ethics more interesting.
- Working with this App is fun.
- The Wi-Fi connection is stable.
- My overall usage experience with this learning trail is good.

When students return to the classroom after the learning trail activity, the instructor requests them to log into the BlackBoard LMS again to answer the following question:

> *From the trail, what have you learnt about 'Plagiarism' and 'Citation'? And how do they relate to Academic Integrity?*

In addition, students are invited to write down any comments (qualitative feedback) on their experience of the learning trail.

4. RESULTS

TIE-1 was piloted at HKBU with two classes of students from various disciplines of study between November and December 2014. A total of 46 students (29 postgraduate and 17 undergraduate students) participated in the learning trail as an activity associated with a credit-bearing course, or as a co-curricular event on a voluntary basis. Four sets of data were recorded from the learning trail:

- Clickstream data
- Responses to pre- and post-trail questions
- Usage experience survey, completed at the end of the learning trail
- Qualitative feedback on the learning trail experience

Clickstream data is the recording of all the button-press events that occur within the learning trail mobile app. Thus, the choices that students made and the time they spent on each learning activity were recorded. These records provided valuable insights into students' interactions and exploratory patterns within the learning activities, which in turn revealed the effectiveness of the learning design of these activities. The collection and analysis of clickstream data from this pilot study is the subject of a separate paper by Chan et al. [9].

Students' responses on their understandings of academic integrity before and after taking the learning trail (pre- and post-trail responses) were entered into a learning analytics (LA) algorithm to detect any changes due to their participation in the AR learning trail exercise. The LA algorithm searches for predefined keywords and key phrases (related to academic integrity and ethics) within the responses, and the number of occurrences of these keywords and key phrases is then used to evaluate the quality of responses. The results of applying the learning analytics algorithm to the data collected in this pilot are described in a separate paper by Li et al. [10].

The focus of the current paper is on the usage experience survey and qualitative feedback provided by the students after completing TIE-1. We will also discuss how these data have informed us about the existing learning trail implementation, and will lead to improvements for future iterations of the learning trail design.

4.1. Usage Experience Survey

Due to some problems with Wi-Fi connectivity while conducting the TIE-1 pilot, not all 46 students were able to fill in the online usage experience survey within the Mobxz mobile application. Thirty-

three student responses (16 postgraduate and 17 undergraduate students) were collected. Table 2 shows the descriptive statistics for the usage experience survey.

Table2. *Descriptive statistics from the usage experience survey (n=33)*

	Mean	S.D.	Min	Max
1. I find this App easy to use.	3.67	0.82	2.00	5.00
2. My interaction with this App is clear and understandable.	3.88	0.70	2.00	5.00
3. This App makes learning about academic integrity and ethics more interesting.	4.06	0.75	2.00	5.00
4. Working with this App is fun.	3.79	0.96	1.00	5.00
5. The Wi-Fi connection is stable.	2.85	1.06	1.00	5.00
6. My overall usage experience with this learning trail is good.	3.76	0.87	1.00	5.00

Likert Scale: 1=Strongly Diagree; 2=Disagree; 3=Neutral; 4=Agree; 5=Strongly Agree

In general, students agreed that the mobile application was easy to use, and the interaction with the mobile application was clear and understandable. They also agreed that this method of learning about academic integrity and ethics was fun and interesting, and that the overall experience of the learning trail was positive. However, the mean score for "The Wi-Fi connection is stable" was the lowest of the six statements. This indicated that the unstable Wi-Fi connection during the TIE-1 pilot had degraded users' experience of this exercise.

4.2. Qualitative Feedback

Students provided qualitative feedback on their experience on a voluntary basis after taking the learning trail, and a total of 13 students gave some written feedback. Analysis of this feedback showed that students' comments centered around three areas: the overall trail experience, the Wi-Fi connection, and possible enhancements to the learning trail design.

In line with the usage experience survey results, students found the mobile application, as well as the overall learning trail experience, interesting and engaging, as reflected in the following comments (note that all comments are reproduced verbatim, without grammatical corrections):

"I quite appreciate the design of app."

"Interesting – enhance communication with others"

"I think it's quite interesting to do a small hunt."

Some students commented that the treasure hunt design (collection of checkpoint codes) had successfully brought a gaming element into the learning trail experience. This is encouraging as it supports the original intention behind the decision to include this design element. It was also interesting to note that some students found communicating and interacting with fellow students had made the exercise an interesting learning experience.

All students used the university campus Wi-Fi for the learning trail pilot. There were numerous negative comments on the instability of the Wi-Fi connection, which had hindered the loading of mobile contents during the learning trail. The following comments reflected this problem:

"Improve the Wifi…"

"…wi-fi can be fix to be stable."

"School wifi connection is not good"

"Connection is too weak… wifi is hard to detect"

"… But the wifi-service is a quite problem…"

"WIFI connection fail"

This qualitative feedback provided further evidence that the unstable Wi-Fi connection had impeded users' experience, as also revealed by the usage experience survey results.

Students also gave constructive feedback on possible enhancements to the learning trail design. Some students felt that the heavy use of text in the learning activities was not engaging, and that the addition of multimedia and interactive elements could improve the learning experience. These views were reflected in the following comments:

"Too much reading."

"…also the text is quit (e) long that I don't like to read. I suggest that we can have another way to learn the plagiarism and citation. For example, video…"

"Could include more interesting content in the interactive game, for example, 'real-life' Whats App message with the character in the game."

In addition, some students suggested that competitive elements, or even social media elements, could be added to enhance the gaming dimension of the learning trail:

"Add in some competition element in the game, like the fastest will get the biggest gift etc."

"…include sharing function: FB (Facebook), Twitter, Instagram."

5. CONCLUSION

Several conclusions can be drawn from these quantitative and qualitative data collected and analyzed in the pilot of TIE-1. First, students who took the pilot learning trail found the learning experience to be positive, and commented that their level of engagement in the learning activities was high. The ease of use of the Mobxz application for displaying and navigating the mobile contents was also positive.

It was, however, clear that the instability of the Wi-Fi connection degraded users' experience and must be resolved. After the pilot trail, we surveyed the four checkpoint locations and noted unstable or weak Wi-Fi reception at two of the checkpoints due to their distance from the nearest Wi-Fi transmitters. In view of this, these checkpoints may require relocation for better Wi-Fi reception. Distance to the nearest Wi-Fi transmitter will also be a factor when considering the location of new checkpoints in the next design iteration of the learning trail. There is also the possibility of requesting students to turn on their mobile data connections (3G or 4G) on their smartphones when taking the learning trail, in order to ensure a continuous internet connection when the Wi-Fi reception is poor.

As some students suggested reducing the amount of text in the mobile contents by using multimedia elements like video, we decided to explore this option as well. The current Mobxz mobile application does support video contents, but issues such as download speed and presentation format will need to be carefully considered. Students also suggested the addition of competitive and social elements, which we are currently exploring. Whether these proposed changes will improve the level of engagement and interest of the learning trail will be examined with future student cohorts using a revised learning trail design.

In addition to the usage experience survey and qualitative feedback, pre- and post-trail responses and clickstream data were collected from the pilot learning trail. As noted earlier, these results are discussed in other related publications from this first pilot. It is worth mentioning that these two sets of data also show encouraging results. In the post-trail responses, students mentioned keywords related to data falsification more than they did in the pre-trail responses. This suggests students can develop greater awareness of this concept through the learning trail. Clickstream tracking captured the ethical choices students made in the learning activities: the pilot trail data revealed that some learning activities were more effective than others in conveying the intended learning concepts, and some ethical choices were more appropriate compared to others in inducing students to explore and learn about the consequences of their decisions. In combination with the data from the usage experience survey and the qualitative feedback, these results will inform future iterations of the learning trail design.

TIE-1 focuses on exploring general academic integrity and ethical issues. Currently, subject-specific scenarios are being developed, where students face cases of ethical dilemmas specific to their disciplines. To this end, staff from different Schools and Faculties at HKBU is engaged in the development of discipline-specific scenarios. Furthermore, this is a cross-institutional project, with HKBU as the lead institution. Thus, the next phase of this project will involve further tailoring the contents of the existing four TIE-1 checkpoints at HKBU, as well as implementing similar checkpoints on other university campuses in Hong Kong.

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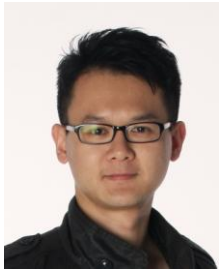

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