Quick Response codes in an educational environment

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ABSTRACT

Quick Response Codes (QR codes) provide a means of encoding information into a matrix barcode, suitable for 'reading' and decoding by a wide range of devices, including cell phones and computing tablets. QR codes provide a means to direct computer users, especially those using smartphones, tablets and other such mobile devices, to information or Internet resources. This paper examines the properties that underlie the technology, and investigates QR code awareness and use by students in a tertiary educational institution. Possible implementations relevant to a tertiary environment are also discussed. QR codes may provide some exciting and interesting opportunities to 'add value' to the polytechnic experience. However, it is important to determine the potential levels of use by the target market – generally young, computer-savvy and smartphone-using learners.

Keywords: Quick Response Codes, QR codes, barcodes, smartphones, Smart Mobile Devices.

1. INTRODUCTION

QR codes provide something of a transition from the realm of barcode readers to computing devices and smartphones. While barcodes provide a code that is intended to be machine-readable, each code provides only a minimal amount of information. QR codes, with considerably more capacity for storage, and with the advantages inherent in more advanced uses of protocols and processing would seem, at first glance, to be a mechanism that might have a rapid uptake, with satisfied users proclaiming the added value.

Instead, QR codes seem to better described as a mechanism in limbo. Rather than bridging the gap from barcodes into the more user oriented computing word, QR codes too often provide a minimal value to users, and sometimes not enough to encourage their on-going use.

Technically, QR codes are quite brilliant. The technology and development of capabilities would lead one to think they could be 'the next best thing'. Instead, for the most part they have not delivered on the expected promises of wide-spread uptake.

2. RESEARCH QUESTIONS

This research is intended to address, primarily, the issues relating to user awareness and user attitudes toward QR codes.

First, however, some of the properties of QR codes need to be examined and explained, to ensure an understanding of the potentially complex capabilities inherent in the technology. The technical capabilities of QR codes are important in the context of a user's understanding of their potential uses.

By then examining their previous experiences, the research attempts to clarify whether users in a tertiary educational environment would be amenable to the use of QR codes for both administrative and educational functions. If users are already predisposed to the use of QR codes, and satisfied from previous experiences that they can add value, their use could positively contribute. If, however, this segmented market of users has not previously perceived QR codes as useful, using them may not provide the degree of user acceptance that would be needed.

Finally, the research summarises some of the potential uses for QR codes in an educational environment, the uses that were identified and discussed in the process of data collection.

3. PROPERTIES OF QR CODES

3.1 Capacity

QR codes have several significant differences to barcodes, in both storage capabilities and the nature of the decoding process.

While barcodes are able to encode information, they are limited in storage capacity to the number of 'characters' available. Though there are a number of barcode formats used, the most common one (EAN-13) will store only 13 digits (Computalabel International, 2015). It is this thirteen digit 'payload' which is then related, through a database entry, to the actual information.

That is, though the barcode might resolve to something such as 9 780201 379624, looking that value up in a database might result it in being associated with a particular product and the various attributes of that product. The barcode itself does not contain all of the information – it simply 'points' to the entry in the database.

QR codes, however, potentially contain more information. Model 2 QR codes (the most commonly used format) can store up to 7,089 digits or 4,296 alphanumeric characters, nearly 600 times more than a simple barcode (Walsh, 2011). The implications for decoding should be obvious – instead of the decoded number being looked up in a database, the QR code has enough storage to convey all of the required information. But if the information is, in fact, the address of a webpage or other resource using the Internet, the QR code can convey not only the address, but also the required protocol for retrieving the resource, assuming that there is Internet connectivity to allow the re-direction to the web resource.

3.2 Protocols and QR Codes

The range of possible protocols dramatically extends the value and use of QR codes (Anonymous, 2016). When the proper data type is used in creating a QR code, it triggers a related client application on the user's device. If the protocol is that of a website, it would open the website in the user's browser. If the protocol is for a map location, it would open an application such as Google Maps, with a pin to identify the location conveyed by the QR code.

A QR code with an email address encoding will cause the user's email client application to open with a blank email ready to write, with the To: address already completed by the code.

Finally, a QR code can encode an event's details. When decoded, the entry would be automatically created into the user's calendar/appointment book application. QR codes can even generate a 'Like' for a particular Facebook page.

There are a number of online QR code generators. Most will allow the selection of a data type, and then allow the addition of the specific 'payload' (the URL, link, text information and so forth) needed to create the QR code (QRStuff.com, 2016).

3.3 Complexity and 'Shortening'

Though a QR code is *capable* of encoding a large number of characters, the more characters included results in a more complex QR code. A complex QR code, with a large number of smaller black and white squares is still valid, and able to be decoded, but the more complexity, the more potential difficulties for the end user arise.

As the QR code involves built-in error correction, some degree of poor reproduction or even complete loss of parts of the image can be overcome, but to provide the easiest experience for the user, the QR code needs to be simple, clear and complete. The more complex a QR code is, the larger it will need to be reproduced in order that the user's device can accurately decode it.

One useful method of enabling a QR code to encode a long URL but still retain a simple image is through the use of URL 'shortening'. Some of the QR code generators provide the ability internally. Otherwise, online services can shorten a URL to create a simpler image that redirects to the same location on the Internet (QRStuff.com, 2016).

Compare the two examples below, which resolve to the same location:

Figure 1. The lack of complexity in the second image would enable better printed reproduction and resulting decoding by the end user

3.4 Error Correction

One valuable aspect of a QR code is that it has sufficient error correction built into it that even damage or an unclear copy can still result in the full information being available when scanned. Four different levels can be used, allowing for 7% - 30% damage before information is lost. This is achieved through a complex mathematical encoding – effectively "mathematically adding backup data to the QR code" (QRStuff.com, 2011).

While the ability to withstand up to 30% damage would appear to be desirable, compared to only 7%, this level of error correction does require a more complex image, often requiring a larger printed size to provide sufficient clarity.

4. RESEARCH METHOD

4.1 Invitation to Participate

A QR code and accompanying text was generated and posted in various locations at the Bongard Campus of the Bay of Plenty Polytechnic, inviting involvement in this research project through completing a questionnaire and participating in focus group sessions. A short text message beside the QR code invited students to participate in the research project, and provided an email address to contact if the student wished to participate.

This was done to ensure possible participation, even by those who may not be able to read the QR code for the details. The QR code was designed to resolve to text of the necessary message. That is, scanning the QR code immediately provided the invitation, rather than a link to the message which would have required Internet access. An email invitation to participate was also sent to the mailing list of current Diploma in Business students.

Students who responded to the invitation to participate were sent to an online survey to quantify the levels of awareness, uses and attitudes toward QR codes. The survey also asked if they would be willing to be part of a focus group to further develop the issues relating to QR codes in an educational environment.

It is accepted that the very nature of the survey would likely bias the response rate to over-represent those people who were familiar with QR codes and/or have used them in the past. An attempt to measure the percentage of students who are familiar with QR codes would require a different methodology. This questionnaire, though available to both students familiar and those who were not familiar with QR codes, was intended more to engage the students into participation in the survey, and ultimately into focus group participation.

4.2 The Questionnaire

The questionnaire was structured to initially determine demographics and general information about the participant. Participants were asked for gender, age banding, computing experience and to identify the types of computing devices they use that are capable of scanning QR codes.

After the first series of questions the participant was presented with a question that was treated conditionally by the survey software. The response to the final general question, "Have you ever scanned a QR code using one of your devices?" was used to direct the participant to two different sets of questions.

Participants who had scanned QR codes were asked questions about the motivation and frequency of use. They were asked about innovative uses of QR codes they have encountered, and suggestions for future use.

Participants who had not used QR codes, or did not even know what they were, were asked if there were any particular circumstances or reasons that they have not scanned the codes they may have encountered.

4.3 Focus Groups

Two focus groups were held, one with 10 participants and the other with 12.

Open-ended questions were asked to draw out user knowledge of and experience with QR codes, as well as attempting to identify possible uses in education.

Users were asked about previous experiences with QR codes, what sort of things they thought were possible with the codes, and whether they could identify any possible uses in an educational environment that would add value to them as learners.

If an idea or issue was introduced, other participants were asked to contribute their own related experiences, with an attempt to identify key topics arising from the discussions.

5. FINDINGS

5.1 Demographics of Questionnaire Participants

There were 56 questionnaires attempted, with 54 completed and submitted. Females submitted 69% of the questionnaires. Age distribution revealed two age groupings that made up the majority of the responses – those from students between 18 and 20 years old (37%) and those from students between 41 and 50 years old (27%).

Participants characterised themselves as generally computer literate, with 85% rating themselves as 3 or more on a 5 point scale where 1 is not very capable at all and 5 is extremely capable.

5.2 Computing Devices of the Participants

The participants indicated that they owned, or used on a regular basis, a range of computing devices. Laptop ownership/use (98%) exceeded desktop computers (61%). 86% of the participants indicated that they owned/used a smartphone (capable of Internet access).
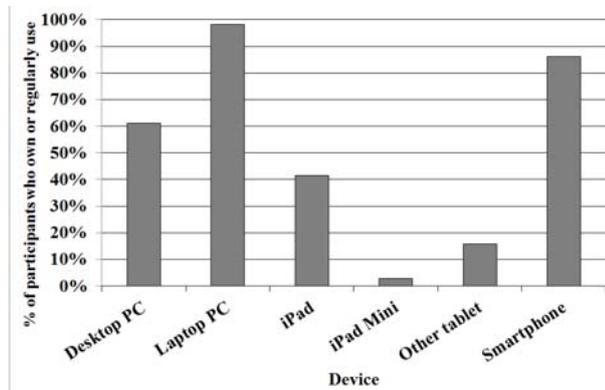
Figure 2. Devices owned and/or used by questionnaire participants

5.3 Participants Who Had Scanned a QR Code

Participants were split fairly evenly between those who had scanned at least one QR code in the past (48% of participants) and those who had never scanned a QR code (52%).

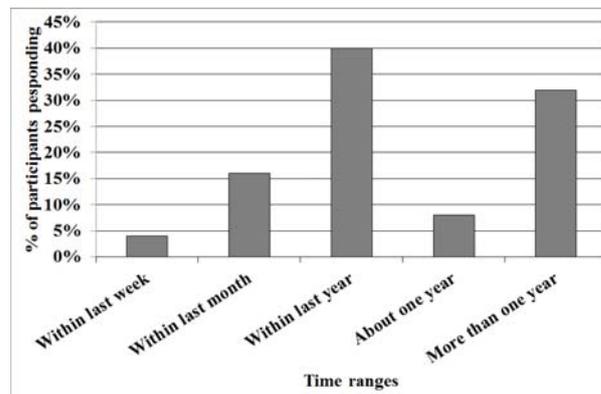For those that have scanned a QR code, most will have done it for the first time within the last year.

Figure 3. Comparisons of when participants first scanned a QR code

Of the participants who had scanned a QR code, very few appear to continue to scan QR codes on a regular basis, with more than 52% reporting that they "hardly ever" scan QR codes, with a further 24% saying they would "never" scan a QR code.
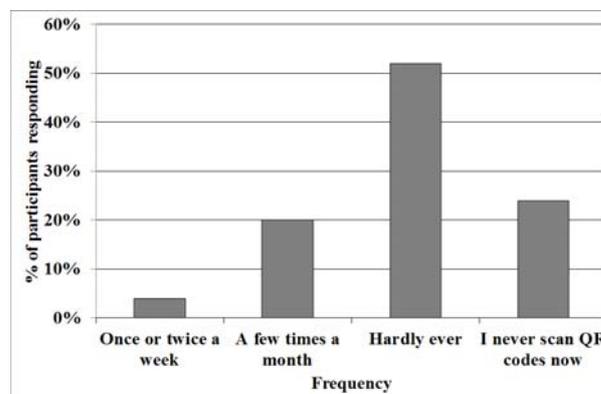
Figure 4. Frequency of QR code scanning by participants

The predominant motivation for having scanned a QR code in the first place was "Novelty and curiosity - I'd never done it but was interested" (60% of those who had scanned a QR code), followed by "I really wanted to get the link/information" (32%).

Table 1. Motivations to scan QR codes

Why did you decide to scan the QR code?	
Novelty and curiosity - I'd never done it but was interested	60%
A friend showed me how	8%
I really wanted to get the link/information	32%
I had read about them and wanted to try them out	16%
I had an 'app' already and wanted to use it	12%
Other	14%

(Participants were able to select more than one motivation. Percentages are reported as a percentage of those who agreed with each statement.)

When asked "What was the *coolest* (neat, surprising, innovative, helpful...) QR code that you have ever seen or used?", only 35% of the responses were positive (or even neutral) in nature. Other responses were such as "Pass" or "Have only used it to read an article" or "I haven't found any decent ones, used the one on the back of a lift plus can and got taken to their website, yay".

Motivations to continue to scan QR codes included interest in the product, curiosity and overall purpose of the link. Loyalty

schemes, coupons, giveaways and "freebies" would motivate 21% of the participants who have scanned QR codes.

5.4 Participants Who Had Not Scanned a QR Code

Of the participants who reported that they had never previously scanned a QR code, the predominant explanation was "I've never learned how but would scan them if I did", selected by 33% of those participants. In fact, 7 of the 8 qualitative responses to the question "Why have you never scanned a QR code before now" referred to either not knowing about them or not understanding their purposes or uses.

There was no clear consensus on what might cause the participants to want to scan a QR code in the future, apart from such generalised statements as "to get more information", "additional value" and "if it was of interest to me".

5.5 Focus Groups

The participants of the two focus groups were, for the most part, reflective of the students who completed the survey, in terms of gender, age grouping and previous knowledge and experience of QR codes.

In each focus group, there was only one participant who did not have an Internet-capable smartphone.

Discussions were lively and interesting, with good participation from just about all of the students who attended. Extensive notes were kept to enable a reconstruction of the flow of ideas and considerations. Students avidly raised possible uses for QR codes, even when saying that they did not necessarily like to use them personally.

6. DISCUSSION

6.1 Awareness of QR Codes by Students

Both the questionnaire and the focus groups revealed that students did not have a very well-developed understanding of QR code use or potential. Further, students who may have been motivated to scan a QR code in the past appeared unwilling to continue to scan codes on a regular basis.

Both focus groups revealed a lack of awareness of the capabilities of QR codes. While aware that QR codes can direct the user to a website, few of the focus group participants were aware of the other possibilities (text, email, maps, business cards, calendar events and so forth).

The participation in this research project would appear to have motivated some of the students into further use of QR codes, but the general lack of a genuine reason for their use was still raised by others.

6.2 Attitudes to QR Codes by Students

The focus groups both identified the lack of cheap, ubiquitous Internet availability as a limiting factor in the potential uses of QR codes. Even the participants who had smartphones with data plans were well aware of potential to use up data allocations, resulting in additional charges. While the polytechnic's wireless network was used by some students who had devices capable of that type of connectivity, even then the participants reported that the experience was not 'seamless', that authentication issues and coverage meant that the use of their devices was not without effort.

QR codes were described as "gimmicky" and as "a bypassed technology" by two participants in one of the focus groups, with general agreement from the others in the group.

Two opposing attitudes emerged about the resources to which a QR code would direct a user. One part of each focus group was well aware of the fact that the codes would be directing them often to advertising and product promotions, and were quite accepting of that. Others expressed the feeling that they would avoid the use of QR codes *because* it would lead often to further advertisements for products, and wanted to avoid that (either philosophically or based on data use and charging reasons).

Both focus groups discussed what could be characterised as gratuitous, unnecessary or inappropriate use of QR codes. A minority of both focus groups took the position that "a QR code is simply a replacement for a link or a web address" and that "the only possible value would be in not having to type in the URL". Other students, while accepting that to some degree, still found value in their use in what might be seen as "inappropriate" situations.

One student who uses a tablet extensively to store Portable Document Format (PDF) files of research papers described such a situation. While most work was done using a desktop PC, she said that in order to get the PDF file to her tablet, she would have to type in the URL. Having a QR code on the web page would allow her to use her tablet to focus on the desktop monitor to effectively send the PDF file directly to her tablet.

Stratten (2013a) would possibly describe a QR code on a page intended to be viewed by a desktop computer to be unnecessary and ill-thought out. Stratten's tongue-in-cheek contention that "QR codes kill kittens" is in fact modified in some presentations, adding a critical new aspect:

> "Every time you use a QR code for your business because you can, and not because you should, whether your market wants them or not, a kitten dies." (Stratten, 2013b).

Providing a QR code, rather than a traditional hyperlink, needs to be carefully considered. It should *provide value*, as described in this case by the focus group participant, rather than just be done because it looks nice.

7. POSSIBLE USES IN AN ACADEMIC ENVIRONMENT

7.1 Administrative

QR codes have developed most interest and use within the marketing and promotional environment. Including QR codes for products can provide, for instance, a barrier-free means of directing a customer to more information about the product or company. While an educational institution can emulate this connection to some extent, it is more often to promote a 'click through' to information about the organisation or its services and courses of study.

This discussion includes a few 'traditional' uses of QR codes, as an educational institution is, to some extent, like any other business. The uses of QR codes that have been identified to provide advantage will be similar, regardless of the nature of a business.

Promotional materials – Placing a small QR code on course brochures, printed copies of the course prospectus and such printed materials as letters to students is a very low impact means of potentially directing students to access more information about the course or polytechnic. The connection might be in a general sense – just a QR code that will direct the user to the polytechnic's website. In the case of course material, the link/URL could be to a specific programme of study. An important consideration is that it will be highly likely that the user will be scanning the QR code with a mobile or portable device. Rather than being directed to a page of a website intended for a desktop or laptop device, the user should, if at all possible, be directed to a mobile optimised page (Moth, 2012).

Figure 5. QR code to direct a user to the BOPP website

Figure 6. QR code to direct a user 'deeper' in the site, to the details about the Diploma in Business qualification

Business cards – A small QR code can easily be included on the reverse of a staff business card. The code could be used to open up the polytechnic's web site for the user – or it can be used to encode the staff member's contact details. If the QR code with contact details is appropriately encoded, the user will not only see the name, address, telephone and email details – but the details can be automatically added into the user's contact list. This would eliminate the 'manual' step of a user having to type in details, and would more likely result in an effective outcome when providing a business card to someone.

Figure 7. QR code containing business card details

Maps – QR codes can be used to provide directions to a particular location. For instance, to direct a prospective student to the Windermere Campus, the QR code in this example will produce a Google Map with a pin to locate the campus. The student can zoom in or out to get more or less details to assist in finding the campus. If the user's application is GPS enabled, driving directions could be automatically generated.

Student Identification in submitting materials – One use identified by Law and So (2010) was independently raised by one of the participants in the focus group – the use of QR codes to 'sign' submitted material. The student described her time in a Japanese university where, at the beginning of the academic year, each student was given several sheets containing QR codes that 'resolved' to provide information about them as students (name, number, contact details). Whenever a paper was to be submitted, the student would put one of the sticky labels on, effectively confirming who submitted the material. Lecturers could then mark the scripts without needing to be aware of which student was involved. Once marked, it was trivial to scan the QR code and record the marks against the particular student.

Figure 8. QR code directing to a map to the Windermere Campus

7.2 Educational

Overview – The three important dimensions in m-Learning (mobile learning) identified by So (2008) can readily be applied to the use of QR codes in an educational environment. So determined that:

- Location Independence,
- Time Independence, and
- Meaningful Content

combine to critically affect the success of m-Learning.

With the majority of students in this study owning smart phones, the location independence is easily satisfied, so long as connectivity is either inexpensive or free.

Time independence is less of a problem, but perhaps not recognised by students. That is, for most QR client applications, if a QR code that directs to an Internet site is scanned when the Internet is not available, the URL is stored and *can* be used to direct to the site when connectivity is present.

The real issue for the educational use of QR codes in a tertiary environment would appear to be the need to provide meaningful content, something that a QR code can provide that is not so readily available by other means.

There are a number of Internet sites describing the use of QR codes specific to the educational environment (Osborne, 2012 and Owen, 2015). Many, if not most, describe QR code use with young learners. Examples of specifically educational use with older and adult students are not so prevalent.

Quizzes – For formative assessments, QR codes could be included with questions to lead learners to model answers. This could be done with embedded text, rather than requiring Internet capabilities. While it might not provide anything that other means of 'revealing' possible answers would give, it might be innovative or interesting enough to encourage students into the experience. A similar example is provided by

So (2011). Susono (2006, pp. 1007-1008) describes a more extensive description, involving not only the use of QR codes to reveal answers in a formative assessment, but also incorporating *ad* hoc student surveys and allowing students to "comment to the teacher and classmates on the mobile web."

Shortcuts to Teaching Materials – For PC use within the polytechnic QR codes do not provide a lot of value. The opportunity to direct a student to a particular resource would be better filled through the use of a hyperlink, either in an electronic document (Word or PowerPoint, for instance) or as a link from with the Moodle Learning Management System. QR codes provide the greatest value when printed. Only then do they provide the time-saving feature of not requiring the student to type in a URL to visit a particular resource initially. Care needs to be taken, too, with authentication and access issues. A QR code that 'points' to an internal polytechnic server, such as the student areas on Drive I: or their own Drive H: will fail if the student is not 'inside' the polytechnic local area network. Even a link to a resource stored in Moodle would encounter security issues. If the student decodes a QR code that directs them to Moodle, they would need to authenticate ('login') before the resource would be made available to them. In the example, the QR code will direct a user to the Diploma in Business 550 – Business Computing Moodle site – and access will fail if you are not a current student in this offering.

Figure 9. QR code with a link to a Moodle video file. The link will require the user to login if they have not already done so.

Links into YouTube – Many tutors direct students to YouTube videos to provide alternative instructions, or additional information about a topic. If the student is actually at a computer, a hyperlink will take the student directly there. But if the student is working from written material, such as a course handout, there is a barrier to typing in the URL. A QR code would promote the use of the materials by the student. In this example, for instance, the short video is about creating a QR code.

Figure 10. QR code with a link to a YouTube video

8. CONCLUSION

QR codes are an innovative way to provide a connection from a user to a resource, but the current levels of student awareness and use, it would be a mistake to overly rely upon them in an educational environment.

The capabilities in allowing a re-direction to a range of resources could be utilised in developing promotional materials and educational experiences. The majority of students in this study did have devices capable of making use of QR codes, but either through lack of awareness, lack of interest or a previous poor experience with QR codes, the students did not seem keen to make use of them into the future.

Some uses of QR codes, such as on the backs of business cards, or on promotional printed materials, could be utilised to provide an alternative to typing in a URL, and *might*, in some instances, encourage students to interact more readily. Other uses, and particularly those directly associated with the teaching/learning activities, appear to be somewhat contrived and less than compelling as reasons to incorporate QR code activities.

Each potential use of a QR code needs to be looked at in terms of the user experience. Rather than simply including QR codes because they are topical is not reason enough; there must be a perception of increased ease of use or additional value to the user to justify QR code inclusion. In every case, alternatives for those who cannot or will not use QR codes must be available.

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