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Jeanne Kossey

Florida Atlantic University, jfkossey@comcast.net


Allison Berger

Florida Atlantic University, allison.berger.1@gmail.com

Victoria Brown

Florida Atlantic University, vbrown22@fau.edu

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CONNECTING TO EDUCATIONAL RESOURCES ONLINE WITH QR CODES

Jeanne Kossey

jfkossey@comcast.net

Allison Berger

Allison.berger.1@gmail.com

Victoria Brown

vbrown22@fau.edu

Florida Atlantic University

Abstract

Quick Response (QR) codes are two-dimensional barcodes which can be scanned with web-enabled mobile devices. These codes connect directly to a website, video, phone number, or text message, providing instant access to information resources whenever and wherever needed. This paper will examine to what extent QR codes are currently being used in schools, and will explore the possibilities of integrating QR codes in school settings. Embedded in this discussion are descriptions of the next evolution of this form of technology.

Introduction

A fascination exists in connecting real world experiences with virtual ones. Virtual worlds allow experimentation and exploration in new exciting ways. The idea is to create engaging learning experiences in a meaningful way that extends beyond the flat two-dimensional paper-based learning. One way of creating that type of learning experience is QR codes. The codes bridge the flat content to the internet. Although QR codes are not as popular some predicted, the concept of the codes is evolving into image recognition (IR) with interesting implications in education. QR codes are still relevant with teachers and students developing innovative ways of using the technology for learning.

The creation of QR codes began in 1994 in the automobile industry, with the Japanese subsidiary Denso Wave, who invented and patented this technology to provide automatic data capture (Law & So, 2010). QR codes can be scanned by camera-enabled mobile devices which retrieve information about the object tagged with the code (Johnson, Levine, & Smith, 2009). This 2-D “symbology” encodes data in two dimensions, vertical (Manevitch, 2011), compared to one dimensional UPC barcodes with only horizontal data. The code consists of black modules arranged in



horizontal and
FDLA Website

a square pattern on a white background (Wikipedia, 2011), with 3 corner position detection patterns enabling multidirectional scans (Lehan, 2011). Free QR code generators produce a code in an image file format, and when scanned by a web-enabled device, the code is interpreted and points to specified data stored on the Internet (Hicks & Sinkinson, 2011). The codes can store up to 7,089 numeric or 4,296 alphanumeric characters, allowing large data capacity in a small 1 square inch print size (Lehan, 2011). The majority of 2-D codes are monochrome, however, Microsoft tags are 4-color (Lehan, 2011). The codes can be encrypted in multiple languages, such as Chinese, Vietnamese, and Korean (Law & So, 2010), and are currently popular for use with mobile devices such as Smartphones and iPods (Naumann, 2011). The sample QR code appearing within this paragraph connects to the FAU website.

The next evolution of augmented reality is combining the QR code technology with image recognition. The QR code drawback is downloading a scanning app, and then using the QR scanning app to read the code. Image recognition allows the user to scan an object, allowing it to become a large QR code providing the same information (Cohen, 2015). Amazon's Firefly app uses object recognition for books, videos, music, email addresses, barcodes, QR codes, web addresses and phone numbers. Scanning the objects launches additional information about the object for marketing purposes (Amazon, 2010-2014).

The power of the QR codes is the visual representation of the URLs available on the Internet. QR codes link the physical and virtual world with on-the-spot access to online resources for objects and locations, a concept known as "mobile tagging" (EDUCAUSE, 2009, p. 1). When the image is scanned from printed materials or from a computer screen by a mobile device, the user is instantaneously connected to the desired online resources without the need to type in a lengthy URL (Johnson & Adams, 2011). In the classroom, the instant connectivity allows the mobile device to act as a compass, pointing to new content or instructional materials (Vandi & Djebbari, 2011). The QR codes allow teachers to provide highly individualized instruction to students (Hicks & Sinkinson, 2011). Students can select the codes they need or the teacher can send codes to students based upon their performance or need.

Educational Applications

Mobile devices and QR code technology can provide enriching educational opportunities for all students in K-12 schools, colleges, and universities by preparing them for the competitive global job market, while also transferring knowledge into valuable lifelong learning skills. Many high school and college students already own and utilize mobile devices for connecting to websites. In the United States, 83% of mobile device owners between the ages of 15-24 use advanced data features, such as Internet access (Hicks & Sinkinson, 2011). Mobile learning, or m-learning, provides education "on-the-go", with less teacher-centered and more student-centered approaches and methods. EDUCAUSE (2009, p. 2) asserts that "QR codes support experiential learning, bringing scholarship out of the classroom and into physical experience". QR codes can take m-learning to a new level, referred to as ubiquitous or u-learning, by providing exactly the right information, at the right time and place, challenging each u-learner through a unique, individualized, wireless learning

environment (Leone & Leo, 2011).

Mobile devices and QR code symbols can offer an ideal method to provide students instant learning assistance using devices they already possess. Integrating digital and text information will bring opportunities for learners to comprehend print material by providing relevant, real-time background knowledge, while allowing students to learn at their own pace (Chen, Teng, Lee, & Kinshuk, 2011). Multimedia digital content via audio/video clips provide students the ability to gather information from a variety of methods which explain concepts in greater detail. Supplementary materials in the form of QR codes give instantaneous availability to digital help via scaffolding questions to support students in the learning process (Chen et al., 2011). Teachers can easily incorporate the use of QR codes with printed material to make learning more rewarding, motivating, and enjoyable for the students.

Several great scanning apps are available for mobile devices that have educational implications. WordLens translates words to or from English, French, German, Italian, Portuguese, Russian, and Spanish. Augmented reality is incorporated by overlaying the translation on top of the original text (Hodgkins, 2015). Another educational use of the scanning software is the three dimensional pop-up books. The mobile device interacts with the book allowing the book to come alive with the images popping up from the book. Crayon is taking this technology one step further with Color Alive, which combines a 3D system with coloring books. Children color their pictures and then take a picture of the colored page, which is converted into a three dimensional representation of the character. Special crayons can add special effects (Krassenstein, 2015).

Addressing Different Learning Modalities

Integrating the multimedia web based content along with paper-based text accommodates multiple learning styles (Leone & Leo, 2011). Using a mobile device to scan the codes introduces a kinesthetic modality into the learning experience. Through the codes, students can select whether to access either video or textual content to match their learning styles. Mobile devices become the intermediary for the users to explore new content by transforming passive documents into an interactive object containing rich information (Vandi & Djebbari, 2011).

Creating New Interactive Workspaces

QR codes are flexible since they are images that can be added to any wall, table, or paper. Combined with the omnipresent cell phone, QR codes can perform multiple tasks, such as finding and renewing library books, linking to online tutorials at workstations in otherwise disconnected spaces, connecting to the librarian's phone number, and providing assistance at the exact place of need (Hicks & Sinkinson, 2011). The display of posters throughout the school can link students to YouTube videos and podcasts on topics related to a variety of topics (Barack, 2010), enhancing the learning opportunities. Point of need information kiosks with QR codes can link to campus maps and event schedules. QR codes on posters at the start of the semester link students and parents to an online schedule and the school's

website (Neubauer, 2011).

In schools where mobile devices are frequently used in class, a teacher can provide a collection of frequently used QR codes on student desktops. Laminating the resource assures that the QR codes will remain protected and usable for a long time. By insuring that the QR codes are literally at students' fingertips, the teacher provides ubiquitous access to a variety of resources designed to increase student engagement, act as scaffolding, and provide feedback instantaneously.

Providing Scaffolding Just-in-Time

QR codes allow students to efficiently and effectively use smartphones to enrich their learning (Fasimpaur, 2011) and teachers to easily integrate electronic scaffolding tools into the curriculum. The links can be used to provide additional scaffolding to students, whether it concerns simple factual knowledge or complex problem solving assignments. For example, homework assignments can be posted on classroom doors, handouts or websites with QR codes that link to online help, enabling students to work independently to find the answers needed as they are working. This may also contribute to increased comprehension and greater retention as the connection between the assignment and the resources to solving the problems are seamlessly integrated in one location.

A variety of online applications are available across the curriculum. The QR codes provide the bridge to these valuable resources which support learning. Reading teachers can display links to educational games, quizzes, and books (Pavey, 2011). Learning a foreign language can be greatly supplemented with links to multilingual podcasts and audio material (Law & So, 2010). Science teachers can connect a YouTube video with a lab demonstration, and also integrate QR codes on a periodic table of chemicals (Law & So, 2010). Moodle printouts automatically add QR codes to the bottom of the page with links to the URL (Law & So, 2010). QR codes have been used in scavenger hunts and field trips to identify objects and places, or to link to a fundraising donation page (Hopkins & Bobeva, 2011).

The usage of QR codes, students can access tutorials at any point in their learning process. A huge amount of online content is available to support students at all levels. These include free resources, such as [Khan Academy](#), [Geogebra](#), and [Algebra Nation](#), or resources that have been purchased by a school or school district, such as [PearsonSuccessNet](#), [Gizmos](#), or [BrainPop](#). Since these resources can be accessed via mobile devices, QR codes are an easy way to access this huge amount of information instantly.

Increasing Student Engagement

QR codes can be beneficial in bolstering student engagement. The codes allow students to use the mobile devices that they are comfortable and familiar with, but the presence of a QR code puts the power for learning in the student's hands; through the use of the code they can further explore a topic or seek assistance on their own

A common use of QR codes is to provide a symbol on a PowerPoint slide that will connect to

a download of the presentation. A slide containing just-in-time information to access online web resources is much more efficient than typing the long URL on a cell phone's keypad (Ramsden, 2008). Teachers can create slides with objective questions using QR codes next to multiple choice questions, and the student can use this to email or text message the teacher. Fasimpaur (2011) mentions a clicker-type application within the PowerPoint presentation to poll the classroom, allowing for students to give anonymous feedback (Fasimpaur, 2011). Some instructors direct students to websites where supplementary information can be found (EDUCAUSE, 2009).

Providing Instantaneous Feedback

Teachers need to constantly provide feedback to students as they engage in problem-solving processes. In class, students are commonly asked to attempt sets of problems whose solutions involve many different steps. Students usually then have to wait until the next class to receive feedback about their work. By attaching a QR code to the problems themselves, students can scan the code to receive the answers instantaneously, whether they are in or out of school. A teacher can also create a document that contains not only the answers, but also the individual steps of the solutions. Such a document can be uploaded as a pdf file in a free document sharing website such as [Tag My Doc](#), which allows students to access the valuable feedback at any time. By making the information available at any moment, teachers can take advantage of more teachable moments by holding students' interest, rather than forcing them to wait until the next class meeting.

Online polls are an effective way to collect statistical data or to instantly gauge student understanding, making them another resource teachers can utilize in order to provide instantaneous feedback. Websites that are designed to allow students to text their responses, such as [Poll Everywhere](#), can be quick and easy methods of assessment. Because such resources are specifically designed to be utilized via mobile devices, accessing them by QR codes is a natural fit. By providing QR codes to such resources instead of URLs, students can access them instantly, dramatically lowering the amount of wasted instructional time.

Implementation of QR Codes in the Classroom

In order to use QR codes in the classroom, the teacher needs to know how to create the QR codes. There are a variety of different options available. The process itself is simple. First, locate or create the web page the students need to use. Then, paste that URL into a QR code generator. The generator will create the image with the information embedded. Copy the image and place it on the worksheet, in a presentation, on a webpage, or anywhere you want the students to access the page.

The best URLs to use in the creation of QR codes are short ones. Short URLs create less data that must be imbedded into the image. The reduced number of characters makes the QR code less dense. The resulting QR code is easier to read when scanned. To reduce the length of the URL, a teacher can use an application such as [bit.ly](#) before creating the QR code, or they may select a QR code generator, such as [goo.gl](#), that will shorten the URL when the code is created.

Dynamic QR codes offer another option for teachers. Dynamic QR codes differ from static

QR codes in that they are editable to allow a change to the destination of the code after the initial creation. Editable dynamic QR codes direct the results to different URLs, text messages, or any other object the QR code can point to, such as a YouTube video or social media site. This is advantageous, as URLs to website pages may no longer be available. If a static QR code is printed, and a student scans to an obsolete website, this can frustrate the learning process by preventing the user from accessing the proper learning material.

A plethora of choices are available in creation and scanning of QR codes. Teachers can select from several options by searching on the Internet or on a mobile device for QR code generators and readers. Kathy Schrock's blog (2013), [QR Codes in the Classroom - Kathy Schrock's Guide to Everything](#), contains a comprehensive list of generators and readers for multiple devices such as mobile smartphones, supported smartphones, tablets (iPads and Android-based), desktops (Mac and PC) for all platforms (iOS, Android, Blackberry).

Several applications have been created to simplify the process of creating the QR codes. Chrome and Firefox provide a QR code tag extension that will automatically display a QR-code tag that corresponds to the URL (web address) displayed in the current tab in the browser. By clicking on the QR code symbol, the image is generated. A QR code add-in is now available for PowerPoint. The add-in places the QR code generator into the Insert ribbon in PowerPoint. This allows the teachers to quickly insert the QR code for a URL directly into the slides of the presentation. [Fttp.com](#) has a QR code add-in for PowerPoint presentations that is easy to use.

The QR codes offer similar advantages similar to websites. Tracking the number of hits on a particular code with services such as Google Analytics provides statistics on the date and frequency of QR code scans, the location country of the scan performed, and the device and platform used. The data collected can be used to monitor and analyze the results in utilizing QR codes in classrooms. Additionally, QR code readers often store the history of the scans performed. Once the QR code has been scanned, the code "link" remains in the history of the QR reader app on the device used for scanning. This feature is similar to the stored history usage within a web browser. Students will not have to "re-scan" the code if a printout is lost or when the actual code is located in the classroom. All the pertinent information remains on the students' mobile device.

Limitations

A potential drawback from a technical and educational standpoint is that the speed may be slower for some smartphones, preventing the loading of the URL. In time, this problem will be corrected by newer, quicker mobile devices and wireless connections. Technical support for districts and schools must ensure that websites for viewing videos and podcasts, or downloading QR scanners and generators are not blocked by school servers (Barack, 2010). Additionally, some students might not have smartphones with Internet connectivity, especially in elementary grades, so mobile web access must become more commonplace in schools (Hicks & Sinkinson, 2011). Until that time, alternatives to m-learning with QR codes must be made available to users without the devices, or students can share several smartphones per classroom.

Part of the initial implementation will be classroom management, since teachers are quite aware that using smartphones may be distracting for the students. Teachers must control mobile device usage in the classroom by ensuring that lesson plans focus primarily on curriculum to drive the new technology. The implementation of mobile devices and QR codes as part of everyday learning in academic environments is a chance for teachers to tap into this emerging technology to enhance and enrich learning.

Teachers must also be aware that the ink on a printout can become smudged or the paper may tear, making the QR code unreadable. Even though QR codes include 30% data correction with redundant data printed on each symbol, there is a chance that the code will be unscannable (Lehan, 2011). Additionally, low light environments and reflective surfaces (i.e. signs behind glass windows) may require larger QR codes or may not work at all (Parsons, 2010). Too many QR codes on printed material are not effective, and can cause learners to feel overwhelmed.

Possible solutions include using URL shorteners to reduce the amount of information on the symbol, which reduces its complexity and size. The more data and error correction used, the higher the pixel count (Lehan, 2011), resulting in a larger QR code (Parsons, 2010). If there is too much data, the cell phone reader cannot interpret the code. Simplifying the code with a program such as TinyURL, bit.ly, or Google URL Shortener will improve the ability to decode successfully on the majority of mobile devices (Lehan, 2011). Smaller codes on a page are more likely to be read correctly by the scanner, and will be less confusing for the student as well.

Teachers must be cognizant of ways to reduce cognitive load associated with finding and processing a large volume of information (Hicks & Sinkinson, 2011). A study on QR codes performed in a university in southern Taiwan discovered that the more complex page design/layout of the QR codes causes “information overload” and frustration for the student that is taking the effort to scan the codes. (Chen, Teng, Lee, & Kinshuk, 2011). Changing the design and arrangement of QR codes will assist the student in the actual scanning and reading of the code, so it’s easier for understanding of the learning material. In addition, teachers must be mindful that due to small cell phone screen size, QR codes should connect to mobile-friendly websites.

Some students may not be able to access QR codes due to a disability. Teachers will need to design accommodations for students with visually and physically impairments. QR codes that are placed on surfaces beyond the desk need to be in close proximity to students with physical challenges (Ramsden, 2008). Students with visual impairments will need full URLs to ensure the screen readers identify the links rather than the image of the code.

Future Implications Scanning Recognition

In the near future, the ability to scan objects with mobile devices to link to web resources is the next evolution of the QR code technology. Teachers will be able to place educational objects around the classroom. Students will then be able to use their mobile devices to

launch premade activities or interactive learning activities that are prepared by the teacher. With object recognition apps, the student could scan similar objects at home. This will expand the learning environment beyond the classroom.

As mentioned earlier, the ability to scan and then overlay information on top of an object or a paper-based product is evolving. Google Glass was an attempt to create a ubiquitous device to scan the environment, and then provide information through the Google Glass. Although the glasses were not able to live up to the promise, other products are currently in the works. Microsoft HoloLens is in development with a possible late 2015 release date. The lens scans objects then overlay information through a hologram and allow the user to interact and create (Microsoft, 2015). What would this type of technology do for education in the future as it become easier and affordable for classrooms?

Another use for augmented reality envisioned in the future comes from Corning Incorporated in the video “A Day Made of Glass 2: Unpacked”. In the video, a transparent mobile device can be used to trigger via sensors a multimedia presentation of a prehistoric dinosaur as the students tour a local park. This very creative learning experience allows the students to be virtually present with dinosaurs, piquing their interest to engage in deeper learning about the past and resulting in a better understanding of the animals (Corning Incorporated, 2012).

Conclusions

Mobile devices are omnipresent in today’s society. Technology improves the learning experience by making it more authentic, and facilitates the transfer of skills from classroom to workplace (Leone & Leo, 2011). The utilization of mobile devices to link with just-in-time access to resources has the potential to transform the traditional classroom environment (McCabe & Tedesco, 2011).

This paper has discussed some of the issues and challenges faced by school administrators and teachers in leading their classrooms with the new, emerging technology which integrates the paper based materials with mobile devices. Mobile device access to the Internet will become more prevalent in the future of education, and will assist in the development of necessary skills to be competitive in the 21st century. Teachers can truly make the most of QR code technology or future evolutions of this type of technology with mobile devices to enrich the acquisition of knowledge.

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Internet Resources

- Algebra Nation: An online textbook and learning resource for students learning algebra. (www.algebration.com)
- Bitly: This web application converts long URLs into shorter ones. Shorter URLs work better in the QR codes. (<https://bitly.com/>)
- BrainPop: This is a great cross curricular educational website with interactive content and instructional cartoons for every content area at any level. (www.brainpop.com).
- Everywhere: The website allows both multiple choice responses and open ended questions to survey questions that can be accessed using mobile devices. (www.polleverywhere.com),
- Ftpt.com <http://www.free-power-point-templates.com/articles/qr-code-add-in-powerpoint>
- Geogebra: A great online resource of interactive instructional materials for teaching mathematical concepts. (www.geogebra.org)
- Gizmos: A great resource for math and science teachers that has simulations and lesson materials to assist children in understanding complex processes and concepts. (www.explorelearning.com)
- Goo.gl: a QR code generator that shortens the URL at the same time. (<http://goo.gl/>) Here is a great YouTube video tutorial on how to use Goo.gl: <http://www.youtube.com/watch?v=yhoLzQD0dMg> .
- Khan Academy: Online tutorials for students needing additional support in learning. (www.khanacademy.org)
- PearsonSuccessNet: Pearson offers a variety of online resources that work with their textbooks to promote student success in classrooms that use their products. (www.pearsonsuccessnet.com),
- Kathy Schrock's Guide to Everything: This page contains a vast array of resources on QR codes from options for QR code generators to ideas for using the codes in the classroom. (www.schrockguide.net/qr-codes-in-the-classroom.html)
- Tag My Doc: This resources allows you to tag documents that you have placed on the web. As the document is updated with new information the other copies are also updated. (www.tagmydoc.com)