

QR Codes in Education – A Study on Innovative Approach in Classroom Teaching

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Abstract: *Technology being an indispensable part of education has initiated mobile and online learning to integrate within classroom settings. QR codes not only make the material more interactive in the class but also captivate the attention of students enabling them to learn effectively. Various aims and goals can be accomplished through it. QR codes can literally hold any kind of information up to several thousand bytes. Coupled with a moderate equipped mobile device, it opens up a new horizon for many applications in the commercial world as well as in education. In our study we found that QR codes can support learning in different contexts. It is also found that QR code supports both collaborative and independent learning. This paper will primarily focus on using of QR code in Education to make smart learning. Our Paper will also encompass on the (a) Introduction to QR code (b) The background of QR code development (c) Characteristic of QR Codes (d) Practical applications of QR Code in Business and industry (e) Innovative Use of QR Code in Education (f) the process of reading and making QR codes (g) Conclusion (h) Future Scope and Limitations*

Keywords: *Quick Response Code (QR) , Mobile Learning, e-Learning, 2D Bar Code, Smart Learning, Creativity in the classroom*

I. Introduction

QR codes were first created in 1994, to track vehicles during the manufacturing process at high speed. In 2002, when Japanese handset makers and others wanted to turn everyone's phone camera into a barcode scanner for marketing purposes, QR codes made perfect sense. With two dimensions to work within, QR codes can store several hundred times the amount of information carried by ordinary bar codes. They can contain anything that can fit into a maximum of around 4k (roughly one page of text). Quick Response (QR) codes are versatile. The QR code, short for Quick Response code, is a kind of matrix barcode (Wikipedia, 2011). The reason for its quick response is that the code could build a bridge between online information and offline materials. It can be decoded quickly by a specialized application, called QR code reader. QR code readers could navigate users to an abundant online information resource, such as Uniform Resource Locator (URL), text, images, audios and videos, as long as the reader figures out what the code represents. In spite of its powerful function, the QR code has only several black modules arranged in a square pattern against a white background. Then these above are all the constituent parts of a complete QR code, making it possible to decode those contents at a high speed. However, the code itself has different formats, such as numeric only, binary, alphanumeric, or Kanji symbols (Byrne, 2011). Coupled with moderate equipped mobile devices, QR Codes can connect the users to the information quickly and easily. QR Codes allow smart phone and tablet computer users to more easily access information. The low technical barrier of creating and reading QR codes allows innovative educators to incorporate them into their educational endeavors. The operations to retrieve or store QR codes are incredibly simple and quick, and with mobile devices, make them the ideal educational tools for teaching and learning. Looking at the increasing scope of QR codes, and the amount of information they can store, we've come up with a few observations on how they can be used in online classes and e-learning. Quick response codes are simple, scannable images that are a form of barcode. By scanning a QR code image through a mobile device, information can be accessed including text, links, bookmarks, Audio and email addresses. QR codes can literally hold any kind of information up to several thousand bytes. Coupled with a moderate equipped mobile device, it opens up a new horizon for many applications in the commercial world as well as in education. In education, we believe that the movement of using QR codes is slow and still in its infancy. This paper is organized as follows. We will first introduce the background of QR development in Section 2. This section highlights on the development of QR code. In Section 3, we introduce the user characteristics of QR code related to curriculum. In Section 4, we provide certain examples showing practical applications of QR codes in different areas. This overview the usage of QR codes in different application area and the benefit of using it. Mobile technologies have changed our societies in many respects. They have affected the way people interact with each other and how they communicate, work and spend their leisure time. Mobile devices, systems and technologies are now universally owned, accepted and used. As a consequence, also the meaning and significance of learning are changing. (Traxler, 2009). Mobile technologies facilitate learning outside of the classroom, and learning materials are no longer limited to textbooks (Shih, Chu, Hwang & Kinshuk, 2011). In Section 5, we provide various examples to use QR code creatively in Education based on literature study.

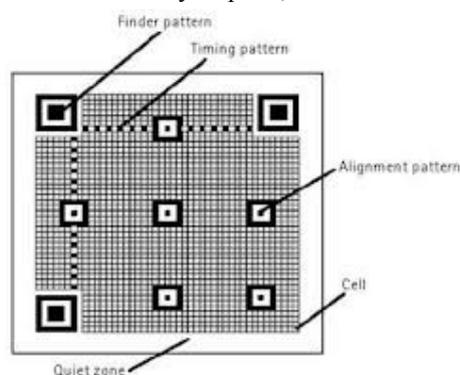
Looking at the increasing scope of QR codes, and the amount of information they can store, we've come up with a few observations on how they can be used in online classes and creative learning. As mobile learning and technology is more readily integrated within classroom settings, QR codes can be used as an interesting method to capture a student's attention and make lesson material more interactive. In Section 6, we explain the way of creating and reading document with QR code. This section explains the installation of software to create QR code and how to read the QR code. This section also emphasis on how to create QR code to store text, URL, Links , Contacts or SMS. In Section 7, we conclude the paper with some reflective remarks and future scope of QR codes in education.

II. Background of QR code development

In 1970, IBM developed UPC symbols consisting of 13 digits of numbers to enable automatic input into computers. These UPC symbols are still widely used for Point-Of-Sale (POS) system. In 1974, Code 39 which can encode (symbolise) approx. 30 digits of alphanumeric characters was developed. Then in the early 1980s, multistaged symbol codes where approx. 100 digits of characters can be stored such as Code 16K and Code 49 were developed. As informatisation rapidly developed in the recent years, requests had mounted for symbols which can store more information and represent languages other than English. To enable this, a symbol with even higher density than multistaged symbols was required. As a result, QR Code, which can contain 7,000 digits of characters at maximum including Kanji characters (Chinese characters used in Japan) was developed in 1994. The history until realising high-capacity and high-density symbols can be described as illustrated in Figure 1 when seeing them from the technology's aspect. Firstly, Interleaved 2 of 5 and Codabar which can encode (symbolise) numbers were developed, followed by the development of Code 39 which can encode alphanumerical characters. Along with the informatisation developments, it had become necessary to have full ASCII encoded, and this resulted in the development of Code 128. Then, multistaged symbols were developed where these linear symbols were arranged in several stages. Toyota Motor's Kanban Code is the world's first multistaged symbol. As computers became popular, these codes developed into multi-row symbols where multistaged codes were extended and into matrix symbols where data were arranged in matrix. The printing area for matrix symbols are the smallest among all, and is seen as highly prospective as the main symbol for the future. QR Code is a matrix symbol which has been developed as the one enabling all of high capacity PDF417, high density printing of data matrix, and high speed reading of maxi code based on the research made on their characteristics.

III. Characteristics of QR Code

Quick response codes, also known as 'QR' codes, are simple, scannable images that are a form of barcode. By scanning a QR code image through a mobile device, information can be accessed including text, links, bookmarks and email addresses. It's basically a quick, scannable barcode-like image that takes you to a



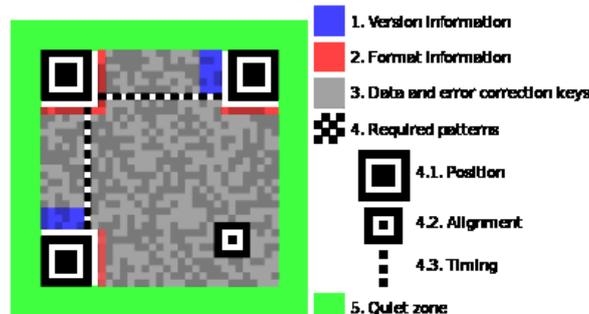
specific digital destination. Additional to the characteristics for two-dimensional symbols such as large volume data (7,089 numerical characters at maximum), high-density recording (approx. 100 times higher in density than linear symbols), and high-speed reading, QR Code has other superiority in both performance and functionalities aspects.

Information that can be stored in QR Codes :

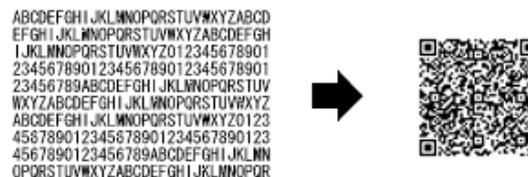
- ✓ A website URL
- ✓ Contact Information
- ✓ Geographical Location
- ✓ Calendar event
- ✓ A text message to be sent on a phone #
- ✓ A plain text message

Salient Features of QR Code

a. All-Direction (360°) High-Speed Reading – Reading matrix symbols will be implemented by using a CCD sensor (area sensor). The data of the scan line captured by the sensor will be stored into the memory. (ITSC 2008) Then, by using the software, the details will be analyzed, finder patterns identified, and the position/size/angle of the symbol detected, and the decoding process will be implemented. Traditional two-dimensional symbols used to take much time for detecting the position/angle/size of the symbol, and had a problem that their readings were less accurate when compared with those of linear symbols. QR Code has finder patterns for notifying the position of the symbol arranged in three of its corners to enable high-speed reading in all directions (360°). Additionally, by identifying the positional relationships of the three finder patterns listed in Figure below from among the image field of the CCD sensor, the size (L), the angle (!), and the outer shape of the symbol can be simultaneously detected. By arranging the finder patterns into the three corners of the symbol, the decoding speed of the QR Code can be made 20 times faster than that of other matrix symbols. Because of their unusual design, the QR codes would certainly draw the viewers eye, the problem is, these codes are meant to be viewed (primarily but not exclusively) on a mobile phone.



b. High Capacity Encoding of Data – As compared to 2D bar code, QR Code is capable of handling several dozen to several hundred times more information. QR Code is capable of handling all types of data, such as numeric and alphabetic characters, Kanji, Kana, Hiragana, symbols, binary, and control codes. Up to 7,089 characters can be encoded in one symbol. In the figure below it shows that a QR code symbol of this size can encode 300 alphanumeric characters. (Denso 2010)

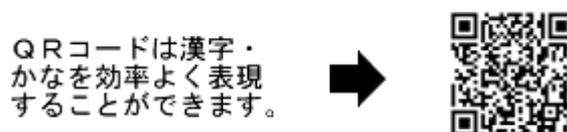


c. Small Printout Size - Since QR Code carries information both horizontally and vertically, QR Code is capable of encoding the same amount of data in approximately one-tenth the space of a traditional bar code. The figure below illustrates the concept.



d. Kanji and Kana Capability - As a symbology developed in Japan, QR Code is capable of encoding JIS Level 1 and Level 2 kanji character set.

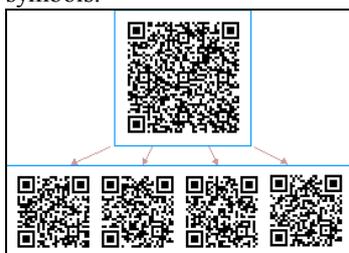
In case of Japanese, one full-width Kana or Kanji character is efficiently encoded in 13 bits, allowing QR Code to hold more than 20% data than other 2D symbologies.



- e. **Dirt and Damage Resistant** - QR Code has error correction capability. Data can be restored even if the symbol is partially dirty or damaged.



- f. **Structured Append Feature** - QR Code can be divided into multiple data areas. Conversely, information stored in multiple QR Code symbols can be reconstructed as single data symbols. One data symbol can be divided into up to 16 symbols, allowing printing in a narrow area. The same data can be read either from the upper symbol or the lower four symbols.



Curriculum related characteristics of QR Code

- a. **Link between Offline and Online Media** – A QR code printed on a paper can link to the user to a beautiful cyber world.
- b. **Quick Readability** - QR codes are quickly readable with phone model easily.
- c. **Hold of Information** - One QR code could contain up to 4000 characters of information so that it becomes possible to pack a ton of information, including a URL, message, text or phone number, into a small space. After the QR codes reader finishes decoding, users would meet with limitless information resources.
- d. **Being Easy to Generate** - In spite of its multiple functions, it is really easy to generate such a powerful barcode. There are several different levels of online QR code generators. Users could also select a proper one satisfying their demands.

IV. Practical Use of QR Code in Business and Industry

Many examples of using QR code in Industry Applications can be found in Australia, Japan , Korea, China, America and Singapore. Now in India QR codes are becoming popular. There are likely countless other applications. The point is that rather than thinking about QR codes as simply an interesting communication tool, think about how this tool might be leveraged in other, more operational ways, to improve your customer service–or your business operations. Some of the practical uses of QR code that may be applied are illustrated below:

- Real estate agents might use QR codes to provide additional detail, video, etc., about properties they have listed.
- Insurance agents might use QR codes that their clients access to launch an application to file a claim following an accident or other incident.
- Health care systems might use QR codes to allow patients having surgical procedures, or visiting the emergency room to check-in without a lot of paperwork.
- At conferences, QR codes might be used to provide detailed agendas, or even a link to handout materials.
- Business Cards - A QR Code on the back of your business card is not only eye-catching but also it can contain all your details in VCard and a person can update all your details to their phonebook with one scan.
- Magazine Adverts - Magazine advertising space is not cheap as we all know and space is limited. Include a QR Code in advertisement that can be link to a mobile website which can give the users as much information as they want, Videos, promotions, products the opportunities are endless.
- Food Products – QR Code can be posted on Food Products , which may contain links/text of recipe.
- QR Code Used For Bus Commuters Pass Issuing System
- Few more uses are illustrated in the figures given below:

McDonald's placed QR Codes on the soft drink cup, burger wrapper, and paper bag amongst other things.

Snack food packaging

QR code used by few brands (qRe8 2010)

1. December 2009 - **Google** announces that [Favorite Places](#) will contain QR Codes
2. January 2010 - **GMC** uses QR Codes to promote the new [Granite vehicle](#)
3. February 2010 - The **Detroit Red Wings** create a QR Code [Game Program](#)
4. February 2010 - The **Weather Channel** allows viewers to download the [Weather Channel Android APP](#) via a QR Code on live television
5. February 2010 - **Best Buy** uses QR Codes to directly link customers to [mobile shopping](#)
6. March 2010 - **Ford** uses a [QR Code](#) in a print ad for the Figo vehicle in an Indian newspaper
7. March 2010 - **Chevy** [places QR Codes](#) on cars during SXSW festival
8. March 2010 - **Starbucks** [uses QR Codes](#) in mobile APPs to allow consumers to pay at cash with a simple scan of a phone
9. March 2010 - **Addidas Japan** launches the [FIFA World Cup 2010 site](#) featuring a QR Code that takes you directly to the mobile version of the site

Innovative Use Of Qr Codes In Education

As smart phones have become the part and parcel of modern life. People are capable of accessing online resources in the classroom. mLearning has become very popular, as it appeals to students of this generation. This technique is very popular and increasingly used in the field of Education in Japan, America and other countries. mLearning stands for Mobile Learning which is location and time independent, student can learn at his own pace after room class also. In India due to limitations of economy, as all students don't have smart phones, so the technique is not fully emerged into classrooms. Figuring out ways to use mobile devices as a tool in the classroom is a strategy that can be put in place to not only enrich student learning but also curve negative aspects of a cellphone in the classroom to a positive use. Students from Japan have done a lot of research work in this field and still in progress. After study of literature and online blogs we can figure out the use QR codes in the classroom teaching:

- **Use QR code to access to mobile sites with important information.** Site may be created for free by using



& So, 2010)



<http://winksite.com/site>. This site allows you to create 5 sites under one user name and automatically generates QR code. That can be given to students and parents or researchers.

- **Learner centered learning** – Learners can produce reports or other materials online and share their wrk with QR codes. (Mikulski, 2011)
- **QR codes can be used to create Treasure Hunt** : Codes can be generated and posted on different locations which contains clues for next location. (Law
- **Green Classrooms** - Instead of making more printouts than everyone needs, give your students a QR that takes them to the instructions, announcement or assignment. It may save few trees.
- **Advertising** – Students can show their event invitation in the form of QR code on Notice board, as QR codes are eye catchy.
- **Show Exemplars** - QR codes can be created for linking students to examples of quality work, whether it's PowerPoint or slideshare for a class presentation.
- **Provide Extension Assignments** – QR codes can be used in a great way to provide optional activities for students who want to excel is to simply put the code on the class assignment and let them follow it to the extension activity or question. It won't take up much space, and might facilitate a little excitement about the extension assignment.
- **Homework and remarks** - Teachers can embed their homework assignments into QR codes. Just paste the code onto the virtual classroom whiteboard, and let students scan it.
- **Keeping record in a less space** – Assignments can be saved online and URL , text can be saved in QR codes which can be decoded easily.
- **Enhance Knowledge** – QR codes can be pasted as sticker on books at relevant points , which may take reader to related video, book summary , web page or some other source of information.
- **QR codes can be added to school magazine** to lead people to gallery work that was submitted but not printed.
- **Integration of QR Codes within printed learning materials** Another use of QR codes is their inclusion in printed learning materials, ie, workbooks. This is to improve the connection between the activity being undertaken in the book and an additional online activity. The learning activity requires the user to complete

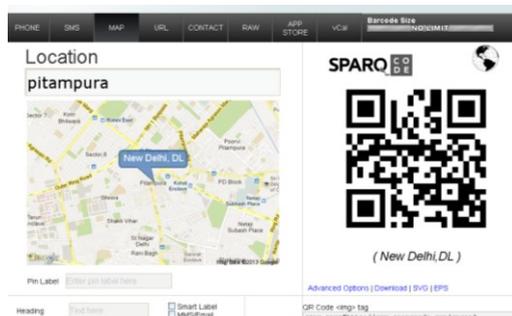
a set of exercises and then access an online discussion forum to further apply these concepts and expose their ideas to the wider community. A QR code is included with each activity in the workbook to provide a deep link to the specific forum on the appropriate Moodle course.

- **Direct link can be provided to students** by the professors, which may contain links to supplemental online materials and readings in QR code format.
- **Create a guided Tour of campus – Insider view** in the form of video clip can be saved in the form of QR code.
- **Extend learning to outdoor activities** - The ubiquitous nature of accessing information through mobile handheld devices creates a so-called u-space for learners. Rather than carrying a laptop or other bulky devices to a location outside the classroom for learning, a learner can immerse into the learning process through a pocket-sized device.
- **Location-based activities or activities related to geographic location** can also be provided through QR codes. As discussed in the previous section, geographic positioning coordinates can be embedded into a QR code. By reading the code, the device can directly invoke a map to pinpoint the location. Many activities can be established by making use of this possibility.
- **Dynamic Assessment** – Assessment is an integral part of any learning and teaching activities. Imagine that learners can participate in a test that QR codes not only can provide the questions and self-evaluated answers like the worksheet described above. The teacher can monitor the progress by observing the flow of answers, interaction and timing. This kind of dynamic information is valuable and reflective to the teacher.
- **Digital Portfolio for the students** can be created, which may contain link of the projects and assignments submitted.
- **Audio Information** can be provided by recording own voice and converting it into QR code.
- Tutorial on equipment can be shown by placing QR codes on equipments.
- In Schools teachers can give QR code at the end of chapter which may contain link to the tutoring website or video with more content.
- It can be used for Formative Assessment tool for CCE pattern exams in school.

Ways to Generate and use QR code

1. **Creating QR codes** - QR codes can be generated for the following heads easily by some websites that can generate the QR code for free. QR codes can be generated for URL, Email address, Phone number, Text, Contact information, SMS, YouTube, Services, Graphical (to put an image into your QR code for a URL), and Google Maps. Few of the sites are as follows through which we can QR codes:
 - ZXing Project : <http://zxing.appspot.com/generator/>
 - Delivr : <http://delivr.com/qr-code-generator>
 - Maestro : <http://www.sparqcode.com/static/maestro>
 - Kaywa : <http://qrcode.kaywa.com/>

An example with Maestro to create QR code of Pitampura Location. Save the generated QR code as image.



codes for phone number, SMS, URL and Text upto 200 characters can be saved as QR code.

2. **Creating free Mobile Website with automatic generated Code**
 - a. Open site <http://www.winksite.com>
 - b. Sign up and fill the details or sign in if you are existing user.
 - c. You can create maximum of 5 sites under one main user name.
 - d. Customize the background and color scheme of mobile site and save.
 - e. Save and publish the QR code for your site.



Mobile Website created with www.winksite.com
Students can scan the code and directly access the site and lectures.

V. Shortening of URL and automatic QR code generation

URL codes can be shortened by the URL shorteners. As smaller the URL code smaller , smaller the QR code. The steps are

Step 1. – type bit.ly

Step 2 – type the URL to shorten

Step 3 – add .qrcode to your bitly address , QR code will automatically get generated.



Step 2 : Generated Shortened URL



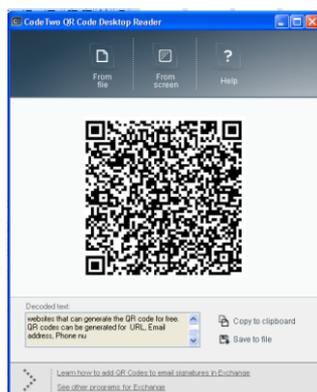
Step 3 : Generated QR Code for the site
www.bvicam.ac.in

3. Reading QR codes: QR codes can be decoded with many application websites supplied the decoders for different mobile devices. These include:

i-nigma: <http://www.i-nigma.com/download-i-nigmaReader.html>

KAywa : <http://reader.kaywa.com/>

4. Reading of QR code without mobile device. Code Two QR Code Desktop reader can be freely downloaded from <http://www.codetwo.com/freeware/qr-code-desktop-reader/> and the code can be decoded easily from screen or from a file.



A code Two QR code Desktop reader

VI. Conclusion

From the above literature study, it may be concluded that QR code is an excellent technique which promotes Mobile Learning, facilitates e-learning and online learning. It is in developed mode in Japan, but in India it is still at beginning stage. Many researchers are doing research in this context and findings are helpful. But Implementation requires mobile devices which is not possible to have in every classroom. It can help parents of school students as they can provide extended knowledge to their children. The basic requirement for this technique is smart technology, which can be used in innovative ways in Classroom teaching. In general, we believe that QR codes have great potential in education. If the mobile devices are equipped with Wi-Fi access and the activities do have the wireless coverage, the cost for communication would be minimal. This observation is quite obvious when we search the web and we can find many web links related to the educational use of QR codes in education. Thanks to its abundant information load, it is also possible for users to access a variety of multiple media contents which could help students to gain more instructions from a paper-based handout. At the same time, the QR code also brings about much more interactivities and interests. Teachers can create their mobile sites and can upload video lectures and notes on the site, and publish their codes to students via www.winksite.com for free. The current education system is in the process of a reform featured with the use of instructional technology with smart learning. Considering these characteristics, the QR code really accords with the trend of educational development towards student-centered instruction. Furthermore, the QR code itself is also in the progress of improvement. No doubt that the QR code has a good potential for being integrated into the curriculum. But with its rapid development, some risks and drawbacks of QR codes are exposed to the public. The privacy, content safety, and availability of QR code reader really threat its further promotion in the area of education.

Future Scope

QR codes can be easily implemented at K5 school level, where parents can access online resources provided by the teacher and QR code can be given in printed form. College students can submit their work and create QR code for the work. QR codes can be implemented at school level and college level both. Our aim in future experiments is to find more proper educational uses of QR codes and to categorize them. We also expect that our future work will offer examples and tips for teachers on how to utilize QR codes in an educational context and that way we can promote mobile learning.

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Write references here (in IEEE format). Two such templates are given hereunder.

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