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The Potential Use of QR Codes in u-Learning Systems

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Abstract: The proliferation and advancement of technologies have made learning become more interactive and innovative. Technology has become an essential component of today's educational systems as most learners in this generation are attached to technology. Integrating technology in u-Learning systems may somehow help drive the attention of students toward learning. Teachers may have already used a number of information and communications technology (ICT) tools in education to improve their classroom instructions. This paper discusses the potential use of QR codes as an effective education technology tool in u-Learning systems. This study further discusses how QR codes can be used inside or outside the classroom. With the students' own personal mobile devices and the teacher's creative ideas, QR codes can be a tool for interactive and enjoyable learning.

Keywords: u-Learning systems, QR codes, information and communication technology (ICT), Connectivism learning theory

1. Introduction

The Quick Response Code (QR Code) refers to a trademark for a certain type of code. It is a two-dimensional matrix code that can efficiently store data or information through a machine-readable optical label using four standardized encoding models namely *numeric*, *alphanumeric*, *binary*, and *kanji* (*e.g.*, Japanese, Chinese, or Korean Characters) [1][2]. Figure 1 depicts an example of a QR code.

Figure 1. QR Code

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Before the creation of this type of code, one-dimensional barcodes [3] were the most frequently used. These codes are commonly seen on the price tags and packages of products in retail or grocery stores. Its data storage feature printed in a small space that is easily be scanned became the reason why it gained much popularity. However, due to the passage of time, the demand for barcodes to store more information in a much smaller area paved a way for two-dimensional codes to be on-trend.

QR Code was first created back in 1994 when a subsidiary of a well-known automotive industry company developed the code in order to help in the manufacturing process [4]. These codes aided in tracking vehicles and parts. Its name was derived from the purpose of its creation. Since it was designed to allow fast decoding speeds, it was then called Quick Response Code [5]. Since its creation, it has gained wide acceptance in such diverse industries as manufacturing, warehousing, logistics, retailing, healthcare, life sciences, transportation, and office automation [6].

The fast growth of smartphones also gave an opportunity for the QR Code to touch the daily lives of people. QR codes were further used in mobile marketing and advertising campaigns. This became a fast and effective way for business entities to connect with the customers and provide end-user content which includes Web links, mobile coupons, and boarding passes [6].

Figure 2 shows the comparison of a QR Code and Barcode having the same content – 19 characters consisting of 17 letters and 2 spaces. The QR Code consists of square dots arranged in a square grid. Data are stored in the patterns that are present in both horizontal and vertical components of the image. On the other hand, the barcode is made up of a series of vertical bars and spaces. Information contained in this type of code is communicated only by the difference in their horizontal dimension or the width of the bars and spaces, and their position from left to right. This figure also depicts that in a small space, data can be more compressed in a QR code. Though a large amount of data can be stored in a barcode, it would cause it to be longer in length, and because of this, scanners can have difficulty in reading the data.

Figure 2. Comparison of QR Code and Barcode

Generally, QR codes are black having white backgrounds but creative QR Code generators can also apply other colors for the image to be visually appealing, some even incorporate shape designs and company logos. Furthermore, there are many types of QR Codes that include QR Code Model 1 & 2, Micro QR Code, iQR Code, Secret-function-equipped QR Code (SQRC), and LogoQ.

This paper deals with the study on the potential use of QR codes in u-Learning systems. The integration of QR codes in u-Learning systems can bring the web into non-ICT classrooms such as in Chemistry, Biology, Geography, Mathematics, and Literature. It can also enable adding of QR codes in handouts, worksheets, assignments, and assessments. In addition, outdoor activities such as Scavenger Hunt can be done using QR Codes.

The remainder of this paper is organized as follows: Section 2 outlines the overview of u-learning systems; Section 3 details the related studies; the potential use of QR codes in u-Learning systems were highlighted in Section 4; and Section 5 concludes the study.

2. Overview of u-Learning Systems

Learning refers to the acquisition of new, or modifying existing, knowledge, behaviors, skills, values, or preferences and may involve synthesizing and combining different types of information [7][8]. Learning may be viewed as a process, rather than a collection of factual and procedural knowledge [7]. This section discusses the overview of u-Learning systems where learning is not limited to the four corners of the classroom but takes place anytime and anywhere.

Ubiquitous learning (u-Learning) enables learning in a broader domain as it is extended outside the classroom making learning resources accessible anytime and anywhere in various contexts and situations. The ubiquitous learning environment (ULE) is efficiently established through context awareness technology providing ubiquitous learning context to the learners. The ULE can be situated in any persistent learning setting where learning is accessible almost anywhere and all around the learners. In this setting, the learning resources and process can be found anywhere and integrated on the objects situated within the learning environment where the learners may not even notice and be required to do anything on the learning process [9][10]. The u-Learning system is a learner-centered paradigm that enables the provision of intuitive ways for identifying the right collaborators, the right contents, the right resources, the right technology, and the right learning services in the right place and the right time based on the learner's environments. These right learning collaborators are the ones that are capable of accommodating on the learner's specific learning needs. The learning resources, services, and the setting are all determined in u-Learning systems [10].

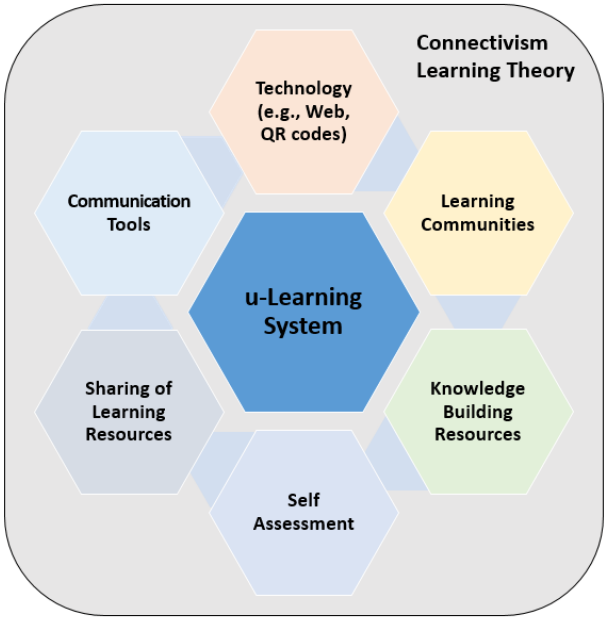

Figure 3. The u-Learning Model

Figure 3 depicts the u-Learning model that is consists of learning communities, knowledge-building resources, communication tools, technology, learning resources sharing, and self-assessment. The model is an adaptive learning paradigm that involves creating learning activities, tasks, projects, assessments, and resources that encourage self-discovery learning [11]. In addition, the u-Learning model can be based on connectivism learning theory that particularly focuses on the learner's collaboration. Connectivism learning theory is based on the concept that knowledge is distributed across a network of connections, thus, learning is comprised of the capability to create and navigate those networks [12][13]. In this theory, knowledge is defined as the set of connections formed by actions and experiences by the learners. The theory emphasizes the concept that people learn and grow when they form connections [12]. The connections can be between the learners or between the learner and their roles and responsibilities in their lives.

According to George Siemens [14], connectivism learning theory refers to the integration of principles explored by chaos, network, and complexity and self-organization theories. The following principles of connectivism applicable to u-Learning have been identified:

- There is an end goal in learning (*i.e.*, the increased ability to "*do something*");
- The multitude of opinions among the different connections will be the basis for learning and knowledge.
- Learning refers to the process of connecting specialized nodes or information sources.
- Learning may reside in non-human appliances.
- Getting more knowledge is more essential than what is currently known;
- Learning continuity requires the enhancement and maintenance of connections.
- A core skill can refer to the ability to see connections between fields, notions, ideas, and concepts.
- All learning activities must be current, accurate, and based on up-to-date knowledge.

3. Related Studies

QR Codes link the physical world with the virtual environment by providing on-the-spot access to descriptive language and online resources for objects and locations [15]. Just like in this study, the codes provided the students with a link to the Internet for them to watch the videos and read related topics about the subject matter. Aside from learning, students can be also given the chance to generate their own QR codes in their projects.

In the study of So [16], QR codes were used by students to check whether their quiz answers are right or wrong. The author also explained how QR codes can be used in outdoor activities and how it provides greater interaction between the students and the teacher. An education article about QR codes usage also enumerated that this can be used as flashcards, link to important forms, give feedback, and conducts polls [17].

In addition, the study of Rikala and Kankaanranta explored the potential use of QR codes and mobile devices in the context of Finnish basic education [18]. Also in schools, QR codes became useful in posting some events and making data charts in classroom activities [19].

Finally, another interesting way to use QR codes for the children is the creation of a virtual museum composed of QR codes having links to the child's scanned artworks. A study by Ceipidor *et al.* [20] deals with a mobile game focused on a museum treasure hunt. The mobile game utilizes QR codes in identifying the correct answers and to enjoy some other services.

4. Potential Use of QR Codes in u-Learning Systems

Learning in school is very important. With all the barriers, it is a great challenge for the teachers on how they can make the students learn a certain subject. They cannot just force students to learn, instead, they must capture the attention of students and drive them towards collaborative and interactive learning. This paper suggests the use of QR codes in u-Learning systems. But prior to its use, several things are needed to be set up. The students with mobile phones or tablets must download a QR Code scanner mobile application. Figure 3 shows how a mobile phone captures a QR code. The teacher may instruct and assist the students on how to do this. The teacher, on the other hand, must be capable of using a QR Code generator. QR codes can also be generated using JavaScript. If the school has no free Internet connection, wireless broadband can help in case the students' phones have no Internet connection.

Figure 3. Scanned QR Code

The following are some of the benefits of using QR codes in u-Learning systems [21]:

- *Learners can easily find links*. Learners can scan QR codes with their smartphones or tablets to easily access digital content (*e.g.*, it takes mere seconds as compared with typing the entire link on a particular content). It eliminates the need to go through search engines in finding the correct location of the desired digital contents or resources in the u-Learning system.
- *QR Codes in u-Learning save time*. Preparing learning activities can be easier and faster through the use of QR codes (*e.g.*, sharing links, videos, images, graphics, PDFs, audio files). Scanning QR codes quickly accesses the desired digital contents (*i.e.*, correct website or YouTube channel) as compared to typing the website's URL (*i.e.*, uniform resource locator). Making mistakes in typing long URLs is also eliminated.
- *Online, outdoor, and classroom learning are enhanced*. Various kinds of QR codes can be incorporated into learning activities in any setting to make learning more interactive and fun (*e.g.*, the usage of QR codes to a grammar quiz enables a more creative way to access the related tasks). The creation of scavenger hunts allows learners to visit various websites in order to gather information on a particular topic. QR codes can be placed in different locations inside the classroom or school premises to allow students to move and get more engaged.

- *Adapting QR codes to any medium is easy as it is completely customizable*. Customization can be done through resizing QR codes, styles (*e.g.*, colors, edges, and frames), and even incorporating logos or images.
- *QR code contents are always editable and can be updated*. Dynamic QR codes have the capability of updating their contents (*e.g.*, QR code links can be changed or QR code types can be changed from images to video).

In addition, the integration of QR codes in u-Learning systems allows learners to get out of their chairs, help learners go back and study or review their learning resources, enable paper-free learning activities, promote exploration, show that learning is all around us, and make learners interact with the world around them.

4.1 Bring the Web into a non-ICT Classroom

During a class discussion, the teacher may post QR codes in the visual aids in order to make a learning activity for the students which is applicable in different subject areas. The following images show how QR codes can be useful. Teachers can furthermore formulate several teaching ideas from these examples. If not all students have mobile devices, the teacher may decide to divide the class into groups in order that all can have the opportunity to participate.

Figure 4 shows the use of QR Codes in the Chemistry subject by incorporating the codes into the periodic table of elements [22]. Figure 5 shows the use of QR Codes in Biology, the codes were used to identify the cell parts [23]. Figure 6 shows the use of QR codes in Geography, the codes were used to identify the different countries [24]. Figure 7 shows the use of QR codes in Mathematics, the codes may be used as a hind or a solution to the problem [25]. Figure 8 shows the use of QR codes in Literature.

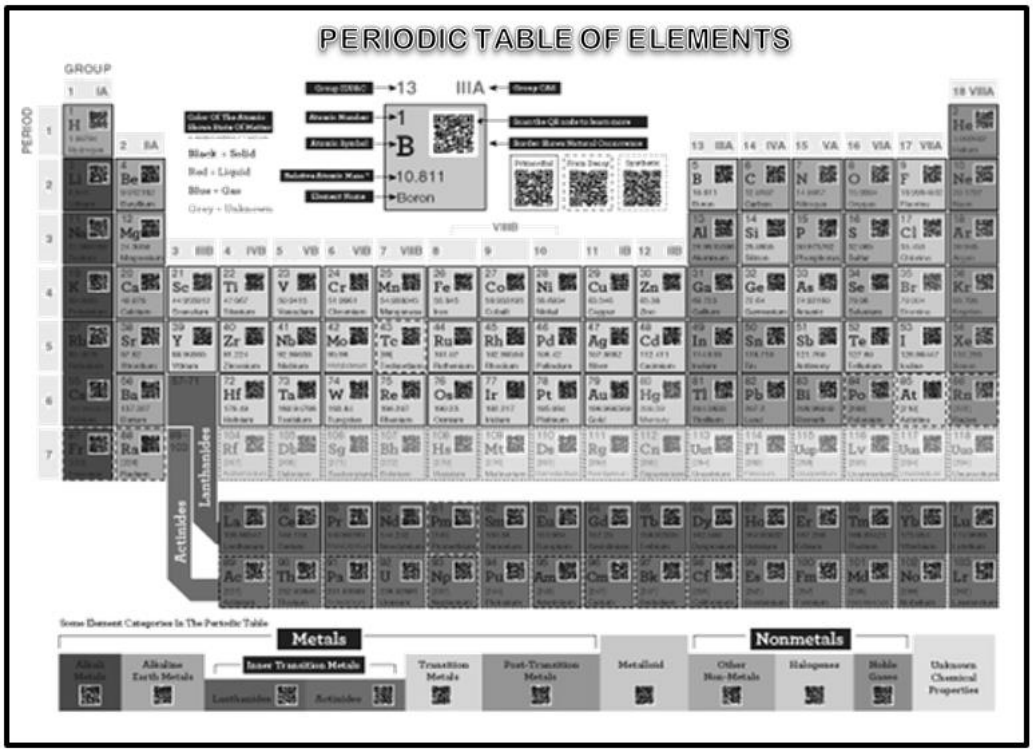

Figure 4. QR Codes in Chemistry

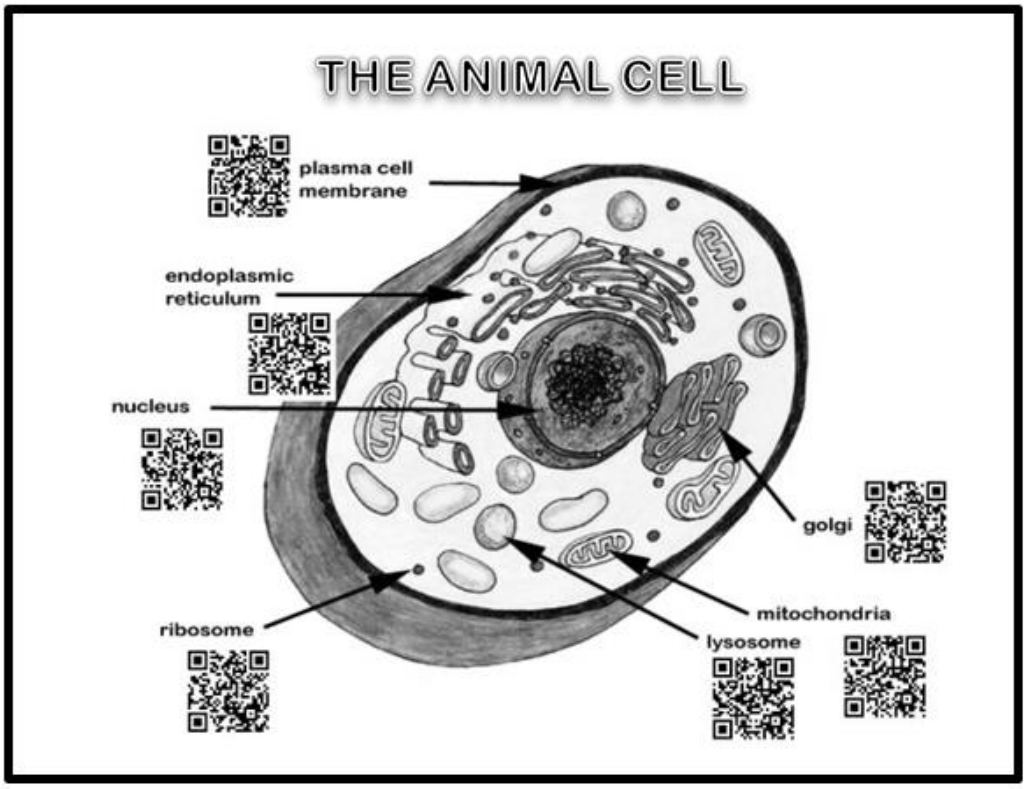

Figure 5. QR Codes in Biology

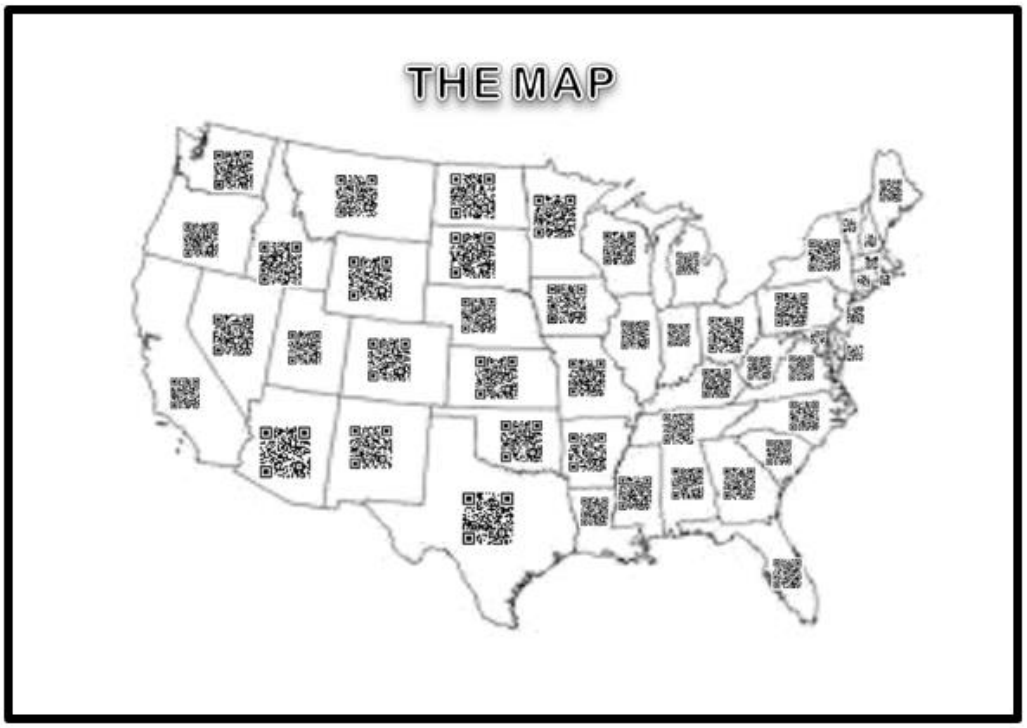

Figure 6. QR Codes in Geography

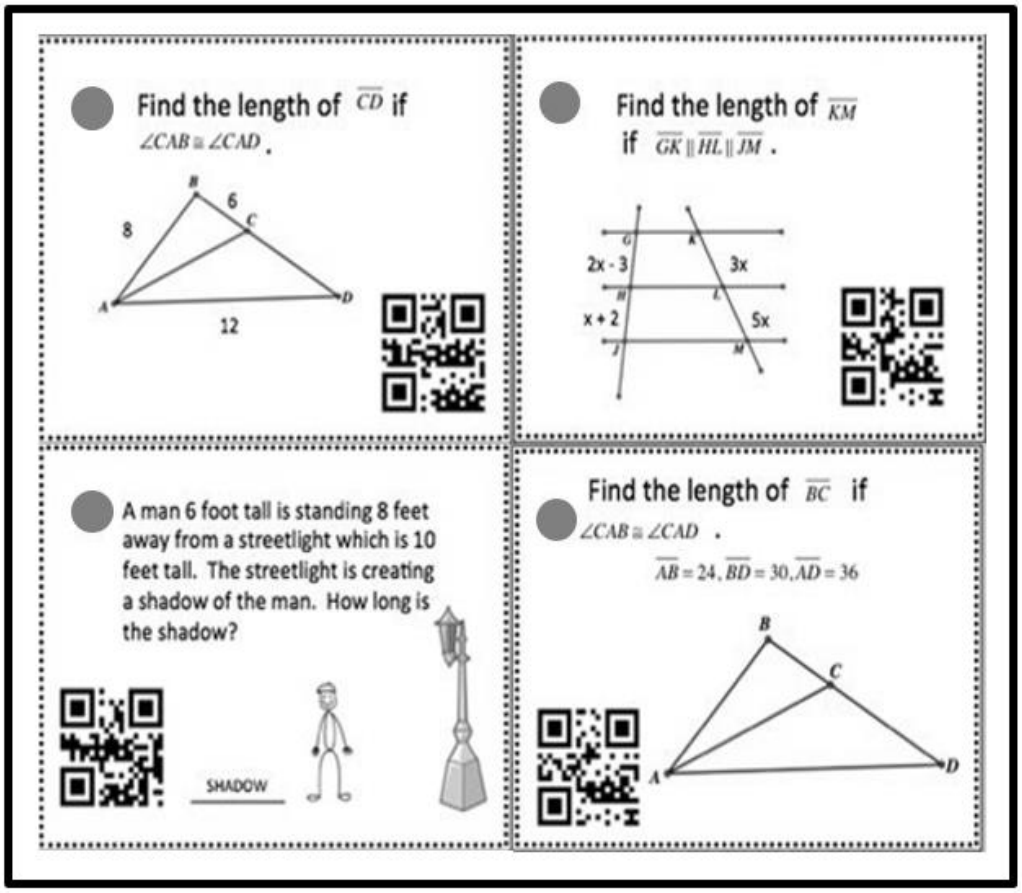

Figure 7. QR Codes in Mathematics

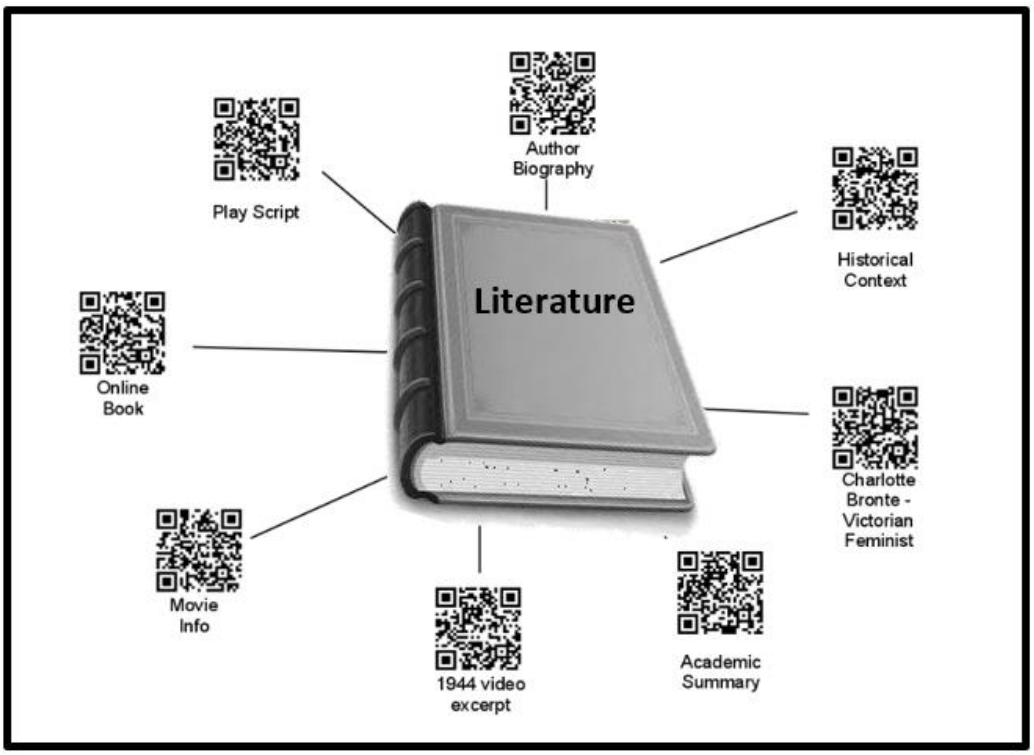

Figure 8. QR Codes in Literature

Furthermore, these codes may link the students to online articles, books, or videos regarding the topic. This would further entice them to learn. To add more fun, the teacher may link the students to a simple online game regarding the subject of study. Another useful learning and assessment link would be an online quiz that the teacher has made or adapted.

4.2 Adding QR Codes in Handouts, Worksheets, Assignments and Assessments

The teachers can also add QR codes in the printed learning materials and assignments that will be given to the students. The teacher must select the online learning materials well; it should be well-reviewed before it is distributed. The websites must be double-checked and will be assessed whether it is appropriate for the age of the students. Since these materials are taken home by the students, they will be enticed to study well at their homes. To add a sense of surprise, QR codes may also be used in the distribution of preliminary grades and comments of the teacher.

4.3 Scavenger Hunt with QR Codes

One of the most enjoyable outdoor activities is the scavenger hunt. The teacher may prepare a list defining specific items, which the students will seek to gather all items on the list or perform tasks or take photographs of the items, as specified [26]. This would be another great chance to test what the student has learned in your lessons. The teacher can inject problem-solving activities into this game. To do this, a QR code with a password can be utilized. The password would be the answer to the problem that was put in a station. Each QR code may lead to the exact location of another QR code as long as the student correctly answers the problem. If in case a student could not answer the problem or question, there must be another nearby QR code that would give hints to the problem or directly to the location of another QR code.

5. Conclusion and Future Works

QR codes' ability to store a big amount of data, became a great help as an educational technology tool. Though these are just simple things, their potential usage in u-Learning may change the mood and attitude of learners toward getting new knowledge. This can be applied to any subject in the school. Because of the fact that students have different likes, dislikes, and attitudes, it is not expected that all of them can be motivated, but apparently, the majority of the students can find this QR code application enjoyable and full of learning. In the future, u-Learning activities integrated with QR codes that implores the four C's in education (*i.e.*, critical thinking, collaboration, creativity, and communication) will be designed.

References

[1] Denso Wave, "*What is QR code?*", www.qrcode.com/en/about/ (Accessed June 28, 2018).

[2] Denso Wave, "*QR code development story*", www.denso-wave.com/en/technology/vol1.html (Accessed June 28, 2018).

[3] Cognex, "*1D Linear Barcodes*", www.cognex.com/resources/symbologies/1-d-linear-barcodes (Accessed June 28, 2018).

[4] Mobile QR Codes, "*History of QR Codes*", www.mobile-qr-codes.org/history-of-qr-codes.html (Accessed June 28, 2018).

[5] Denso Wave, "*History of QR Code*", www.qrcode.com/en/history/ (Accessed June 28, 2018).

[6] Denso ADC, "*QR Code Essentials*", www.delivr.com/resources/files/1058/DENSO_ADC_QR_Code_White_Paper.pdf (Accessed June 28, 2018).

[7] R. Gross, "*Psychology: The Science of Mind and Behaviour*", 6th Edition, United Kingdom, Hachette UK, 2010, ISBN: 978-1-4441-6436-7.

[8] "*What is Learning?*", igi-global.com, www.igi-global.com/dictionary/an-overview-of-learning-and-teaching-from-the-past-to-the-present/16813 (Accessed July 20, 2018).

[9] V. Jones and J. H. Jo, (2004). "*Ubiquitous learning environment: An adaptive teaching system using ubiquitous technology*", In *Beyond the comfort zone*, Proceedings of the 21st ASCILITE Conference, R. Atkinson, C. McBeath, D. Jonas-Dwyer, R. Phillips, Eds., Perth, December 5-8, 2004, pp.468-474.

[10] H. J. Kim, R. D. Caytiles, T. H. Kim, "*Design of an Effective WSN-Based Interactive u-Learning Model*", International Journal of Distributed Sensor Networks, vol. 8, no. 1, 2012, doi: 10.1155/2012/514836.

[11] S. Yahya, E. A. Ahmad, K. A. Jalil, "*The definition and characteristics of ubiquitous learning: A discussion*", International Journal of Education and Development using Information and Communication Technology (IJEDICT), vol. 6, no. 1, 2010, pp.117-127.

[12] "*What is Connectivism*", igi-global.com, www.igi-global.com/dictionary/ensuring-quality/5367 (Accessed July 20, 2018).

[13] S. Downes, "*Connectivism and Connective Knowledge: Essays on meaning and learning networks*", National Research Council Canada, 2012, ISBN: 978-1-105-77846-9.

[14] G. Siemens, "*Connectivism: A Learning Theory for the Digital Age*", International Journal of Instructional Technology and Distance Learning, 2004, www.itdl.org/journal/jan_05/article01.htm (Accessed July 20, 2018).

[15] Educause, "*7 Things you should know about QR codes*", www.worklearnmobile.org/files/2013/05/ELI70461.pdf (Accessed July 20, 2018).

[16] S. So, "*Beyond the simple codes: QR codes in Education*", In *Changing Demands, Changing Directions*, Proceedings of the Ascilite 2011, G. Williams, P. Statham, N. Brown, and B. Cleland, Eds., Wrest Point, Hobart, Tasmania, Australia, December 4-7, 2011, pp. 1157-1161.

[17] P. Cauley, "*QR Codes and education*", www.itbabble.com/2011/09/03/qr-codes-and-education/ (Accessed July 20, 2018).

[18] J. Rikala and M. Kankaanranta, "*Blending Classroom Teaching and Learning with QR Codes*", 10th International Conference on Mobile Learning, Madrid, Spain, February 28-March 2, 2014 https://files.eric.ed.gov/fulltext/ED557237.pdf (Accessed July 20, 2018).

[19] Honeycomb, "*10 creative ways to use the mighty QR code*", www.honeycombagency.com.au/10-creative-ways-to-use-the-mighty-qr-code/ (Accessed July 20, 2018).

[20] U. B. Ceipidor, C. M. Medaglia, A. Perrone, M. De Marsico, G. Di Romano. "*A museum mobile game for children using QR-codes*", In Proceedings of the 8th International Conference on Interaction Design and Children (IDC '09), Association for Computing Machinery, New York, NY, USA, pp. 282–283, doi: 10.1145/1551788.1551857.

[21] QR Code Generator, "*How Teachers Are Using QR Codes in the Classroom to Enhance Learning*", www.qr-code-generator.com/blog/qr-codes-in-the-classroom/ (Accessed July 20, 2018).

[22] Classroom Aid, "*Periodic Table of the Elements with QR Codes*", www.classroomaid.wordpress.com/ 2012/09/30/periodic-table-of-the-elements-with-qr-codes/, (Accessed July 20, 2018).

[23] M. Diazgranados and V. A. Funk, "*Utility of QR codes in biological collections*", PhytoKeys, vol. 25, 2013, pp. 21–34, doi: 10.3897/phytokeys.25.5175.

[24] J. Moreno-Vera and M. I. Vera-Muñoz, "*The Use of QR-Learning for Field Working in Geography Education. A Didactic Experience*", Didáctica Geográfica, no. 18, 2017, pp. 299-306.

[25] Math Techniques and Strategies, "*Math QR Codes*", www.new-to-teaching.blogspot.com/p/math-qr-codes.html (Accessed July 20, 2018).

[26] D. Wise, "*Great big book of children's games: over 450 indoor and outdoor games for kids, ages 3-14*", McGraw-Hill Professional, (2003), pp. 158.