# QR Cache: Connecting mLearning practice with theory

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**ABSTRACT**
Qatar presents a unique opportunity to explore potential mLearning applications in a theoretical context. The geographically small country in the Arabian Gulf has nearly ubiquitous mobile and wireless network coverage. The penetration of devices such as smartphones is also incredibly high, including amongst students. And those students have expressed an overwhelming desire to integrate their mobile devices into their learning. With its virtual absence of infrastructural barriers, Qatar offers the potential to focus research on how mobile technologies can fulfill the promise of increasing student engagement by creating novel situated learning experiences. QR Cache was developed to provide an exemplar of mobile reusable learning objects (RLOs). In the pilot phase, RLOs accessed by scanning Quick Response (QR) codes were developed to teach English computer terminology. Feedback was solicited from participating students and instructors to demonstrate the desirability of using such RLOs in combination with learners' own mobile devices. The study also draws upon *Transactional Distance Theory* (TDT) (Moore, 1989, 1991) and Koole's (2009) FRAME model to provide theoretical grounding for both RLO and instructional design decisions. Early results show increased engagement, and reduced transactional distance. They also indicate that the RLOs show a strong convergence of the activity types delineated by the FRAME model.

**Author Keywords**
FRAME, mobile learning, Qatar, QR Codes, reusable learning objects, situated learning, Transactional Distance Theory,

**INTRODUCTION**
The QR Cache project was developed as a response to stakeholder needs at College of the North Atlantic-Qatar (CNA-Q) and in the State of Qatar. Learners have expressed a desire to see more integration of their own mobile devices (Warraich & Dahlstrom, 2012). CNA-Q has expressed a desire to promote blended learning (CNA-Q, 2011). Employers have expressed a desire to deliver just-in-time, situated learning for both technical and workplace English training. The current infrastructural context allows research to focus on pedagogical elements, as opposed to technical barriers (MacLeod, 2011; Metodieava, 2012; Nagy, 2012; Warraich & Dahlstrom, 2012). The QR Cache project uses a Design-Based Research (DBR) approach to explore the iterative development of mobile RLOs to meet stakeholder needs. TDT (Moore, 1989, 1991) and Koole's (2009) FRAME model are used to guide the RLO design process, and to evaluate their pedagogical effectiveness.

The first phase involved the development of a set of mobile RLOs to be used by English Foreign Language (EFL) students enrolled in CNA-Q's Technical Preparatory Program (TPP). The RLOs were accessed by scanning Quick Response (QR) codes, and were used to learn English computer hardware terminology. Participants have shown a positive response to the situated strategy. It is hoped that future iterations will lead to increased adoption of mobile RLOs by college instructors and in the Qatari workplace, as well as to the development of a comprehensive mLearning strategy at CNA-Q. It is also hoped that future iterations will lead to an increased understanding of how mobile RLOs can improve student engagement and learning by reducing transactional distance and increasing activity between students, content, their peers, and technology itself. Lessons learned from this, and future iterations of the QR Cache project will be used to help develop a practical mobile RLO design checklist, grounded in applicable learning theory, that can guide instructors in the development of effective mLearning activities and resources.

**RESEARCH QUESTIONS**
The specific research questions explored in the first phase of the QR Cache project are:

1. How do learners respond to the use of mobile RLOs, accessed by scanning QR codes, to learn English computer terminology and concepts?
    a. Do learners experience any difficulties when accessing the RLOs?
    b. Do learners enjoy using such mobile RLOs?
    c. Would learners like to use such RLOs more often?
2. Does the integration of the mobile RLOs, accessed by scanning QR codes, reflect the principles and benefits of effective mLearning design?

a. Do the RLOs help to reduce transactional distance between learners and content, learners and other learners, or learners and teachers (Moore, 1989, 1991)?

b. Do the RLOs create optimal interaction between individuals, technology, and social elements, as outlined by the FRAME model (Koole, 2009)?

## LITERATURE REVIEW

The QR Cache research project is grounded by work that has contributed to an understanding of how learners interact in technology-mediated learning situations (Moore, 1989, 1991), how multimedia elements impact teaching and learning (Clark, 1994a, 1994b; Hastings & Tracey, 2005; Joy & Garcia, 2000; Kozma, 1994a, 1994b), and what should be considered when designing effective mLearning experiences (Bradley et al., 2009; Elias, 2010; Fitzgerald, 2012; Koole, 2009; Naismith & Smith, 2009; Traxler & Wishart, 2011). These works have shaped an understanding of what an effective mLearning RLO should look like.

Moore's *Transactional Distance Theory* (TDT) (1989, 1991) has been central in much of distance education and mLearning research. TDT views learning as an attempt to reduce physical and mental distance between the learner and the instructor, the content, and other learners. Koole's FRAME model (2009) builds upon TDT, as well as Vygotsky's *zone of proximal development*, in an mLearning context (p. 37). It presents a framework for designing and evaluating mLearning by maximizing key elements, and by reducing the gap between "what the learner is currently able to do and what she could potentially do with assistance from more advanced peers (p. 37)". The reduction of transactional distance through situated learning is a central aim of the QR Cache research project. Koole's FRAME model is used to examine how effectively the RLOs create such a learning scenario (p. 41).

In light of understandings of TDT and media effectiveness, recent work has focused on providing practical advice for instructional design using mobile technology (Beddall-Hill, 2011; Bradley et al., 2009; Elias, 2010; Fitzgerald, 2012; Koole, 2009; Naismith & Smith, 2009; Traxler & Wishart, 2011). Koole's FRAME model (2009) illustrates how learners, social interaction, and mobile technologies intersect to create optimal mLearning scenarios. Elias (2010) and Traxler and Wishart (2011) provide checklists for the effective design of mLearning. Bradley et al. (2009) and Naismith and Smith (2009) provide case studies of how mLearning RLOs should be designed to meet the needs of specific groups of learners. Similarly, Fitzgerald (2012) explores standards for creating mLearning applications with effective interaction and the production of meaningful RLOs. These works provided the bases for the development of the RLOs for the QR Cache project, and are used to provide theoretical grounding in the analysis of the effectiveness of the mobile RLOs.

## METHODOLOGY

### RLO Design Methodology

The QR Cache project involved the development of a set of mobile RLOs for use in a specific course. Each RLO is designed to be completed in less than five minutes. Students use an app on their own devices to scan QR codes mounted on computer devices. This redirects their mobiles to the online RLOs (Educause, 2009; Ramsden, 2008). The RLOs use a linear progression strategy (Bradley et al., 2009), and contain a combination of graphics and text (to provide pronunciation guidance, and brief functional descriptions of the related computer hardware component(s)). At the end of each RLO, students can access a survey designed to "Test Your Knowledge" of the topic. The surveys are incorporated to provide formative feedback, and to spark discussion amongst students and their instructors.

### Research Methodology

For the first phase, the mobile RLOs were used to replace workbook-based learning for a computer hardware components unit in the TPP Introduction to Computers course. A primer lesson was integrated to teach students about QR codes, and provide them with an opportunity to explore the QR code scanning capabilities of their mobile devices. When necessary, instructors and students worked together to locate and install QR code scanning applications. The next two class sessions were used to explore samples of computer hardware components to which QR codes had been mounted. Students were responsible for learning the English terminology and basic functions of the devices.

Upon completion of the in-class activities, participating students were invited to complete on online questionnaire about their learning experiences using the QR codes and their own mobile devices. The questionnaires consisted of a combination of fixed and open-response items (Cohen et al., 2011, p.382) covering such themes as ease of access, the look and feel of the RLOs, levels of interaction with their peers and instructor, and overall impressions. A similar questionnaire was prepared for participating instructors to provide feedback on the learning activities and RLO designs. Responses to fixed and open-response questionnaire items were coded to reflect the research issues (p. 559-563). These were analyzed for the identification of major themes related to student and instructor perceptions, and evidence of effects upon transactional distance and the types of activities that form the domains of the FRAME model.

## RESULTS

A total of seven students and two instructors completed questionnaires during the first phase. Responses to demographic questions about mobile device ownership were consistent with previously reported figures for CNA-Q, Education City,

and the State of Qatar (MacLeod, 2011; Metodieava, 2012; Nagy, 2012; Warraich & Dahlstrom, 2012). All of the students owned smartphones. Four students reported owning two devices, and one student reported owning three (or more). Only two students had a QR code scanning app installed on their devices prior to the study. The remaining respondents were able to download a free app without any reported difficulty. Four students had previously scanned QR codes to access websites, while only one reported previously accessing text-based content, and one reported previously using a QR code to automatically dial a phone number.

All of the students indicated that scanning the QR codes was either easy or very easy and that the RLOs loaded quickly on their devices. Only one student reported that an RLO did not load properly. All of the students responded that it was easy to view the text and images, and the RLOs were easy to navigate. Six students indicated that it was either easy or moderately easy to understand the content, and to complete the "Test Your Knowledge" feedback questions at the end of each RLO. One student indicated that the RLOs contained too much information, and that the "Test Your Knowledge" activities were difficult to complete.

With respect to interaction with technology, content, peers and instructors, six out of seven student respondents indicated that they shared their mobile devices with another classmate while participating in the RLO activities. Five students and both teachers indicated that they discussed the mobile RLOs during the class activities, and four students indicated that they engaged in discussions of the "Test Your Knowledge" activities. All seven students indicated that they viewed the RLOs more than once, and five indicated that they showed the RLOs to friends outside of the class.

Students and teachers generally indicated that they found the use of the RLOs, and their own mobile devices, appealing. Five of the seven students responded that they found these types of learning activities appealing, while one reported a neutral opinion, and one indicated that they found it somewhat unappealing. Only two of the seven students reported having ever used a mobile device for formal learning before, but all of the respondents indicated that they would like to do so again either at school or while on the job. When asked what they liked about using QR code scanners and their own mobile devices to access RLOs, students commented on the speed and ease of accessing the learning materials. As one student commented, "it's very easy to scan and find the page that you want."

## DISCUSSION

The results of the first iteration of the QR Cache project show trends in mobile device ownership and the desire to use mobile devices in formal and informal learning similar to those previously reported in Qatar (MacLeod, 2011; Metodieava, 2012; Nagy, 2012; Warraich & Dahlstrom, 2012). Students and teachers reported enjoying learning with their mobile devices, and found the RLOs easy to access and use. Students indicated that they would like to use their mobile devices for learning more often. These results provide a degree of justification to pursue further investigations into integrating mLearning strategies at CNA-Q. But a stronger justification can be provided by grounding these findings in learning theories that explain how the mobile RLO approach creates an effective learning experience.

TDT (Moore, 1989, 1991) and the FRAME model (Koole, 2009) provide useful and complimentary lenses for examining the effectiveness of the QR Cache RLOs. Student and teacher responses show a reduction in transactional distance between learners and the content. The content is easy to access and re-access, and it is situated so that it is easier for learners to contextualize the topics. Learner-learner and learner-teacher transactional distance also appear to have been reduced. Data indicate that students interacted with each other and their instructors while participating in the learning activities. The results also indicate that the RLOs generated appropriate activity across the domains of the FRAME model. Student and teacher survey responses indicate a high degree of device usability. They also show that learners are actively engaged in social interaction during the learning activities, and that the use of their mobile devices facilitated that interaction by creating a shared situated learning experience, and by generating both formal and informal social discussion. Beyond creating an enjoyable and easily accessible learning experience, TDT and the FRAME model illustrate how the use of the mobile RLOs positively affect the learning that is taking place.

There are limitations which must be considered when interpreting the findings of this research (Cohen et al., 2011). The online questionnaire was the only method of soliciting feedback used in the first phase. The survey schedule would benefit from an in-depth piloting and refinement phase. The addition of either one-on-one or focus group interviews would provide further opportunity to solicit qualitative feedback, and to triangulate the findings with respect to learner perceptions (pp. 382, 412-417). Data on student achievement on two standardized assessment instruments was collected during the first phase, for comparison with a control class of learners who did not use the mobile RLOs. While all learners demonstrated mastery of the required competencies, the sample size was too small to obtain confidence in the results of statistical analyses of the achievement data (p. 144). The refinement of the online questionnaire and development of interview scripts could be carried out before the implementation of a second DBR phase. A second DBR iteration of the QR Cache project would greatly benefit from their integration, as well as from the statistical analysis of standardized assessment results across a larger sample of the student population.

## CONCLUSIONS

While the first phase of the QR Cache project was a small-scale pilot of the mobile RLOs designed for the TPP MC-105 Hardware Components unit, the results do hold promise for future research and understanding of the effectiveness of

situated mLearning approaches. Future iterations of the DBR project are needed to verify the findings with larger samples, and to provide further RLO exemplars for instructors at CNA-Q. Further research is also needed to more deeply explore the ability of such RLOs to reduce levels of transactional distance, and to create an optimal convergence of learner, device and social interaction activities. Such research holds promise for moving beyond merely exploring the utility of mLearning strategies, and moving into their justification through connection to established learning theory.

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