Motivating Learners in Massive Open Online Courses: A Design-based Research Approach

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Abstract

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Motivating Learners in Massive Open Online Courses: A Design-based Research Approach

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There has been a growing interest among educators and researchers in studying Massive Open Online Courses (MOOCs) and their impact on education. Issues and problems have been reported in the research and in practice, including problems related to MOOC learners’ motivation and engagement during the course. However, very few studies have adopted a design-based research (DBR) approach based on educational theories or instructional design models to solve these problems. These approaches would provide practical guidance to educators and designers, and would then contribute to refining the theories or models. The present study aimed to contribute to better understanding of MOOC learners’ motivation for the course and their engagement in the course as well as how MOOCs can be better designed to promote learners’ motivation.

The study implemented motivational strategies from the ARCS (Attention, Relevance, Confidence, and Satisfaction) motivational design model in a MOOC. The study also aimed to explore learners’ motivation and their engagement and learners’ perceptions of the motivational design strategies in the course. Furthermore, it intended to provide practical implications in increasing learners' motivation in MOOC design and enhancing the understanding of the ARCS model in MOOCs.
The study first presented the motivational design results and then systematically integrated ARCS motivational design strategies into MOOC instructional design. Then MOOC learners’ reactions, in terms of the four components of ARCS in regards to the whole course design, were explored preliminarily by the Instructional Materials Motivation Survey (IMMS), which was designed specifically for the ARCS model. Learners’ perceptions of the ARCS motivational design strategies were examined in more depth through online/phone interviews. The researcher also kept a design journal documenting the design process and feedback about the course design. Based on implementation of the first iteration, modifications of the ARCS motivational design strategies were implemented and applied to the second iteration.

The findings indicated that MOOC learners enrolled in courses for a variety of reasons. Potential fun and enjoyment from the courses was an important factor. The results revealed that many MOOC learners selectively paid attention to information that was closely related to their goals for the courses and ignored the other information. Relevance of MOOCs was self-decided to a large extent for many learners. Although many MOOC learners in this study were confident that they were able to achieve their goals, the instructor’s encouragement and sympathy for the learners in videos were effective in increasing their confidence. Learners’ satisfaction could come from different aspects. For example, some learners were proud because they were able to complete a course successfully; some felt achieved for the knowledge they gained from the course. Although obtaining the statement of accomplishment (SOA) was not the goal for all learners in the study, the SOA did contribute to the sense of satisfaction. Videos and
instructors were critical components that they affected learners’ experience in MOOCs greatly. A large number of learners participated in this study were self-regulated and used many study strategies to help learning. Based on these results, implications for designing motivational strategies from the ARCS model were provided for MOOC environments.
Dedication

This dissertation is dedicated to:

My parents, who always love me and support me no matter what.
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Chapter 1: Introduction

The Massive Open Online Course (MOOC) has been a popular topic recently, which has led to a great deal of interest and research (Breslow et al., 2013; Daniel, 2012; Martin, 2012; Q. Yang, 2014). In the title Massive Open Online Course, ‘massive’ refers to the large number of students that are able to enroll in online courses compared to the relatively small number of students in traditional classrooms. ‘Open’ means that the course is not restricted to users within a school or organization like a university course or a corporate private training session. ‘Online’ means that the course is organized or distributed on the web. ‘Course’ indicates that instead of simply uploading all materials online, a MOOC has certain topic coverage, some structure and organization, one or more instructors, and students participating in course activities. Pappano (2012) referred to the year of 2012 as “The Year of the MOOC” (title) indicating the prevalence of this phenomenon in The New York Times.

Because they are based on two different pedagogical frameworks, MOOCs are classified as either cMOOCs or xMOOCs. On the one hand, the ‘c’ in cMOOCs stands for connectivism, which is the theory that learning happens under the circumstances of connections with other people or other course components (Siemens, 2005). On the other hand, the ‘x’ in xMOOCs stands for extended, which stems more from the perspective of behaviorism, the study of behaviors (Daniel, 2012). In addition, cMOOCs and xMOOCs usually utilize different tools (Rodriguez, 2012). cMOOCs mainly utilize Web 2.0 tools to connect student to student, and student to materials. For example, one of the earliest cMOOCs is The Connectivism and Connective Knowledge course taught by Stephen
Downes and George Siemens in 2008 (https://sites.google.com/site/themoocguide/3-cck08---the-distributed-course). In the course, the students used different Web 2.0 tools online to connect with each other and to complete the coursework. Connectivism, however, has been critiqued as insufficient to contribute new ideas to learning theories (Clarà & Barberà, 2013). On the contrary, xMOOCs have been considered to be based on a more solid theoretical framework. They usually involve more structure and organization and provide more comprehensive learning experiences than cMOOCs (O’Toole, 2013).

xMOOCs are further defined in the next paragraph.

xMOOCs have received great attention for they are “more traditional, content based, and more closely resemble traditional educational models” (El-Hmoudova, 2014, p. 30). xMOOCs have grown rapidly with several different organizations emerging and partnering with elite universities around the world to create open learning opportunities. Several large xMOOC providers include the US-based Coursera, Edx, Udacity, the British-based FutureLearn, and the Australian-based OpenLearning. Through July 9, 2014, there were 691 courses with 8,429,897 learners in the Coursera community (https://www.coursera.org/). xMOOCs basically include a series of instructional videos explaining or demonstrating topics, auto-graded assignments with deadlines, peer review assignments, programming assignments, and/or exams. Currently, most xMOOCs are based on a weekly schedule, that is, materials are released and completed week by week. Students obtain a statement of accomplishment based on pre-defined criteria of the assignments and/or projects. An example of an xMOOC is Andrew Ng’s Machine Learning, shown in Figure 1, offered on Coursera (https://www.coursera.org/course/ml),
which is also one of the early xMOOCs. In the course, instructional videos are released on a weekly basis with machine-graded weekly exercises and programming exercises based on the course’s content. A discussion forum is built inside the course where students can interact with each other by asking and answering questions and by discussing course content in-depth. This paper will use MOOCs referring specifically to the mode of xMOOCs, as many news and other media already have done (Kay, Reimann, Diebold, & Kummerfeld, 2013).

![Machine Learning MOOC offered on Coursera.](Image)

Researchers have been examining MOOC students’ demographics, students’ motivation, predictions of students’ performance based on their behaviors in the course, MOOCs assessment methods, and design principles for MOOCs, etc. Early researchers focused on who MOOC audiences were and found a huge amount of diversity of MOOC students. They argued that a major challenge for MOOC instructors and course
development teams was the extent of student diversity (Breslow et al., 2013). Masters (2011) advocated that traditional assessment should not be used as ways to measure students’ achievement; instead, students’ own goals and objectives differed, so students should assess their own success in MOOCs.

Advanced statistical models have been built to predict students’ behaviors and performances in MOOCs based on student-generated data recorded by MOOCs’ systems. Research found that students’ background predicted their performances in MOOCs (Breslow et al., 2013). Others found that students’ interactions with peers in the course influenced their persistence (D. Yang, Sinha, Adamson, & Rosé, 2013). It was possible to predict students’ motivation and whether a student was at risk of dropping the course based on what they wrote on the course discussion forum using linguistic analysis (Wen, Yang, & Rosé, 2014). Peer assessment and discussion forums have shown to be effective assessments and effective communication methods for students to get feedback in order to compensate for the ratio of one instructor to many thousands of students (Creed-Dikeogu & Clark, 2013; Glance, Forsey, & Riley, 2013; Kop, 2011; Pappano, 2012; Suen, 2014).

MOOC pedagogy has received attention and the instructional design principles that are specific to MOOCs have raised interest among education researchers. Pappano (2012) and Suen (2014) both mentioned that because of the massive enrollment in MOOCs, course design should be carefully considered to ensure that there are interactions with peers and with the instructor(s). Teaching presence, which is a feeling that the instructor is available and willing to help, influences students’ perceptions of the
course greatly (Kop, Fournier, & Mak, 2011). Yousef, Chatti, Schroeder, and Wosnitza (2014) surveyed MOOC learners and providers to examine their perceived importance of some course design principles. Although their results showed that compared to learning analytics and assessment design, MOOC instructional design was considered less important by these learners and MOOC providers, not enough studies have validated the finding. Potential reasons that MOOC learners and providers think instructional design is less important include that instructional design in MOOCs is less explored than learning analytics and assessment design (Yousef et al., 2014).

To be more specific, Guàrdia, Maina, and Sangrà (2013) presented concrete design principles for MOOCs from learners’ perspectives. These ten design principles included the following ideas. They argued that MOOCs should apply a learner-centered approach and encourage learners to actively participate in the course to meet their goals. Learners should also be provided with detailed plans for the course, such as course schedules, course activities, assignments, deadlines, and grading policy, and so on. Various technologies should be used in the course to promote learners’ engagement. MOOC students should be encouraged to collaborate in the form of small groups based on interest, and to support and learn from each other. In this collaborative process, social networking tools could be used to enhance communication. Although several of these principles have already been well-explored and nicely established as instructional design theories in non-MOOC education, the authors did take the diversity of massive enrolled students in MOOCs into consideration when describing these principles (Guàrdia et al., 2013).
Problem Statement

Signing up for a MOOC takes only one or two mouse clicks, but learning from MOOCs requires learners to be autonomous as well as have good learning habits and time management skills. Potentially due to these features, a drastic decrease in learners’ activities always occurs in the course over time (Breslow et al., 2013; El-Hmoudova, 2014; Ramesh, Goldwasser, Huang, Daume III, & Getoor, 2014; Q. Yang, 2014). This is also believed to be true in most distance courses (Keller, 2010). One extreme disengagement situation is that some learners register for MOOCs and do not even enter the course when it opens. Normally, one signs up for a MOOC for a variety of reasons, such as interest in the topic, fondness of the instructor or the university, or skill-related advantages to school or work. Something has to attract the learner to sign up for the specific course among the thousands of other courses. However, continuing with the course for weeks or even months is more complicated and time-consuming. As a result, designing materials and activities to keep learners engaged and persisting in the courses that they have signed up for is a problem for practitioners working with MOOCs.

In the field of online education, researchers have noticed and explored the relatively higher dropout rates and increased challenges for students to persist in online courses than in face-to-face courses. In a literature review of online education and dropout rates, the authors categorized reasons for drop-out students: student characteristics, course/program design, and environmental factors (Y. Lee & Choi, 2011). Student characteristics refer to students’ background, previous academic achievement, experience related to the course content, skills dealing with time and task conflicts, and
psychological characters such as motivation. Course/program design is about how well the course or program is organized to meet students’ needs, to support students, and to encourage students’ interactions with each other. Environmental factors include students’ work outside of the MOOC, students’ other responsibilities, and emotional support from family and friends. In learning environments that have open enrollment and no prior student selection criteria, students are always have greatly varying characteristics (Y. Lee & Choi, 2011). Since MOOC is one of such environments that anyone in the world can sign up for easily and some courses have over 10,000 students, diagnosing students’ characteristics before the course is harder to accomplish than in traditional online courses. Controlling environmental factors is extremely difficult and cumbersome. Furthermore, the authors advocate that course/program design should be emphasized when creating the MOOCs to encourage students to persist in such courses (Y. Lee & Choi, 2011). Thus, course design should be used as the main intervention to encourage students’ long-term involvement in the course rather than trying to diagnose individual students’ needs and performances or to control the environmental factors (Y. Lee & Choi, 2011).

**Purpose of Research**

The purposes of this study are to (a) develop strategies that increase students’ motivation in a MOOC based on the ARCS motivational design model; (b) explore MOOC learners’ initial motivation for enrolling in the course and monitor their motivation changes during the course; (c) obtain students’ perceptions of these strategies in the course for strategy improvement; (d) incorporate the MOOC environment into the
motivational design literature; and (e) investigate the theoretical and practical implication of integrating the ARCS model into MOOC environments. Based on the purposes, this study adopted a design-based research approach with qualitative data collection methods.

**Research Questions**

There are three research questions in this study:

1. What are MOOC learners’ initial motivations for enrolling in a course?
2. How do learners perceive the ARCS motivational strategies that are used in the courses?
   2a. Are there differences in learners’ motivation in terms of the ARCS model through the IMMS between the two MOOC courses?
3. What are MOOC learners’ perceptions of and experiences in the courses?

**Significance of Study**

Instructional design and technology (IDT) has been criticized by researchers from other fields for its ineffective research design, disconnection with practice, and insignificant impact to science (Reeves, 2000, 2006). Design-based research (DBR) may improve the current IDT research condition because:

…the overarching, explicit concern in design-based research for using methods that link processes of enactment to outcomes has power to generate knowledge that directly applies to educational practice. The value of attending to context is not simply that it produces a better understanding of an intervention, but also that it can lead to improved theoretical accounts of teaching and learning (The Design-Based Research Collective, 2003, p. 7).
Some IDT researchers propose that current studies should adopt a design-based research approach more frequently in order to improve the disappointing research status in IDT and to make greater contributions to the field (Reeves, 2000; Walker, 2006). DBR researchers in IDT advocate an increase adoption of design-based research that contributes to both theory and practice (Herrington, McKenney, Reeves, & Oliver, 2007; McKenney & Reeves, 2012; Richey, Klein, & Nelson, 2004).

Increased numbers and rapid development of MOOCs have led to a renewed interest in researching them. Taking advantage of the fact that MOOCs can generate a large amount of data, some researchers focus on statistics, computer science and machine learning perspectives to build statistical models to study analytics in the course. More educational researchers are starting to conduct research in MOOC settings to explore the characteristics of MOOCs, how learners learn in MOOCs, and how to improve the current MOOC design in order to facilitate learning. As discussed in the background section, some researchers have already recognized the importance of examining instructional design issues and applying instructional design theories in MOOC environments. Researchers argue instructional design in MOOCs may be different than in traditional educational environments, but the importance of MOOCs’ instructional design is not less than that of other course formats (Kop et al., 2011; Pappano, 2012; Suen, 2014). Other studies focus on the specific instructional design principles that are applicable to the MOOC environment (Guàrdia et al., 2013; Yousef et al., 2014). The problem is that MOOCs are frequently critiqued for the high dropout rates and low engagement, which should raise educators’ concerns. Researching learners’ motivation
and how to increase their motivation in MOOCs should begin to explain to the problem in more depth.

Despite the fact that several articles (Guàrdia et al., 2013; Suen, 2014; Yousef et al., 2014) show that there has been an increasing interest in exploring instructional design in MOOCs, few studies have applied and refined instructional theories or models in the MOOC environment. Also, little effort has been put into exploring the high dropout rates and low engagement issues in MOOCs or implementing potential solutions systematically. Taking DBR approach in this project, I implemented pre-designed ARCS motivational strategies and assessed students’ perceptions of those strategies in a MOOC.

The study presented in this dissertation contributes to the literature on both integrating ARCS model into real educational settings and on designing to increase students’ motivation. The ARCS model is widely used in a variety of contexts with audiences of different cultures in a diverse subject areas (Keller, 2010). The contexts include both distance learning and face-to-face learning as well as varying from K-12 classrooms (Feng & Tuan, 2005; Song & Keller, 2001; Y. Yang & Chin, 1996) to college classes (Frymier & Shulman, 1995; Hung, Chao, Lee, & Chen, 2013; Means, Jonassen, & Dwyer, 1997; Moller & Russell, 1994) to corporate or other organizational adult employee training (Visser & Keller, 1990). Applying the ARCS model into MOOCs will further add to the model in this unique learning environment, which has probably the most diversified audience group with the most varied goals and dynamic motivation. Furthermore, whether some innovative ideas can be added to the ARCS model, inspired by MOOC teaching and learning paradigm, will be determined by the study results.
Besides the contributions to theory, this study will also contextualize the ARCS model and provide practical guidance on its implementation in the MOOC environment. DBR itself has the potential of providing concrete practical guidance to educators and practitioners based on empirical study results (Reeves, 2006; The Design-Based Research Collective, 2003; Wang & Hannafin, 2005). Interviewing is an important method in qualitative research since it can reveal things that are impossible or harder to obtain by observing; it can also provide an opportunity for participants to express their opinions and perspectives about a phenomenon or experiences of being involved in a program or environment (Glesne, 2011; Patton, 2002). The presented dissertation research provided implications to motivational strategies that can be integrated into MOOCs through exploring MOOC learners’ motivation and educators and practitioners can also acquire information related to decision-making in the process of designing motivational strategies and integrating them into a real course using a systematic method.

**Limitations/Delimitations**

One limitation of this study is that both the survey and interview data were self-reported. Although self-reported data can be subjective and biased, it is able to reveal participants’ feelings and attitudes that are difficult to obtain by other methods. Another limitation is that being a non-native English speaker, the author may encounter more difficulties conducting the interviews. The author asked native English speakers to check all the interview questions to eliminate any confusion before the interviews to make sure that the questions were all well-stated.
Only two MOOCs were selected as research sites based on my access to courses and time frame to conduct research because of convenience of access. Students enrolling in other subject areas may have different goals and motivations in the courses, leading to different perceptions of the motivational strategies. Because the study did not use random sampling strategies and the participants were in these two courses, the findings are not meant to be generalized to other participants in other MOOCs. However, some researchers claim that it is more of the readers’ responsibility to determine the relevance of research to specific settings based on the rich descriptions in the study than the researchers’ responsibility to identify all applicable settings (Firestone, 1993; Lincoln & Guba, 1985). Thus, rich descriptions of research settings, participants, the researcher(s), research design, and data collection procedures are provided in Chapter 3.

**Definition of Key Terms**

*ARCS model:* ARCS stands for Attention, Relevance, Confidence, and Satisfaction. It is a systematic motivational design model to enhance learners’ motivation proposed and refined by (Keller, 1979, 1983, 1987a).

*DBR:* DBR (Design-based Research) generally starts with a difficult problem in educational settings. Then the researchers review relevant literature and propose a potential solution to the problem. The solution is designed to be incorporated into real educational settings by the researchers and educational practitioners, who then evaluate the effects of the solution under the educational setting. The whole process, called one iteration in DBR, is documented in detail by the researchers for future reference. Changes
are made based on the data the researchers collected during the whole iteration process and more iterations are conducted based on the revised solution.

**MOOC:** MOOC stands for Massive Open Online Course. It refers to a kind of online course that is free for everyone to enroll and usually has a large number of registered students.

**Motivation:** Motivation is defined as “…the study of why people think and behave as they do” (Graham & Weiner, 1996, p. 63). Keller also defines motivation as “the magnitude and direction of behavior” (Keller, 1983, p. 389). In learning, students’ motivation can determine their choices of time spent on tasks, effort put into learning, and attitude toward learning (Keller, 2006).

**Motivational design:** Keller defines motivational design as “the process of arranging resources and procedures to bring about changes in motivation” (Keller, 2006, p. 3). The ARCS model is the systematic motivational design model he established.

**Chapter Summary**

This chapter introduced the background, research topic, and research questions. The next chapter reviews literature on motivation, motivational design, ARCS model and its applications, Massive Open Online Course, Instructional design, and design-based research (DBR). The third chapter describes the research method, including the DBR process, research setting, research instrument, data collection procedures, data analysis method, researcher and practitioner, and strategies used to ensure research rigor. Chapter 4 describes the motivational design process and products in each step. Chapter 5 presents
the findings of the study. Chapter 6 discusses the results and interprets the meanings. It also concludes the entire study and recommendations for future studies.
Chapter 2: Literature Review

This chapter reviews theoretical frameworks and publications related to this study starting from the concept and its development of instructional design, the approach of design-based research, to the three major concepts relevant to the research: motivation, motivational design, and Massive Open Online Course (MOOC).

Motivation

Motivation was defined as “…the study of why people think and behave as they do” (Graham & Weiner, 1996, p. 63). Graham and Weiner (1996) further categorized motivation into “the choice of behavior”, “the latency of behavior”, “the intensity of behavior”, “the persistence of behavior”, and “the cognitions and emotional reactions accompanying the behavior” (p. 63). Motivation can be used to explain why people choose to do certain things and how much effort they put into doing them (Bandura, 1994; Graham & Weiner, 1996; Keller, 2010, p. 71). People with motivation toward certain things will be active in doing these things while those who are not motivated will act passively in performing tasks (Ryan & Deci, 2000). Motivation is such a complex issue in that it is dynamic and there are no widely accepted rules to predict it (Keller, 2010). Different people have motivation toward different things. Even for the same person toward the same thing, motivation is not constant in different situations or at different times (Hartnett, St. George, & Dron, 2011; Ryan & Deci, 2000).

Motivation and learning. Motivation is critical in education. Small and Gluck (1994) asserted that students’ motivation was essential and as important as their learning abilities and their learning achievements. Prensky (2002) claimed that motivation was so
important in learning because “learning requires effort” (p. 5). Motivation explains students’ effort and time spent on learning challenging tasks especially under the condition of voluntary learning (Lei, 2010). When learners’ motivation is inspired, they show curiosity into the learning topic, immerse themselves into the learning tasks and conduct activities that will make them learn better (Hodges, 2004; Wlodkowski, 2008). It is assumed that students with higher achievement will be more likely to have continuing motivation in the future (Hodges, 2004). Students’ motivation and their learning outcome, usually measured by test scores, were found positively correlated (Busato, Prins, Elshout, & Hamaker, 2000; Liu, Bridgeman, & Adler, 2012; Sankaran & Bui, 2001; Waschull, 2005). Learners lack of motivation can lead to not engaging in learning activities and poor performance (Dumont, Istance, & Benavides, 2010; Starcher & Proffitt, 2011). By interviewing college seniors about their academic motivation, Van Etten, Pressley, McInerney, and Liem (2008) reported that senior students’ internal motivators included their willingness to graduate and to obtain high GPA, their locus of control beliefs, and success expectations, etc., while external motivators included course/program design, instructor characteristics, and college environment, etc.

Students’ lack of motivation, however, has been a problem in identifying learning by researchers and educational practitioners. Students entering elementary school have a decreased intrinsic motivation on learning than their infant and toddler time (Cordova & Lepper, 1996). Starcher and Proffitt (2011) analyzed that students’ lack of motivation may be one reason that they did not complete assigned text readings for classes. Science and engineering graduate students in Taiwan who showed dissatisfaction with their
graduate life were found to have low motivation in what they were studying (Lin, 2012). Nguyen, Jang, and Yang (2010) claimed that non-English major English as a foreign language (EFL) learners had much lower level of motivation in learning English compared with English major EFL learners.

To deal with the problem of low motivation in learning, various methods have been implemented into the learning process to improve motivation. Instructional design and materials and activities quality are found to be more important than students’ time on task (Artino, 2010). There are studies focusing on using certain communication techniques to increase students. For example, Hancock (2002) discovered that graduate students who received verbal praise from their course professor concerning assignments showed higher motivation to learn and devoted more time on learning tasks than their peers who did not receive verbal praise. Learning materials can be designed in a way that can promote motivation. Gao and Lehman (2003) found that students received interactive instructional materials in an online lesson perceived themselves with higher learning motivation than those who received non-interactive materials. Lee and Boling (1999) asserted that in interactive multimedia, certain designs could increase learners’ motivation. By providing choices to students and personalized learning contexts, Cordova and Lepper (1996) reported improved intrinsic motivation and better learning involvement.

Motivation in distance education. Due to the uniqueness of online learning, learners’ motivation becomes a well-investigated issue in the online learning environment. In a literature review, Bekele (2010) found that most studies being
reviewed have reported Internet-supported learning environment (ISLE) is itself a motivator to learners; and ISLE also supports learners’ satisfaction. Moore and Kearsley (2011) considered learners’ motivation as a very important factor that was related to learners’ success in distance education. Studies find that learners enrolled in online courses show stronger intrinsic motivation than their peers enrolled in traditional courses (Rovai, Ponton, Wighting, & Baker, 2007; Wighting, Liu, & Rovai, 2008). Motivation is significantly related to learners’ online course achievement (Klein, Noe, & Wang, 2006; Shih, Gamon, & Emeritus, 2001). Interestingly, Martens, Gulikers, and Bastiaens (2004) found that learners with higher intrinsic motivation did not achieve higher than their peers who had lower intrinsic motivation. Instead, students with higher intrinsic motivation show more exploratory learning behaviors than their peers. Learners show higher motivation are able to confront obstacles and to adjust their own emotional status better and more easily (Bird & Morgan, 2003). Hartnett et al. (2011) found that online learners reported both learners’ intrinsic motivation and extrinsic motivation, so designing instruction to promote extrinsic motivation is necessary in online learning. A study conducted by Clayton, Blumberg, and Auld (2010) revealed that students who preferred different educational environments – traditional courses and online courses had different motivational components. Students who chose traditional courses believed that the format suited their learning style better and thus they were willing to spend more time and put more effort into learning; whereas students who preferred online format were more confident that they could deal with the online learning.
Several indicators, according to research studies, affect students’ motivation. The literature review on Internet-supported learning describes that external as well as internal factors affect learners’ motivation in Internet-supported learning environment (ISLE) (Bekele, 2010). External factors include the technologies in the course, the quality of the course/program design, and student support service, etc. Different strategies have to be used to judge and to promote learners’ motivation in online learning environments, which is different from face-to-face instruction, in which teachers can observe students’ reactions to judge their motivation or provide immediate verbal feedback or emotional support to those with low motivation (Frymier & Shulman, 1995; Meyer & Turner, 2006).

Completion and dropout rates have been examined widely in the literature of online learning environment; and motivation and its constructs are always identified as important factors to influencing online retention rate. Song (2000) states that “when learners do not have proper motivation to persist, they will drop the course or they will procrastinate” (Song, 2000, p. 227). Emotional support from faculty and friends and learners’ self-efficacy were important factors for students who persisted in distance learning (Holder, 2007; Kemp, 2002; Park & Choi, 2009). A literature review conducted by Hart (2012) revealed that learners’ motivation was one of the most important components that made them persist in online learning environments.

Merely admitting the importance of motivation in online learning environments or examining learners’ characteristics that make them success in online courses is not
enough; researchers and practitioners have explored methods to increase learners’ motivation in instructional design.

**Motivational Design**

Despite the divergent methods used to enhance motivation, motivational design, a systematic approach aimed at improving people’s motivation, has been studied and different models have emerged (Keller, 2010). Keller (2006) defined motivational design as “the process of arranging resources and procedures to bring about changes in motivation” (p. 3). Motivational design is “based on scientific literature on human motivation” and includes principles and rules to guide a longer systematic process (Keller, 2006, p. 3). Keller (2010) pointed out that motivational design was not isolated when used in designing instruction; instead, it should be integrated into instructional design models. Compared with the extrinsic rewards used commonly in education, the goal of motivational design is to make instruction appealing to learners and make learning match students’ interests and goals (Keller, 2010; Wlodkowski, 1978). Although motivational design theories or models usually involve comprehensive guidelines to handle different aspects of motivation, they all emphasize the importance of adapting to one’s own situation when applied these theories or models (Keller, 2010; Wlodkowski, 1978). The Motivation in distance education section has included motivation studies about students’ personal characteristics as well as how the course/program design can all affect their motivation. According to Keller (2006), motivational design primarily focuses on improving the motivational features of courses though some motivational design models try to include guidelines for how to promote SRL learning skills for learners.
**ARCS model.** The ARCS Model is the most widely used model in motivational design. It was first created by John Keller in the 1970s and modified in his following publications; it was then validated by following studies (Keller & Suzuki, 2004; Small & Gluck, 1994). The major theoretical foundation of the ARCS model is expectancy theory (Keller, 2010). ARCS stands for Attention, Relevance, Confidence, and Satisfaction. Attention means that designers need to draw learners’ attention, and more importantly, hold learners’ attention for some time during instruction. Relevance means learners should be well informed why they need to learn the content, how the content is related to the learners needs. Confidence, the third factor in ARCS model, is the degree learners believe they can success; and it can affect learners’ success during the learning process greatly. Satisfaction is the degree that learners feel achieved and satisfied with their learning results (Keller, 1983, 1987a). Motivational design process is similar to traditional instructional design processes and ARCS model should be used in conjunction with these instructional design models (Keller, 2010). Detailed steps of how to apply ARCS model in instructional design has been given in the book *Motivational Design for Learning and Performance: The ARCS Model Approach*.

The model begins by analyzing background information, which includes analyzing learning goals, audience, course descriptions and other general aspects of the learning environment. Afterwards, the model suggests an audience analysis, where weaknesses in any of the four ARCS components should be identified. This audience analysis helps to select the appropriate motivational strategies for each of the ARCS components in a later step. If the audience is rated as high in any of the four components,
then few or none of the strategies aimed at improving those components should be implemented. After audience analysis, existing learning materials and learning environments should be analyzed and revised for improvements in terms of the four components. Appropriate motivational strategies should then be chosen based on learning objectives and results from the previous steps of analysis. At this point, learning materials, learning environments, and instruction can be effectively designed and developed. After class instruction, formative evaluation should take place to assess the outcomes of the interventions.

A considerable amount of literature on the ARCS model’s applications in educational settings has been published (Huett, Moller, Young, Bray, & Huett, 2008; Kim & Keller, 2008; Means et al., 1997; Song & Keller, 2001; Visser & Keller, 1990). Some studies have found significant improvements in learning achievement and in learners’ motivation when applying ARCS model or ARCS-related motivational strategies in instruction (Chang & Lehman, 2002; Feng & Tuan, 2005; Huett, Kalinowski, Moller, & Huett, 2008; Huett, Moller, et al., 2008; Hung et al., 2013; Kim & Keller, 2008; Means et al., 1997; Song & Keller, 2001; Visser & Keller, 1990). Other studies have yielded results of the ARCS model obtained from investigating other aspects of the instruction, such as students’ positive attitudes toward or higher satisfaction of the ARCS-based instruction (ChanLin, 2009; Hodges & Kim, 2013; Liao & Wang, 2011). Although some studies did not find significant differences in learners’ motivation and learning achievement between learners in the ARCS group and the control group (Moller & Russell, 1994; Naime-diefenbach, 1991; Wu, Tsai, Yang, Huang, & Lin, 2011), the
researchers provided alternative explanations such as the course was elective so learners spent minimal efforts into the course. Researchers also advocated that the ARCS model be applied more in various subjects and learning methods, such as English as Second Language (ESL) (Zhang, 2015), nursing education (Gormley, Colella, & Shell, 2012), and pharmaceutical education (Wongwiwatthanankanik & Popovich, 2000).

**ARCS model application.** The ARCS motivational design model has been widely applied to multiple learning environments on different subjects. To deal with the overall motivational issues or certain components of the ARCS model, the whole model or one or two components in the model can be applied into instructional design process. The ARCS model has been used in different educational settings, from K-12 classes to higher education to adult professional development. The instructional format includes face-to-face classes, computer-assisted instruction, blended courses, and purely online learning environments. The interventions designed based on ARCS model can be in multiple forms or focus on a single technique, such as emails or personal messages (Huett, Kalinowski, et al., 2008; Huett, Moller, et al., 2008; Visser & Keller, 1990) and videos (Hodges & Kim, 2013). Differences in participants’ motivation and their learning achievement between treatment and control groups are compared the most often. Learners’ motivation is usually measured by the Instructional Materials Motivation Survey (IMMS) designed by Keller (1993). The Course Interest Survey (CIS) by Keller and Subhiyah (1993) was also used in some studies (Hodges & Kim, 2013; Huett, Kalinowski, et al., 2008). Exam or test scores are commonly used to measure learning achievement. Besides experimental or quasi-experimental design studies, some
researchers use case study to document the design process and examine the ARCS model’s effect (Damanhooori, Muton, Zakaria, & Mustaffa, 2012; Shellnut, Knowlton, & Savage, 1999; Visser & Keller, 1990). Attitudes and continuing motivation are also measured sometimes to determine other effects of the ARCS model (Hodges & Kim, 2013; Song & Keller, 2001).

Researchers and practitioners have applied the ARCS model into their teaching to examine its effect on learners’ motivation, attitudes, and learning achievement. ChanLin (2009) used the ARCS model as a framework to identify students’ motivational problems in an information technology lesson then designed a new lesson using the ARCS model at a university in Taiwan in order to deal with those problems. The author also found a positive relationship between students’ involvement in the lesson and their achievement. Feng and Tuan (2005) applied the ARCS model to an 11th grade science class in Taiwan. The study used a quasi-experimental design to measure students’ differences in achievement and motivation between the experimental and the control group. Results showed significant improvements in students’ achievement and motivation in the experimental ARCS model group compared to the control group that received no ARCS-enhanced instruction. Additionally, the experimental group demonstrated significant increases in students’ self-efficacy, students’ perceived value of learning science, and active learning strategy. Similarly, Wu et al. (2011) used a quasi-experimental approach to examine the differences in achievement and motivation between experimental and the control groups in an information technology course in a technical and vocational college in Taiwan. The experimental group received instructions that were developed based on
the ARCS model while the control group received non-ARCS instructions. Their results, however, demonstrated no difference in achievement or motivation between the groups, and no increase in these two measurements from the pre-test to post-test of the experimental group. The authors conducted a follow-up interview with students trying to identify the reasons for this lack of improvements. They speculated that the course was probably of low relevance to students because it was an elective course so students did not pay as much attention to learning the course, limiting the effects of the motivational strategies.

To account for the low personal relevance, Means et al. (1997) conducted a study in which they asked students enrolled in two different courses to study a lesson on the human heart. One was a statistics course, which had low relevance to the learning content (the human heart); whereas the other course was human physiology, which had high relevance to the learning content. Then half of the students were assigned to the treatment or the control groups in each course. The materials for the treatment group were designed using relevance strategies from the ARCS model, while the control group used materials that were not designed to incorporate relevance strategies. The results showed that students that had high internal relevance to the learning content had higher motivation and performance than those who with low internal relevance. The relevance strategies from the ARCS model were shown to be effective in increasing motivation and improving performance, especially for students with low internal relevance.

Studies also examined the effects of on utilizing specific techniques or tools, designed incorporating ARCS strategies. Hodges and Kim (2013) designed ARCS-
enhanced videos and implemented them into a blended college Math course in the U.S. They used a true experimental design approach to investigate the differences in learning achievement, attitudes toward Math, and course interest between the experimental and control groups. Results showed that the experimental group had higher positive attitudes toward Math but no difference in achievement or course interest. The authors suggested that in addition to the ARCS model, multimedia design principles should be integrated into the interventions to improve student learning. Hung et al. (2013) designed a robot teaching assistant that reads in English for undergraduate and graduate students in Taiwan. The study used a quasi-experimental design method as well as repeated measures for the experimental group to measure the differences in learning motivation, continuance intention and performance between the experimental and control groups and the variations of motivation at different stages within one group. The experimental group had higher learning motivation, continuance intention and performance at the end of the study. Examining within the experimental group also indicated that the experimental group’s learning motivation increased across the semester. Huett, Kalinowski, et al. (2008) used emails based on the ARCS model to find out differences in learners’ motivation and retention rates in a university in the U.S. The experimental group received emails designed from the ARCS model regularly while the control group received emails that did not contain motivational messages. Results showed significant higher overall motivation of the treatment group than the control. The experimental group also had a higher completion rate than the control group.
Instead of applying all four components in the ARCS model as a whole, some researchers apply only one or two components and design instruction aiming at increasing specific outcomes accordingly. For example, Moller & Russell (1994) attempted to influence the confidence component by integrating confidence-building strategies into a treatment group using a print-based instruction. They failed to find any differences in learners’ confidence or their achievement between the treatment and control groups. In another experimental study, Huett, Moller, et al. (2008) embedded certain ARCS confidence-building strategies emails and sent them to the treatment group to examine the differences in learners’ confidence and performance in a college computer application course. The study reported a significant difference in performance but failed to find a significant difference in learners’ confidence between the two groups. These studies show that if learners are low in part of the ARCS components, researchers can only apply the correspondent component into motivational design.

More complicated research design methods have been used to understand the ARCS motivational design. Chang and Lehman (2002) conducted a 2x2 factorial experimental design manipulating relevance and assessing initial intrinsic motivation (high or low) to explore the differences in achievement and motivation between students in an English as second language class. They reported significant main effects in achievement and motivation between students with higher intrinsic motivation and students with lower intrinsic motivation. Significant main effects in achievement and motivation were also found between students who received relevance-enhanced instructions and students who did not. No significant interaction was found between
intrinsic motivation and treatment. Students who had higher intrinsic motivation and had been assigned to the relevance-enhanced group scored the highest in achievement and motivation than students in the other groups. Additionally, Means et al. (1997) studied two kinds of relevance: intrinsic, which was perceived by students as valuable and meaningful and extrinsic, which referred to as the strategies embedded purposefully by the researchers into instructions. They examined the effects of extrinsic relevance on learners’ achievement and motivation. The results indicated that extrinsic relevance strategies were effective in promoting learners’ motivation and increasing their performance, especially for students who had lower perceived intrinsic relevance. Song and Keller (2001) designed a motivationally adaptive computer-assisted learning module for a biology course in a U.S. K-12 school. The researchers randomly assigned participants into three groups: motivationally adaptive learning module, non-adaptive but motivationally enhanced learning module, and a control group without using any motivational strategy. The results showed that students in the motivationally adaptive group had higher motivation and better performance than students in the other two groups after completing the learning module. Learners’ continuing motivation, on the other hand, was not significantly different among the three groups. These more complicated designs take other factors than the four ARCS components into consideration when designing motivational instructions. They can help with understanding the ARCS model more comprehensively and extending design options more creatively.

Besides these quantitative approaches used in ARCS application studies, there are also case studies, qualitative or design-based research (DBR) describing the design and
development processes. A case study conducted by Visser and Keller (1990) integrated the ARCS model into a professional development course and designs motivational messages for adult learners. They reported motivational messages being effective, and they also provided rich descriptions of the design, development and implementation processes as well as the research context for future researchers and practitioners to apply the ARCS model. Damanhoori et al. (2012) designed an e-mentoring system based on the ARCS model. They described the major motivating features in the system and the techniques that were used to develop the system. The next step of their approach is to employ evaluation methods to measure the effectiveness of the system in terms of users’ motivation. Gormley, Colella, and Shell (2012) discussed instructional strategies that could be used in online learning environments based on the ARCS model. By asking preservice teachers to explain what factors they considered to contribute to attention, relevance, confidence, and satisfaction in learning, Izmirli and Izmirli (2015) reported three common sub-themes that emerged from more than one components of the ARCS model: “relevance to individual differences, flexibility, and instant feedback” (p. 63). Relevance to individual difference referred to the fact that learners could choose how, where, and when to learn based on their own styles. Flexibility allowed learners to re-learn the concepts that they did not understand previously in online environments. Instant feedback was the timely feedback learners could get in online environments. Depending on the purposes of the research, DBR can be applied to describe the process of applying the ARCS model into real educational situations for future researchers and practitioners.
Motivation Measurement

Measurement of motivation is a difficult problem in motivational design (Keller, 2006). Behaviorally speaking, students who are motivated to learn choose challenging tasks freely, spend more time on learning, put more efforts in learning and performing tasks, and persist longer (Wolters, 2003). Direct measures of motivation include “time-on-task, intensity of effort, or latency of response” (Keller, 2006, p. 9). There are also instruments that are designed to measure motivation indirectly such as from psychological views. For example, one widely used instrument measuring learners’ motivation and their usage of self-regulated learning skills in learning is called the Motivated Strategies for Learning Questionnaire (MSLQ) (Pintrich, Smith, Garcia, & Mckeachie, 1993). The questionnaire is based on three psychological constructs: “expectancy, value, and affect” (Pintrich et al., 1993, p. 3), which refer to students’ beliefs about themselves, the meaning of a specific learning task to them, and their anxiety about taking exams respectively. It also measures students’ use of learning strategies, including “cognitive, metacognitive, and resource management” (Pintrich et al., 1993, p. 802). Cognitive skills include various strategies that one uses to process information in learning; metacognitive is to control one’s own cognitive processes; and resource management refers to controlling resources such as his/her own time. The MSLQ is most often used in studies of self-regulated learning.

As previously mentioned, two instruments have been used frequently in the ARCS model literature: the Course Interest Survey (CIS) (Keller & Subhiyah, 1993) and
the Instructional Materials Motivation Survey (IMMS) (Keller, 1993). These instruments share several similarities:

1. They both are designed to measure students’ motivation toward specific courses or trainings, not overall trait motivation.
2. They both measure motivation in terms of the four components of the ARCS model.
3. Each of the four constructs of A, R, C, and S in both instruments can be used independently.
4. Both instruments can be revised depending on the specific learning situations that are under examination.

The difference between the two instruments is that the CIS is more suitable in “instructor-led instruction” while the IMMS is “to measure reactions to self-directed instructional materials” (Keller, 2010, p. 277). One example of a typical instructor-led instruction situation is a face-to-face course with one or more instructors doing lectures most of the course time. One example of self-directed instruction is an iTunes University statistics course, in which learners choose the topics and paces to learn these topics. The courses in this project were MOOCs that provided flexibility to students so that they can regulate their own learning. The IMMS was selected as one instrument measuring motivation in terms of the four components in A, R, C and S in this dissertation study.

Self-regulated Learning

Self-regulated learners are often considered being aware of their own learning; being able to control their learning based on the goals they have set; reflect on their
learning progress and adapt any strategies to assist learning (Zimmerman, 1986). Self-regulated learning was defined as “an active, constructive process whereby learners set goals for their learning and then attempt to monitor, regulate, and control their cognition, motivation, and behavior, guided and constrained by their goals and the contextual features in the environment” (Pintrich, 2000, p. 453). Self-regulated learning does not necessarily happen to one learner all the time; instead, a learner can be self-regulated in one learning task but not in another (Pintrich, 1999; Zimmerman, 1986). Self-regulated learning models often “derive their constructs from an analysis and application of psychological models of cognition, motivation, and learning” (Pintrich, 2004, p. 388).

To further define self-regulated learning, Pintrich (1999) illustrated that self-regulated learners are able to use “cognitive learning strategies, self-regulatory strategies to control cognition, and resource management strategies” (p. 460). Cognitive learning strategies refer to strategies that can help learners’ academic performance, such as strategies to help understanding or memorizing. Self-regulatory strategies involve methods that assist learners’ own awareness of their cognition and the abilities to control their learning behaviors. Resource management strategies include strategies to optimize learning resources such as time and locations (Pintrich, 1999).

Within the self-regulated learning model, Pintrich (2004) developed the four-phase framework of self-regulated learning to better explain the step-by-step process of how learners may use self-regulation. Pintrich (2004) proposed that, first, self-regulated learners plan time and resources based on the goals they set for the specific learning tasks under certain circumstances. Second, they monitor their own cognition, motivation,
behaviors, contexts, learning tasks, and so on during the actual learning process. Third, based on these self-monitoring results, self-regulated learners make adaptations by using various cognitive and self-regulatory strategies for their own learning process and for the specific contexts. In the fourth phase, learners reflect on their learning process including their cognition, motivation, and behaviors.

Many scholars in addition to Pintrich considered motivation to be deeply embedded into self-regulated learning. Motivation is considered as deeply embedded into self-regulated learning. Learners’ goals, self-efficacy beliefs, and affections can all affect self-regulation (Schunk, 2005). Researchers have found that learners who have intrinsic goals (learning or mastery) for the learning tasks tended to use more self-regulated learning strategies (Kolić-Vehovec, Rončević, & Bajšanski, 2008; McWhaw & Abrami, 2001; Wolters, Yu, & Pintrich, 1996). Students who were also confident with their academic abilities (high self-efficacy perceptions) used more self-regulated learning strategies when learning (Zimmerman & Martinez-Pons, 1990). Pekrun, Goetz, Titz, and Perry (2002) found that students’ academic emotions were closely related to their self-regulated learning strategies and academic performances; therefore, they advocated that students’ emotions should be taken into consideration of when researchers and educators examined performance and self-regulated learning.

Massive Open Online Courses

First, MOOCs are introduced in detail in this section. Then some common issues, problems and critiques about MOOCs are discussed. Last, some new research topics that are associated with MOOCs are presented.
**Defining MOOCs.** Massive Open Online Course (MOOC) refers to the teaching method, which has thousands of students registered for free and course components are delivered via an online management system (Masters, 2011). Tschofen and Mackness (2012) defined MOOCs as “courses in that they provide a structured curriculum around a given theme or topic, but learners are expected to be autonomous and manage their own learning by making their own social and conceptual connections to suit their own needs” (p. 126). More specifically, except for the massiveness of learners, free and open access to course materials, Glance et al. (2013) and Butler (2012) stated that most MOOCs usually included short lecture videos with embedded questions, auto-graded quizzes, peer or self-assessment, and an online discussion forum; some had virtual office hours when instructors interacted with students using web conferencing tools. The MOOC is one stage of the distance education evolution (Masters, 2011; Rodriguez, 2012). Kop et al. (2011) examined MOOC from a connectivism point of view and stated that “MOOCs invite open online participation around a topic of interest and a schedule or agenda, facilitated by people with a reputation or expertise in the topic of discussion, relying on successful formations of learning networks to assist people studying the topics” (Kop et al., 2011, pp. 78–79).

Although MOOCs usually have typical components like videos and quizzes, their formats can vary largely depending on the course’s subject areas, the technologies, support teams, and/or instructor’s preferences of making the course. Instructional videos normally are picture-in-picture, that is, instructor’s talking head inside the slide. There are also other types of videos including chroma key (also referred as green screen) video,
panel discussion, expert interview, lab demonstration, software simulation, and outdoors shooting. The typical length of a MOOC video is eight to twelve minutes (Pappano, 2012). Students have full control of playing, pausing, and rewinding during video watching, which gives them more chances to investigate in the difficult parts of content more. Practice exercises, quizzes and exams are often machine-graded comparing students’ responses to pre-defined correct keys and providing a score after submission. Question types that are used often include multiple choice, short answer, and numeric answers. A discussion forum is used as one major method of communication in MOOCs. Students, teaching assistants, technical staff and the instructor interact with each other on a wide range of topics related or unrelated to the course content. In one research article, discussion forum is shown to be very efficient: “due to the high volume of students enrolled in the course, the median response time for a forum question was 22 minutes” (Glance et al., 2013, Online forums and video discussions section, para. 2).

MOOCs contain many unique characteristics due to their differences from traditional online courses. The number of registered students in a MOOC is usually very high and the population is quite diverse (Belanger & Thornton, 2013; Breslow et al., 2013). According to Kolowich (2013b), the median number in the courses that are surveyed in the study was 33,000. Varied student backgrounds, including location, age, highest degree earned, participation in class, experience with subject area, and reasons for selecting the course, is another uniqueness of MOOCs (Breslow et al., 2013). Universities who offer popular MOOCs reach a much larger population around the whole world than they ever could before (El-Hmoudova, 2014). Students who successfully complete most
MOOCs do not receive university credits (El-Hmoudova, 2014); instead, MOOC students usually receive a certificate signed by the course instructor indicating that they have completed the MOOC. Technology and content support always rely on very few staff members, so discussion forum is used as a medium for students to interact with peers and support each other (Glance et al., 2013; Kop et al., 2011; Pappano, 2012). Large diverse student populations can cause unpredictable situations but at the same time promote discussions and knowledge creation (Breslow et al., 2013; deWaard et al., 2011). The instructor’s role has evolved into a facilitator or even a learner because the instructor is constantly learning new things by becoming involved in students’ interactions (Kolowich, 2013b; Masters, 2011; Rodriguez, 2012). Daniel (2012) and El-Hmoudova (2014) pointed out that MOOCs could be a great environment to develop and test new pedagogies. El-Hmoudova (2014) advocated that it was important to consider learning styles when designing MOOCs due to the fact that there were a variety of students with different learning styles. Tschofen and Mackness (2012) pointed out that MOOCs provided great opportunities to understand diversity and to better support diversity in education.

**Issues and concerns.** Extremely low completion rate (10 % and less) (Daniel, 2012; El-Hmoudova, 2014; Kolowich, 2013b) is the most common critique in articles or reports on MOOCs (El-Hmoudova, 2014; Rodriguez, 2012); however, researchers have argued that it is too restricted to view MOOCs from just this one perspective. When signing up for MOOCs, different learners have different learning objectives and needs, so their levels of participation, their choices of time and effort commitment, and their
learning outcomes differ as well (Kop et al., 2011; Rodriguez, 2012). Some researchers disagree with the completion rate calculation by arguing that a large number of students signing up for a course do not have the intention to finish it nor to earn a completion certificate. Thus, it can provide inaccurate information by comparing completed student numbers with the total number of signed up students (Kolowich, 2013c; Rivard, 2013). Kizilcec, Piech, and Schneider (2013) classified MOOC students into four types by their amount of engagement: Completing, auditing, disengaging, and sampling. Completing students were those who attempted most parts of assessment from the beginning to the end; auditing students watched most of the videos and attempted some assessments; disengaging students tried beginning assessment but then disengaged most of the time; and sampling students watched some videos or browsed through some learning materials at the beginning or the end of a course. The study results found that completing learners and auditing learners almost had the same level of positive learning experience taking a MOOC. Thus, the researchers suggested auditing students needed to be supported together with completing students by course designs instead of leaving them out because they did not complete the course.

Instead of critiquing the low completion rate of MOOCs, some researchers have explored possible reasons, which prevent students from keeping up with their MOOCs. Since MOOCs are different from any university credit-based courses, it may not apply to consider the retention rate and achievement as researchers do in traditional courses (Breslow et al., 2013). Some reasons for disengagement are due to personal characteristics more such as bad learning habits and low self-efficacy; whereas other
reasons are more objective, like language barriers and no or limited access to technologies required in the course (Kop, 2011; Kop et al., 2011). Unlike students in traditional classrooms, MOOC students have to be autonomous on their own learning and be able to manage time well (Kop, 2011). Students who are not able to control their own learning or who are not ready for this autonomous learning environments may not be able to keep up (Kop, 2011; Mackness, Mak, & Williams, 2010).

MOOCs also raise concerns on several other important issues. Suen (2014) discussed several obstacles that current MOOCs had, most of which were due to the massive number of student enrollment, including but were not limited to lack of informative one-to-one feedback from the instructor to individual student both on assignments and discussion forum, auto-graded multiple choice assignments’ inability to show students’ mastery in learning, and unconcern of international students who were different in language and culture in peer assessment. The discussion forum has the problems of having not many participations and having large amount of low quality posts (Creed-Dikeogu & Clark, 2013; Glance et al., 2013). Butler (2012) and Chen (2014) pointed out the copyright and legal usage of resources in MOOCs as well as the ownership of course content problem. The authors suggested research libraries get involved in MOOC production concerning library materials and resources. However, it is a challenging task for librarians, even experienced ones, because the uniqueness and specialty of MOOCs often leads to difficulties in applying general copyright law (Creed-Dikeogu & Clark, 2013). There have been discussions about how MOOCs can survive within current higher education especially they have to compete with other learning
management system providers, with publishers, and with each other (Kolowich, 2013a). Some researchers and educators are concerned that the quality of MOOCs and also the lack of guidance for novice learners for most MOOCs require students to be self-directed (Chen, 2014; Hew & Cheung, 2014; Mazoue, 2014). Some researchers pointed out the issue that MOOCs should be designed to incorporate interactive pieces during learning to compensate for the lack of face-to-face interaction (Creed-Dikeogu & Clark, 2013; Decker, 2014; Mazoue, 2014; Schmidt & McCormick, 2013; Suen, 2014).

**New educational and research aspects.** Despite of the concerns and critiques, MOOCs have revealed new opportunities of teaching, learning, and researching. In 2014, President Obama stated that Coursera offers professional development courses to teachers across the country (Coursera Blog, 2014). Dellarocas and Van Alstyne (2013) pointed out there are a variety of models that MOOCs can be useful for the society and also to make a profit for the MOOC providers, such as providing students’ learning analytics to approve the qualification to employers and making large corporations as sponsors for mutual benefits, to name a few. Researchers are interested in knowing the impact of offering MOOCs on university’s residential students’ learning (Breslow et al., 2013; Daniel, 2012; Martin, 2012). Because of the widely used peer assessed writing assignment in MOOCs, a number of studies have focused on peer assessment with diverse student groups. Researchers in education, computer science, and statistics collaborate closely to examine the massive data generated by the large amount of students in the courses by building models and algorithms to understand students’ behaviors in the course and the relationships among behaviors, achievement, persistence and so on (Breslow et al., 2013;
DeBoer, Stump, Seaton, & Breslow, 2013; Kizilcec et al., 2013; Wen et al., 2014; D. Yang et al., 2013). MOOCs offer a great opportunity to study pedagogy, so new pedagogy is demanded to be explored by educators (Daniel, 2012).

In response to the critique of the lack of interaction in MOOCs due to large number of students, researchers have attempted to prove the pedagogical value of discussion forum and peer-assessed assignments in MOOCs. With massive data generated from two MOOCs, it was found that although few students participated in MOOC discussion forum, discussion is shown to be valuable to those who participated in enhancing learning and understanding (Comer, Clark, & Canelas, 2014). Some MOOC providers have incorporated peer assessments as part of their platform features to increase peer support and interaction (Kay et al., 2013; Yuan & Powell, 2013). Although Kulkarni et al. (2013) reported a significantly correlated result of peer grades with staff grades, computer scientists and statisticians have been trying to create models that can increase peer assessments’ grading accuracy (Diez, Luaces, Alonso-Betanzos, Troncoso, & Bahamonde, 2013; Kizilcec et al., 2013; Kulkarni et al., 2013).

There are other studies examining MOOC students’ motivation of signing up for certain MOOCs. It is pointed out that “in a MOOC, assessment does not drive learning; learners’ own goals drive learning” (Masters, 2011, Be prepared to forgo set goals and objectives that “must be met” section, para. 1). When given only one option among the many options on initial motivation for taking the edX’s Circuits and Electronics course, over half respondents reported that they took the course to gain knowledge and skills (DeBoer et al., 2013). Duke University provided multiple options for students on their
motivations for enrolling in Duke’s first MOOC on Coursera: Bioelectricity. The most often selected motivation is “general interest in the topic”, followed by “extending current knowledge of the topic” (Belanger & Thornton, 2013, p. 10). Breslow et al. (2013) did not find a relationship between students’ motivations of enrolling in edX’s Circuits and Electronics course and their learning achievement, which was measured by grades earned, in the course. Students’ perceptions of the course value and their participation in the course may change during different times of the course if the course design makes them feel not excited but bored at some point (Q. Yang, 2014).

**Instructional Design**

Instructional design (ID) aims to “make learning more efficient and effective and to make learning less difficult” (Morrison, Ross, & Kemp, 2006, p. 2). Reigeluth (1983) defined ID as a “linking science – a body of knowledge that prescribes instructional actions to optimize desired instructional outcomes, such as achievement and affect” (p. 5). Learning theory/theories explain(s) the predictions that an instructional design theory provides, that is, why certain instructional outcomes occur under certain circumstances (Merrill, 2007). Branch and Merrill (2012) defined ID as “a system of procedures for developing education and training curricula in a consistent and reliable fashion” (p. 8). Dick, Carey, and Carey (2001) explained that every element of instructional design should be integrated and interacted during the design process, and they suggested that the term instructional design should be used as an “umbrella term that includes all the phases of the ISD process” (p. 4). Instructional design to teaching and learning is like blueprint to buildings for they both provide models that will later be developed or constructed in
real settings (Reigeluth, 1983). Compared to other theories, instructional design theory is prescriptive in nature rather than descriptive (Landa, 1983; Reigeluth, 1983). The systematic instructional design procedures originated during World War II, although visual media had been used in education for several decades before (Reiser, 2012). Multiple schools of learning theories and various newly emerged technologies have assisted the development of instructional design and technology. Based on learning theories, systems theory, and philosophical perspectives, different instructional design models were developed, most of which include analysis, design, development, implementation, and evaluation (ADDIE) (Branch & Merrill, 2012).

While the field of Instructional Design and Technology (IDT) is expanding rapidly, other things related to IDT grow as well, including some characteristics of the field itself, its work environments, and requirements for people who work in IDT, etc. Early IDT focused on using video and audio techniques in instruction; then systematic procedures of designing instruction emerged; then with computers, computer supported learning became a piece of hot topic; the Internet also influenced IDT greatly over the past decades (Reiser, 2012). During World War II, ID was widely used in the military. More and more other fields such as higher education, industry, and K-12 education began to embrace ID afterwards. Currently, multiple work settings have instructional designer or similar job titles to conduct ID work. Reiser and Dempsey (2012) have a whole section discussing issues of IDT in various settings, including business and industry (Tracey & Morrison, 2012), military education (Bratton-Jeffery & Jeffery, 2012), health care
education (Locatis, 2012), P-12 education (Lowther & Ross, 2012), and higher education in other nations other than the U.S. (Nemoto & Ross, 2012).

**Chapter Summary**

This chapter began by reviewing motivation in learning and describing motivational design model. Then MOOCs and relevant studies in MOOC environments were introduced. Lastly, the big picture of instructional design and design-based research was presented. The next chapter will present research method.
Chapter 3: Method

This study aims to understand learners’ goals, objectives and behaviors of taking a Massive Open Online Course (MOOC), as well as to explore how to design and implement motivational strategies based on the ARCS model by examining learners’ perceptions of these strategies in the course. To answer the research questions, a design-based research approach using multiple data collection methods was applied.

Design-based Research

Design experiment was first named by Brown (1992) and Collins (1992); then it has been developed and named differently, such as design research (Collins, Joseph, & Bielaczyc, 2004; Reeves, Herrington, & Oliver, 2005), design-based research (Anderson & Shattuck, 2012; Barab & Squire, 2004; Joseph, 2004; Kelly, 2004; The Design-Based Research Collective, 2003) and developmental research (Akker, 1999; Richey et al., 2004). Developmental research studies specific instructional design steps and impact, or the entire instructional design process while it is being implemented, or specific instructional design components during the process. Developmental research is classified into two types: Type I and Type II research. Type I research refers to the “study of specific product or program design, development and/or evaluation projects” while Type II research focuses on the “study of design, development, or evaluation process, tools, or models” (Richey et al., 2004, p. 41).

Design-based research, design studies, and developmental research usually refer to similar methodology, so Anderson and Shattuck (2012), as well as Wang and Hannafin (2005) use the common term design-based research (DBR) to refer to this type of
research. Throughout this dissertation, I use design-based research (DBR) to refer to this research approach. In the Wang and Hannafin (2005) article, DBR was defined as a "systematic but flexible methodology aimed to improve educational practices through iterative analysis, design, development, and implementation, based on collaboration among researchers and practitioners in real-world settings, and leading to contextually-sensitive design principles and theories" (pp. 6–7). Ma and Harmon (2009) advocated for educational researchers to adopt DBR to generate “design theories or knowledge, which provide detailed guidance on choosing and implementing instructional methods under specific situations” (p. 76).

One way to distinguish DBR from other studies is that design-based studies should “produce an artifact” (Kelly, 2004, p. 116) that other researchers can revise and use in other studies. Instead of natural educational settings, design studies use design products as the research context. Design in this setting refers to “intervention” instead of research design (Sandoval, 2004, p. 213), and design researchers study the interventions in real learning situations (Joseph, 2004). DBR is common in learning science and the instructional design field (Barab & Squire, 2004; Reeves et al., 2005; Richey et al., 2004; Wang & Hannafin, 2005). It not only seeks practical solutions to significant education problems, but DBR also produces knowledge that can be used by other researchers (Cobb, Confrey, Lehrer, & Schauble, 2003; Reeves et al., 2005; The Design-Based Research Collective, 2003; Wang & Hannafin, 2005). DBR does not simply emphasize a single product but also focuses on theory and the relationship between theory and practice (Barab & Squire, 2004; The Design-Based Research Collective, 2003). Design
research is iterative and adaptable to the results of every implementation and to changes from circumstances such as audience input and researcher’s reflections (Cobb et al., 2003; Edelson, 2002; Kelly, 2004; Reeves, 2000; Reeves et al., 2005; Shavelson, Phillips, Towne, & Feuer, 2003). Because of the multiple iterations, DBR usually lasts for a relatively long period of time compared to other research types such as experimental research and mixed method research (Reeves, 2000).

There are several differences between DBR and other research approaches. Unlike traditional experimental design, DBR always involves participants in the decision making process (Collins et al., 2004). DBR can be time-consuming and resource-consuming because learning is considered to be a relatively complex phenomenon (Barab & Squire, 2004; Brown, 1992; The Design-Based Research Collective, 2003). DBR should provide "rich descriptions of context, guiding and emerging theory, design features of the intervention, and the impact of these features on participation and learning" (Barab & Squire, 2004, p. 8). Instead of trying to seek the differences when one variable changes while others are kept constant, design-based researchers need to deal with multiple variables in a more complicated environment; they should focus on asking the questions of how well certain theories, models or interventions work under certain circumstances and how to refine them in order to work better (Wang & Hannafin, 2005). Multiple data collection and analysis methods are always used, including interviews, surveys, observations, design journals, documents and transcript analysis, etc. (Brown, 1992; Collins et al., 2004; Hoadley, 2004; Joseph, 2004; Richey et al., 2004; Wang & Hannafin, 2005).
To conduct DBR, the researchers need to begin with identifying and analyzing literature related to the research problem (Wang & Hannafin, 2005). Researchers can apply an existing theoretical framework or initiate a new one into their research (Wang & Hannafin, 2005). Various research methods can be applied in design-based research (Akker, 1999; Anderson & Shattuck, 2012; Richey et al., 2004; The Design-Based Research Collective, 2003; Wang & Hannafin, 2005). Edelson (2002) pointed out that the theory used as guidelines in DBR was not detailed enough for every decision, so researchers had to make a significant amount of decisions in the design process to prepare for challenges, solve design problems, and balance limitations and opportunities. Therefore, qualitative documentation is always used in DBR (Wang & Hannafin, 2005). In education, whatever method is used in design-based research should lead to practical knowledge in education (The Design-Based Research Collective, 2003). Kelly (2004) suggested DBR use appropriate methods during different design stages and for different research goals.

Although the definition and characteristics of DBR are similar to those of action research, researchers have noted the differences between the two types of research approaches. Anderson and Shattuck (2012) claimed that unlike action research, which was usually conducted by the teacher alone, DBR involved the researcher, the practitioner, and research participants. DBR is considered to have the potential to contribute to both theory and practice, while action research does not emphasize the combination of the two areas of contribution (Reeves et al., 2005). Similarly, Amiel and Reeves (2008) argued that action research lacked the capability of developing theory; on
the contrary, DBR aimed at both solving practical problems and contributing to refining theory. This study focuses on both solving a real problem and contributing to theory, so the study adopted DBR instead of action research approach.

Like other research methodologies, there are advantages and disadvantages of conducting DBR. Reeves (2000) advocated that more instructional technology researchers become involved in development research because it will add value to education field, but he admitted that it will be a difficult transition “because it requires fundamental changes in our epistemology and our mental models of the research process” (p. 12). Real world educational settings are more complex than experimental labs (Collins et al., 2004). Generalizability is one issue since DBR is usually carried out in one specific educational setting (Barab & Squire, 2004; Collins et al., 2004; The Design-Based Research Collective, 2003). Given the context-specific issue, Wang and Hannafin (2005) claimed that the validity and generalizability of research increased when DBR was conducted and verified in various settings; and theories and knowledge could be revised or generated more legitimately. Compared to other educational research approaches, DBR generates more data, both quantitative and qualitative, which can make data collection and analysis challenging (Collins et al., 2004). Wang and Hannafin (2005) listed challenges that DBR encounters, including:

1. It needs rigorous methodology as research guidelines.

2. Because of the limitations of DBR methods, it is sometimes not preferable in educational settings.
3. Evaluation methods vary so there should be new requirements in the research process.

4. Due to limited time and resources, very little data can be analyzed and reported (Wang & Hannafin, 2005).

Despite the fact that DBR is not yet a mature field, it has several benefits for the fields of IDT and general education. DBR helps educational practitioners to better understand decision-making in the design process; DBR usually contributes to innovative educational interventions; and DBR can help further develop and refine educational theory from practical applications (McKenney & Reeves, 2012). Based on the disappointing results of educational technology research for decades, IDT researchers encourage more researchers to adopt DBR in their research (Reeves, 2000, 2006).

Study Design

Since MOOC learners’ engagement level decreases over time (Jiang, Warschauer, Williams, ODowd, & Schenke, 2014; Onah, Sinclair, & Boyatt, 2014), the current research first sought to understand MOOC learners’ original goals and motivations for enrolling. It implemented pre-designed strategies for increasing learners’ motivation as an instructional intervention. At the end of the course, learners’ perceptions of those motivational strategies were explored through surveys and interviews to determine how motivational strategies could be better integrated into MOOCs.

The research fit well with a design-based research (DBR) paradigm. Starting with a practical educational problem, a potential solution was designed based on existing literature related to the problem. Then the potential solution was applied in a real
educational setting and later was evaluated qualitatively for future improvements and for theoretical and practical development (Cobb et al., 2003; Reeves, 2000; Reeves et al., 2005; The Design-Based Research Collective, 2003; Wang & Hannafin, 2005).

This study used the four-step procedure (Figure 2) proposed by Reeves (2000) on how to conduct design-based research in the field of instructional technology. Permission to reuse this graph is attached in Appendix A. The research started with the practical problem of decreased engagement in MOOCs. The relevant literature was then reviewed to examine the issue in more depth. After reviewing the literature, strategies for increasing learners’ motivation based on the ARCS model were developed and implemented in a MOOC. The MOOC learners’ perceptions on the entire course and these motivational strategies were examined for future improvements. The whole process was documented in detail and reflected upon. Then the revised strategies were implemented in another MOOC as a new iteration based on the data, documentation, and reflection of the previous iteration.

![Figure 2. Design-based Research in IT Field. Recreated with Permission from Reeves (2000), p. 9. (Personal Communication with Dr. Thomas Reeves on Dec. 2, 2014)](image)

The following sections present the four DBR steps that were applied in the present study.
Step One: Analysis of the Real World Problem

The real world educational problem in this research is the decreasing engagement over time of MOOC learners. In non-MOOC online learning environments, researchers conducting empirical research and literature reviews have considered learners’ motivation as one of the major factors affecting such students’ commitment to studying (Bird & Morgan, 2003; Hart, 2012; Y. Lee & Choi, 2011). Motivational design researchers have been attempting to improve retention rates in online courses by designing interventions to increase learners’ motivation (Huett, Kalinowski, et al., 2008; Keller & Suzuki, 2004).

Review of the literature. After identifying this real world educational problem, the next step is to review relevant literature to better understand the problem and related concepts as well as to investigate how other studies have treated the problem. Motivation - a complicated and multifaceted concept - has been studied extensively in psychology, education and many other fields. To some extent, motivation explains why people choose to do certain things, how they approach doing them, and how much time and effort they choose to put into them. In education, learners’ motivations have been explored as an important factor affecting academic performance, attitudes toward learning, time and effort put into learning, active learning behaviors in and out of class, retention, and continuing motivation. In a literature review on factors influencing drop-out rates, the researchers reveal that poor course design is one important factor in students' decision to drop a course (Y. Lee & Choi, 2011). Motivational researchers believe that by incorporating motivational interventions into the course design process, students’
motivation can increase. One of the most widely used motivational design models is the ARCS model designed by Keller (1983, 1987a, & 1987c).

The ARCS model proposes that instructional materials and instruction should engage and sustain learners’ attention, make connections between the content to be learned and other areas of study or everyday life, increase learners’ confidence in learning, and promote greater satisfaction with learning (Keller, 1983). Applications of the ARCS model are widely reported in various subject areas and in different countries. These studies have shown positive effects of applying the ARCS model in courses or partial components of a course, like the email function, in students’ motivation, attitudes and/or performances (ChanLin, 2009; Feng & Tuan, 2005; Hodges & Kim, 2013; Huett, Moller, et al., 2008; Hung et al., 2013; Wu et al., 2011).

With the development of Internet and web-based learning, the control of setting and meeting learning goals would be switched from teacher to learner (Garrison, 1997). The MOOC is a unique web-based learning environment for learners have more choices and control of their own learning compared with traditional online courses. For example, learners are free to choose among hundreds of available courses; learners have more flexibility in studying time and topics as well as diverse learning goals which can often be met without completing the course. Garrison (1997) also argues that for a long time research on self-directed learning has focused more on its self-directed part, that is, “external control and facilitation” (p. 20), than on the learning part, which is the learners’ cognitive and motivational aspects. Nevertheless, these two are equally important in self-directed learning. Therefore, this research project focuses on learners’ motivation using
DBR to design and implement motivational interventions in a MOOC and to explore learners’ reactions.

**Problem analysis and exploration.** This step includes collaborations with practitioners to determine the focus and objectives of the research project. The step also requires the review of relevant literature to shape the problem and narrow data collection methods. Initial exploration of the research problems and their related issues should be conducted to prepare for later design and evaluation (McKenney & Reeves, 2012). As stated in the section describing the real world problem, a large number of students do not persist in MOOCs, but what is not well understood is why they decide not to complete the course. MOOC students are different in backgrounds and skills, and they normally have varied needs when signing up for particular courses. Do some of them not persist in the course because a short time of engagement with the course materials and activities has already satisfied with their demands, because they lack motivation to continue the course for a long time period, or, perhaps, because they have to give up due to technological difficulties or other life commitments?

**Step Two: Practical Solution to the Problem**

To deal with this practical problem, ARCS model was selected as the design model to tackle motivational problems. This model is widely used in instructional design research emphasizing on motivation. Detailed steps in integrating the ARCS motivational design model into regular instructional design have been provided by Keller (2010), its creator. In the ten steps, the designer first obtains (1) course and (2) audience information and then (3) analyzes them for deficiencies of (4) existing materials to the potential
learners in the four components of ARCS respectively. Next the designer (5) composes her motivational design objectives and aligns assessments with each objective. Based on the designer’s previous analysis and pre-designed objectives, she can (6) brainstorm all possible motivational interventions regarding to attention, relevance, confidence, and satisfaction. Then according to the real instructional situations, limitations, and restraints, the designer (7) selects the most appropriate interventions, (8) implements them and (9) develops learning materials and the whole course with these strategies. Lastly, the designer (10) evaluates the design based on her pre-designed assessments to make improvements to the course.

This ten-step model fits well with the design-based research paradigm in that once the real world problem has been determined to relate to motivation, motivational design can begin with obtaining and analyzing course and audience. After the ten steps are completed, the potential solution to the problem is designed, implemented and evaluated in real courses. Design-based research encourages the designer to document the design process. The detailed ten-step process can help with organizing the documentation. Chapter 4 presents the design results based on the ARCS motivational design model in each of the ten steps. Data collected to evaluate the motivational strategies is also provided.

Step Three: Evaluate the Potential Solution in a Real Setting

Research setting. The research settings are two series of courses on one famous MOOC provider –offered in Fall 2014 and Spring 2015 respectively. Many MOOCs continue to launch their courses again on their provider’s platforms after the first launch;
these two were also offered more than once in 2014 and 2015. Each time the course launched is called a session. Instructors and course designers can make revisions to the course based on the experience and student feedback from the previous session. The first time these courses were offered, they were one longer course, which was an eleven-week long course implemented between January 2014 to April 2014. After this first session, the instructor decided to split the original course into two independent parts running sequentially, based on the first session’s student feedback about the course’s workload. Learners are not required to take the first course if they only want to learn the content in the second course. In this dissertation, the first MOOC that launched in 2014 is referred to as the 2014 R & R course while the second MOOC in 2014 is called the 2014 S & S course. The same naming rule applies to the courses launched in 2015.

The 2014 R & R was open between August 2014 and October 2014 and the 2014 S & S was open between October 2014 and December 2014. The 2015 R & R was open between February 2015 and April 2015. Depending on the course schedule and my schedule, the author decided to use the 2014 S & S as the first iteration and the 2015 R & R as the second iteration in this DBR project. The timeline of the course’s sessions in 2014 and 2015 is shown in Figure 3, with the two researched sessions highlighted.

The two MOOCs were both introductory level. Both courses last for nine weeks with a one-week break in the middle for students to catch up on previous work and two weeks at the end for completing the final exam. Both courses include approximately six to twelve video lectures and a quiz assessing students’ basic understanding of the
material each week. A bi-weekly advanced problem set containing more application level problems is provided for higher-level mastery of the content.

Figure 3. Courses and Research Timeline.

In the first iteration, which was the 2014 S & S, I implemented my pre-designed ARCS motivational strategies and collected informal feedback from the students, the practitioners and the instructor. Based on the feedback, changes were made to the original strategies, which were applied to the second iteration: the 2015 R & R. Informal as well as formal feedback were collected during the second iteration to evaluate the effects of the revised strategies.

So to summary, major course materials, including instructional videos, assignments, and external references, were designed and developed by the instructor and the instructional team during the development period (July 2013 to January 2014). The current research study had not started at that time so motivational design was not incorporated into the course design and development. During March 2014 and August
2014, the original course was changed into a two-series shorter course. At the same time, the researcher started designing motivational strategies and incorporating them into instructional design process. The opinions of the instructor, other course development team member and an expert in web and visual design were taken into consideration to design the most appropriate ARCS motivational strategies in MOOC environments.

**Research instruments.** Three types of instruments were employed to collect data to examine with the research questions: pre and post-course surveys, the Instructional Materials Motivation Survey (IMMS), and the semi-structured interview questions.

**Pre and post-course surveys.** The pre and post-course surveys were parts of the standard course evaluation conducted by the university who offered the MOOC. The pre-course survey (Appendix B) was distributed to students before or on the course launch date and the post-course survey (Appendix C) was distributed after the course is over. The purpose of the pre-course survey was to collect students’ demographic information, reasons for signing up for the course, previous knowledge on the subject area, and plans in the course. The post-course survey sought to collect students’ experience with the course, why they enroll in the course, their satisfaction with the course and its activities, their knowledge before and after taking the course, and their future studying plans after this course.

**Instructional Materials Motivation Survey (IMMS).** Students’ motivation in terms of attention, relevance, confidence and satisfaction was measured by the Instructional Materials Motivation Survey (IMMS) designed by Keller (1987b). The IMMS measures the four constructs of the ARCS model and contains 36 items using a
five-point scale response type: not true, slightly true, moderately true, mostly true, and very true. Keller (2010) estimates the reliability of the instrument is 0.96 and the reliabilities of the four constructs, 0.89, 0.81, 0.90, and 0.92 respectively. In this research, the IMMS was modified slightly in the language to reflect some specific course features. For example, number 25 of the original IMMS is “After working on this lesson for awhile, I was confident that I would be able to pass a test on it”. It was modified to “After working on the course for a while, I was confident that I would be able to pass a test on Chemistry” to be more specific on the course and the subject matter. The adapted IMMS is attached in Appendix D. Permission to use the IMMS is in Appendix E.

At the end of the IMMS, an open-ended question was included for participants to write any comments they had about the course. The last question asked them to leave their contact email addresses if they were willing to participate in a later interview.

**Interview protocol.** Semi-structured interviewing was selected in this project because I wanted to have a structured plan for asking about certain issues in the courses as well as have the freedom to probe other interesting ideas that emerged in the discussion (Glesne, 2011). The interview questions were developed and refined based on my experience with the the MOOC platform as a MOOC course developer and the review of the literature. Probing questions were guided by the interviewee's responses. A full list of interview questions and their rationales are attached in Appendix F.

An interview protocol was designed to include an opening ‘getting to know you’ question, space for taking notes, and important questions and comments at the end of the interview. It was used in each interview to record interview information and notes. The
protocol is presented in Appendix G. A post-interview summary sheet was also
developed to record important information in each interview and whether new interview
questions could be generated. The post-interview summary sheet is presented in
Appendix H. This summary sheet was adapted from the tutorial *One-on-one interviews: A qualitative assessment approach* developed by Center of Inquiry in the Liberal Arts at Wabash College.

**Data collection procedures.** Data used to evaluate the motivational strategies included surveys, interviews, and design journal. All surveys sent in the two MOOCs, the entire interview procedures, and data analysis are introduced in the following sections as part of the evaluation process in the four-step DBR. The design journal is described in the reflection section as part of the reflection and document process.

Survey and interview participant numbers and the approximate response rates are demonstrated in Table 1. Since the enrollment numbers changed on a daily basis in these MOOCs, the approximately response rates were calculated according to the date when the surveys were sent out and the enrollment on that specific day.

**Table 1**

<table>
<thead>
<tr>
<th>Survey and Interview Participant Numbers and Response Rates</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td>2014 S &amp; S Number (Approximate Response Rate)</td>
</tr>
<tr>
<td>2015 R &amp; R Number (Approximate Response Rate)</td>
</tr>
</tbody>
</table>
Table 2 presents the active rates and the survey response rates of learners at the same time as the surveys were sent out. Active rates were calculated as (number of learners visited the course) / (total registered learner number) at the beginning, middle, and end of the course period. Both the active rates and the response rates decrease by time. To evaluate the proportionality of the decreasing rates between the active rates and the survey response rates, a metric $\tau_{ab} = \text{var}\{\log(r_a/r_b)\}, a, b = 1, 2, 3, a < b$ is defined. Clearly, $\tau_{ab} = 0$ indicates a perfect proportional relationship exists among the decreasing ratios. In contrast, the larger the value of $\tau_{ab}$, the more departure from a perfect proportionality. A measure of the degree of proportionality is given by $\rho_{ab} = \exp(-\sqrt{\tau_{ab}})$. In this way, $\rho_{ab} = 0$ means zero proportionality and $\rho_{ab} = 1$ means perfect proportionality. In the 2014 S & S, the results are $\rho_{12} = 0.596, \rho_{23} = 0.866, \rho_{13} = 0.689$. In the 2015 R & R, the results are $\rho_{12} = 0.740, \rho_{23} = 0.945, \rho_{13} = 0.783$. The results indicate that the decreases of activate rates and response rates are somewhat proportional. Between the middle and the end of both courses, the proportionality is near perfect.

Table 2

<table>
<thead>
<tr>
<th></th>
<th>2014 S &amp; S</th>
<th>2015 R &amp; R</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Active Rates</td>
<td>Response Rates</td>
</tr>
<tr>
<td>Beginning</td>
<td>70.8%</td>
<td>18.1%</td>
</tr>
<tr>
<td>Middle</td>
<td>13.0%</td>
<td>1.6%</td>
</tr>
<tr>
<td>End</td>
<td>5.3%</td>
<td>0.8%</td>
</tr>
</tbody>
</table>
**Survey data.** In the 2014 S & S, the pre-course survey was distributed to all students by email on the launch date. An announcement containing the same information as the email was posted on the course announcement page so that students registered later could still access the survey.

In week 6 of the 2014 S & S, the Instructional Materials Motivation Survey (IMMS) was delivered through the course announcement tool. The IMMS was delivered later in the course so that students had a more comprehensive sense of the whole course. At the beginning of the IMMS, the consent form was presented to all respondents, and after reading through the form, participants responded to a multiple-choice question asking them if they would like to participate. Those who selected not to participate were prompted to the end of the survey. The full study consent form is attached in Appendix I.

After the statements of accomplishment for the course were generated and distributed to students who passed the course, the post-course survey was delivered through announcement/email tool.

The 2015 R & R, survey data collection and consent procedures were the same as in the 2014 S & S.

**Interview guide.** At the end of the IMMS, all respondents were asked to leave their contact email address if they were willing to participate in an additional online audio interview. This allowed the researcher to contact interested participants to schedule an interview. In this study, participants’ perspectives about the ARCS motivational strategies and their experiences taking the course were explored during the interview. A detailed interview guide is needed in qualitative interviewing because the guide helps the
interviewer develop the most relevant interview questions, organize them comprehensively, and make the best use of the limited interview time (Patton, 2002). The interview guide is described below.

*Sampling strategy.* In this study I planned a mixed purposeful sampling strategy (Patton, 1990). To satisfy the intensity sampling aspect, I looked for intensity cases in the data. Intensity cases are information rich, but they are not extreme cases. So respondents who expressed thoughtful opinions in the open-ended question provided richer information than those who left the question blank or simply wrote “it’s all good” or “everything is wrong” without leaving further information. For example, a learner who wrote that he/she is taking a chemistry course from a community college and how enrolling in the chemistry MOOC helped and enhanced learning was selected for the rich information in the open comments. Only those who had left their contact information indicating willingness to participate in the interview were included in the sampling. First, I browsed the comments from the open-ended questions in the IMMS and identified five respondents whose comments were meaningful and had potential for probing, as the intensity sampling strategy proposed by Patton (1990). Five individuals were considered having relevant responses to the research questions and were contacted for further study.

Second, to explore more on the four components of ARCS, outliers using IQR were calculated and two high/low outliers under each category were identified and included in the interview. In this case, information rich cases both in general and in the four specific components of the ARCS model could be selected to provide more
information from various perspectives. These constituted the 21 total interview interviewees.

In the 2014 S & S, there were 39 who responded to the interview invitation question. In the 2015 R & R, there were 80 who responded to the interview invitation question. However, during the actual sampling process, the response rate to the interview scheduling invitation email was so low that I finally invited all students who had previously indicated willingness to participate in the interviews. In the actual interview process, new information was produced in almost each new interview. Those who replied the email and set up a time for the Skype/Google Hangout interviews were all included in the final interviews. No face-to-face interviews were conducted in this study. The interview participant number in the 2014 S & S was 16 and the 2015 R & R was 30.

**Invitation procedure.** For each potential interviewee, I sent out information about the interview, several time slots for them to choose at their convenience, as well as the interview consent form in PDF format (Appendix J). I asked for interviewees’ preferred online audio chat platform: Google Hangout, Skype, telephone or other platform. Internet interviewing compensates for the distance between the researcher and the interviewee (Glesne, 2011). The invitation email is attached in Appendix K.

**Interview process.** One laptop PC was used to connect with interviewees via Google Hangout audio, Skype audio, or Google Voice phone calls, while another laptop mac recorded the interview with free audio recording software, Audacity (http://audacity.sourceforge.net/). The audio was later exported into MP3 format for transcript. All audio recordings were stored both on the PC laptop and on a 512GB
external hard drive and will be deleted permanently for privacy purposes. Depending on time and funding, some interviews were transcribed by a professional service, CastingWords https://castingwords.com/. I then transcribed the remaining interviews.

At the beginning of the interview, it was important to ensure that interviewees had read the interview consent form carefully. After connecting with the interviewees, I asked them whether they had read and agreed to the interview consent form. If they answered yes, I emphasized important points from the consent form, such as (a) confidentiality and anonymity to participate, (b) rights to withdraw the study, and (c) rights to ask questions about the research. If no, I read the consent form to them and asked if they agreed to continue participating in the interview then proceeded to the interview questions.

During the interview, the interview protocol was established to guide me through the process and to document important information. I asked interviewees pre-designed interview questions as well as frequently incorporated in appropriate probing questions to explore deeper into their thoughts and feelings. Interviewees’ previous MOOC experiences were discussed at the beginning of the interview to acclimate participants to the interview process. If the conversations went off-track, I kept listening to interviewees’ responses but brought the topic back to the relevant questions. When asking the question of whether the interviewee was still taking the course and conducting course activities, I was careful not to sound judgmental of the interviewee (Glesne, 2011). All interviews lasted between 25 minutes and 60 minutes.
At the end of the interview, interviewees were asked for other comments that they had but did not discuss during the interview. I then thanked them for their participation and we both left the session.

Post-interview. After each interview, I spent approximately fifteen minutes reflecting on the interview content and documenting everything that was surprising, noteworthy, and unexpected in the interview. The post-interview summary sheet was filled out immediately after the interview reflection and was kept with the interview protocol for each interviewee.

The whole study process and data collection procedure is presented in Table 3.

Data analysis. There are three research questions in this study.

1. What are MOOC learners’ initial motivations for enrolling in a course?

2. How do learners perceive the ARCS motivational strategies that are used in the courses?

2a. Are there differences in learners’ motivation in terms of the ARCS model through the IMMS between the two MOOC courses?

3. What are MOOC learners’ perceptions of and experience in the courses?
<table>
<thead>
<tr>
<th>Course</th>
<th>Time</th>
<th>Procedure</th>
<th>Data/Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>2014 S &amp; S</td>
<td>Course launch date (October 2014)</td>
<td>Sent out the pre-course survey.</td>
<td>Demographic data, initial motivation, self-commitment</td>
</tr>
<tr>
<td></td>
<td>Sixth week – break week (November 2014)</td>
<td>Sent out The IMMS.</td>
<td>Reactions to course materials regarding A, R, C and S</td>
</tr>
<tr>
<td></td>
<td>Interview invitation was at the end of IMMS.</td>
<td>Potential interviewees’ contact emails</td>
<td></td>
</tr>
<tr>
<td></td>
<td>After the statement of accomplishment was issued (December 2014)</td>
<td>Sent out the post-course survey.</td>
<td>Experience regarding taking the course, ratings of some course components, continue motivation</td>
</tr>
<tr>
<td>Between 2014 S &amp; S and 2015 R &amp; R</td>
<td>December 2014 – February 2015</td>
<td>Scheduled and conducted interviews.</td>
<td>Interview recordings and transcript</td>
</tr>
<tr>
<td></td>
<td>February 2015</td>
<td>Analyzed survey and interview data preliminarily to revise ARCS strategies.</td>
<td>Revised version of ARCS motivational strategies</td>
</tr>
<tr>
<td></td>
<td>A week before course launch date (February 2015)</td>
<td>Sent out the pre-course survey.</td>
<td>Demographic data, initial motivation, self-commitment</td>
</tr>
<tr>
<td>2015 R &amp; R</td>
<td>Fifth week – break week (March 2015)</td>
<td>Sent out the IMMS.</td>
<td>Reactions to course materials regarding A, R, C and S</td>
</tr>
<tr>
<td></td>
<td>Interview invitation was at the end of IMMS.</td>
<td>Potential interviewees’ contact emails</td>
<td></td>
</tr>
<tr>
<td></td>
<td>After the statement of accomplishment was issued (April 2015)</td>
<td>The post-course survey was sent out.</td>
<td>Experience regarding taking the course, ratings of some course components, continue motivation</td>
</tr>
<tr>
<td>After 2015 R &amp; R</td>
<td>March 2015 – April 2015</td>
<td>Scheduled and conducted interviews.</td>
<td>Interview recordings and transcripts</td>
</tr>
<tr>
<td></td>
<td>February 2015</td>
<td>Analyzed survey and interview data for practical implications and theory construction.</td>
<td>Revised and constructed theory</td>
</tr>
<tr>
<td>Between motivational design project beginning to the end</td>
<td>July 2014 – April 2015</td>
<td>Design journal</td>
<td>Ideas, thoughts, outcomes, etc. regarding motivational design</td>
</tr>
</tbody>
</table>

**Table 3**

Data Collection Procedure and Design Journal
Overall, both quantitative and qualitative data analysis were used to answer the questions. To be more specific, for research question one, descriptive statistics related to questions concerning reasons for registering and initial commitments to the course activities were calculated to gather a general perspective of learners’ initial motivation. Qualitative data analysis of the interviews was applied for detailed insights into these same issues. For research question two, descriptive statistics of the IMMS were assessed from a quantitative perspective. Deeper understanding of this question was obtained by analyzing the open-ended question in the IMMS and the interviews. To answer research question three, analysis of the interviews and the design journal were applied. The research questions and corresponding data collection methods and data analysis methods are presented in Table 4.

**Step Four: Documentation and Reflection**

Documentation and reflection records the design process as well as the evaluation process. This section first describes the researcher and the practitioner in the study and then introduces the design journal that was kept in the entire study.

**Researcher and practitioner.** As the researcher of the project, I have a Master’s degree in Computer Education and Technology, which emphasizes the integration of technology into curriculum and the practical aspects of instructional design. I was a doctoral candidate in Instructional Technology, allowing for familiarity with the theoretical and practical perspectives of motivation, instructional design, online education, and research design. Additionally, I have been working as a course staff member for a private Eastern university’s MOOC projects since July 2013. I have been
involved in the design and development of approximately ten MOOCs, which enhances my familiarity with the MOOC environment, MOOC learners and the provider platform.

I have worked on the MOOC and its following series, R & R and S & S, are among these MOOCs. However, I did not have any personal relationships with any MOOC learners in the researched courses.

Table 4

<table>
<thead>
<tr>
<th>Research Question and Method</th>
<th>Research Questions</th>
<th>Data Collection Methods</th>
<th>Data Analysis Methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>What are MOOC learners initial motivation enrolling in courses and their motivational change during the course?</td>
<td>Pre-course survey</td>
<td>Descriptive statistics</td>
<td></td>
</tr>
<tr>
<td>Interview</td>
<td>Qualitative coding for themes on motivation enrolling and how motivation changes due to different reason</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IMMS</td>
<td>Descriptive statistics</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interview</td>
<td>Qualitative coding for themes on comments relating to the design feature of A, R, C, and S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Design journal</td>
<td>Qualitative coding for themes on the four components and other design factors that would increase learners’ motivation in a MOOC</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| What are MOOC learners’ perceptions of and experience in the courses? | Post-course survey | Descriptive statistics |
| Interview | Qualitative coding for themes on learners’ experience and perceptions of major course components |
| Design journal | Qualitative coding for themes on learners’ experience and perceptions of major course components |

The practitioner of the series MOOC is a senior academic technology consultant. He is interested in and has been involved in integrating technology into teaching, e-learning, social networking, online productivity tools, video and multimedia, and
visualization. He is also involved heavily in various on campus projects focusing on teaching and learning as well as video production. He has more than ten years of work experience in the instructional technology office of higher education and three years of experience with the platform. These have provided him with the expertise of working with faculty members developing both face-to-face and online courses.

The course instructor, the academic technology consultant, and I constitute the major course development team. Since the beginning of this course development, the course team has met on a weekly basis to report progresses and to discuss problems, issues, and further plans to each other. The course team has established a good collaboration during the whole course planning, development, implementation as well as the actual course open time. While the instructor was working on developing the course content, she accepted suggestions from the academic technology consultant and I on the platform features, like what the platform can do and what it cannot. Following these recommendations, she modified the videos and exercises in order to fit the capabilities of the MOOC platform. When I encountered problems designing the course site, editing the course videos, building exercises or answering questions on the discussion forum, I would consult the academic technology consultant, other colleagues and the instructor in order to find the best solutions to these problems. The academic technology consultant supervised the course development on a project management level and worked closely with the course team and higher-level leadership board.
**Design journal.** I, as the designer and researcher of the study, kept a design journal from the first day of the motivational design project. This design journal was also analyzed in this study. An example excerpt of a design journal entry is as follows:

From the discussion forum that asked students why they took the course, about $\frac{2}{3}$ of them said it is for learning new knowledge or for refreshing their old knowledge. About $\frac{1}{3}$ of them responded that the subject is related to their future potential fields of study, life or their career.

**Limitations and Strategies to Ensure Research Rigor**

Researcher’s bias is a part of qualitative research studies (Patton, 2002). My long-term involvement in this course might result in a prejudiced position in the study. This may occur unconsciously, but effort to control such biases can be implemented by keeping an open mind and considering alternative theoretical support when interpreting data (Patton, 2002).

A code-recode procedure was conducted when analyzing interview data to establish the dependability of the study (Krefting, 1991). The design journal was recorded in detail to capture important issues from the whole design process, and it was cross checked during the entire study as the “researcher’s reflective commentary” (Shenton, 2004, p. 68) to establish the research’s credibility. Data in the study, including survey results, interview transcripts, and design journals, were collected through multiple data collection methods, so “methods triangulation” and “triangulation of sources” (Patton, 2002, p. 556) were implemented in data analysis to ensure the credibility of the study.
Chapter Summary

This chapter explained why a design-based research approach with mix method was selected to answer the research questions. A detailed process of conducting DBR was presented based on Reeves (2000) DBR procedure framework. In the step of designing the practical solution, ARCS motivational design was described using the practical processes Keller (2010) developed. Then the research setting, participants, researchers, research instruments, data collection, and data analysis methods were described. At last, methods to ensure the rigor of the qualitative part of the research were clarified. Next chapter will include the motivational design results and data analysis results.
Chapter 4: Design Process and Results

In this chapter, the interventions were implemented into the two MOOCs after development. The Motivational Design Results section presents products of the second phase in the four-step DBR model that was introduced in Chapter 3. The Data Analysis section including results analyzed from the surveys, interviews and design journal is presented in Chapter 5: Data Analysis. These data analysis results belong to the third and the fourth phase in the four-step model, as demonstrated in Figure 4.

![Figure 4. The Four-step DBR and Products in Each Step.](image)

The following sections are based on Keller’s ten-step motivational design (Keller, 2010) discussed in Chapter 3. Results of each step are presented under each section.

Course Analysis

As discussed in the Research Setting section in Chapter 3, the MOOC courses that were used as research sites were two chemistry courses Learners were not required to take the first course if they just wanted to learn the content in the second course.

After the first session of the course ended, the course development team implemented several revisions starting April 2014. Both the instructor and the researcher
kept journals documenting students’ feedback from the first session so that we could revise course components based on this feedback. Besides the change of splitting the original course into two, other revisions included clearer instruction, consistent language, typo correction, correction of misspoken words in videos, and exercise adjustment. For example, the words exercise and quiz were used interchangeably in the first session both referring to the weekly basic exercise. One revision was replacing quiz with exercise throughout the whole course to avoid confusion.

**Audience Profile**

According to Keller (2010), audience information is the basis for performing audience analysis, which is critical in motivational design. The pre-course survey result was a good estimation of the course audience. Because the motivational design target in this project was the 2014 S & S, it would have been too late to analyze the pre-course survey for the 2014 S & S. Therefore, the audience demographic information from the first session in spring 2014 was used as the best guess audience profile for this researched session.

There were 3306 students who completed the age question in the pre-course survey. Their age distribution is shown in Table 5.

Among the total of 3258 responses who answered the first language question, 1696 (52.06 %) reported that English was their first language while 1562 (47.94 %) answered English was not. There were 3323 respondents answered the gender question, 1536 (46.22 %) were male, 1761 (52.99 %) were female, and 26 (0.78 %) were others.
Table 5

Potential Audience Age Distribution

<table>
<thead>
<tr>
<th>Age range</th>
<th>Under 18</th>
<th>18 - 25</th>
<th>26 - 34</th>
<th>35 - 44</th>
<th>45 - 54</th>
<th>55 - 64</th>
<th>Above 65</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>310</td>
<td>817</td>
<td>897</td>
<td>526</td>
<td>399</td>
<td>257</td>
<td>100</td>
</tr>
<tr>
<td>Percentage</td>
<td>9.38%</td>
<td>24.71%</td>
<td>27.13%</td>
<td>15.91%</td>
<td>12.07%</td>
<td>7.77%</td>
<td>3.02%</td>
</tr>
</tbody>
</table>

Of the 3317 total responses to the question about prior experience in the subject area, having some course or work experience was selected the most frequently – by 33.10% of the participants, while having a degree or great experience had the least percentage – 11.55% of the participants. The different experience levels that students had prior to taking the course are presented in Table 6.

Table 6

Potential Audience Prior Experience with the Subject

<table>
<thead>
<tr>
<th>Experience</th>
<th>New to the field</th>
<th>Explored</th>
<th>Some experience</th>
<th>Great experience</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>973</td>
<td>863</td>
<td>1098</td>
<td>383</td>
</tr>
<tr>
<td>Percentage</td>
<td>29.33%</td>
<td>26.02%</td>
<td>33.10%</td>
<td>11.55%</td>
</tr>
</tbody>
</table>

Of the 3325 total responses to the question about highest degree that had completed, most participants indicated that they had a bachelor’s degree consisted 30.23% of the total responses while least participants selected that they had less than high school education, which was approximately 7.13% of the total responses. The numbers and percentages of each degree category is presented in Table 7.
Table 7

*Potential Audience Highest Degree Earned*

<table>
<thead>
<tr>
<th>Degree</th>
<th>Less than high school</th>
<th>High school or equivalent</th>
<th>Some college</th>
<th>Bachelor’s degree</th>
<th>Master’s degree</th>
<th>Doctorate or professional</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>237</td>
<td>364</td>
<td>689</td>
<td>1005</td>
<td>748</td>
<td>282</td>
</tr>
<tr>
<td>Percentage</td>
<td>7.13%</td>
<td>10.95%</td>
<td>20.72%</td>
<td>30.23%</td>
<td>22.50%</td>
<td>8.48%</td>
</tr>
</tbody>
</table>

When asked about their planned time and effort into the course, a majority of participants planned to spend four to six hours per week in the course, consisted of 45.85% of the total number, while only 3.04% planned to spend more than twelve hours per week in the course. The planned time to spend each week is shown in Table 8.

Table 8

*Planned Time to Spend Each Week in the Course*

<table>
<thead>
<tr>
<th>Hours</th>
<th>One to three</th>
<th>Four to six</th>
<th>Seven to nine</th>
<th>Ten to twelve</th>
<th>More than twelve</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>862</td>
<td>1523</td>
<td>604</td>
<td>232</td>
<td>101</td>
</tr>
<tr>
<td>Percentage</td>
<td>25.95%</td>
<td>45.85%</td>
<td>18.18%</td>
<td>6.98%</td>
<td>3.04%</td>
</tr>
</tbody>
</table>

A multiple answer question was included to find out which course activities the students would participate. Watching video was selected as most frequently planned activity with 3221 selections (97.02%), followed by taking the exercises with 3018 selections (90.90%), then taking test (exam) with 2834 selections (85.36%), then earning a certificate with 1695 selections (51.05%), and the last participating in discussion forum with 1428 selections (43.01%).

Generally speaking, most learners in the course did not know each other, neither would they know where other learners were or what background others had. Because this course was not a required course for any degrees, it was assumed that when signing up
for the course there was at least one thing that makes this particular course stand out from hundreds of other MOOC courses. For example, it could be either chemistry was interesting to the learner, or the university or the instructor offered the course was unique to the learner, or other factors. Learners’ attitudes toward taking MOOCs depended on their prior experience taking other MOOCs. Since this course was not required or needed for college credit to graduate, few learners should have the pressured feelings of “I have to finish the course no matter what”. On the other hand, it was much harder for them to persist because there was almost no harm in not completing it. When designing learning and motivational materials, it could be assumed that these learners were able to follow instructions to locate information because most learners were adults and had at least some levels of formal education. In the prior experience with the subject questions, the fewest learners fell under the professional category. Thus, additional resources should be provided for novice learners and advanced terms should be avoided to prevent confusion.

**Audience Analysis**

After obtaining audience information, analyzing audiences’ attitudes, potential learning behaviors, and motivational problems was conducted based on this information in order to select more suitable motivational strategies (Keller, 2010). Learners who had extremely high or extremely low motivation would be less likely to perform well later because those who with initial motivation that was too high would probably fall back due to too much pressure; whereas those who with extreme low motivation might put little effort into learning (Keller, 2010). From the audience demographic and educational information obtained from the chemistry MOOC survey (see the Audience profile
section), one could tell that a large percentage of course participants were well educated and had prior knowledge/experience with the subject. Most of the participants had other schoolwork or jobs other than taking MOOCs and they were willing to spend a relatively short time each week in the chemistry MOOC.

It is difficult to analyze audiences’ motivation and motivational trend in distributed learning environments (Keller, 2010). Despite all the challenges, it is emphasized that researchers should conduct audience analysis even only using the best guess strategy (Keller, 2010). In this project, there were students who had optimal attention level, perceived relevance, confidence, and satisfaction toward the course. The more important thing needed was to help them sustain their optimal motivational level. However, there were students who did not log onto the course site even once and those who glanced at the course site very quickly without even trying to read the learning materials, they obviously had extremely low attention in the course even though they signed up for the course earlier. Not many students would probably treat the chemistry MOOC as a very critical part of their work or life, so there might not be many students who had extremely high relevance level. Instead, there could be a number of students who really wanted to learn the content and were quite motivated when the course launched, but found the course did not offer exactly the same topics they desired. For them, the chemistry MOOC might have a really low relevance to their interest or career. As a result, these students’ motivation, engagement and participation would decrease rapidly (Kizilcec et al., 2013; Nawrot & Doucet, 2014).
In addition, it was rather unlikely that many students would perceive this course as quite important to them or there would be negative outcomes if they did not finish. It was possible that students who did not have any coursework or experience with chemistry before would have low confidence in mastering the content. On the other extreme, students could be overconfident and assumed they could complete the course successfully without doing much work. As for satisfaction, on one hand, it was likely that students did not achieve their goals at the end of the course or they were having bad learning experience in the course, so they would have a low satisfaction of the course. On the other hand, some might have an extremely high satisfaction for everything they had achieved successfully in the course.

One issue with learners’ motivation in MOOCs might be that their motivation could change dramatically by time especially in relatively long courses. Students who had high attention when the course launched might lose attention even in the second week of the course. It was especially true when the course content was released every week without many changes to the format. So a decrease in numbers of logging on the course site and conducting any course activity occurred by week in a lot of MOOCs. Thus, messages containing motivational--especially attention catching--strategies, could be implemented in MOOC designs to sustain learners’ attention and encourage them to continue with the course.

Perceived relevance could vary by individual learners. Perceived relevance could also change according to different students during the course. Students might fail to find any connections between taking this course and their future field of study, thus their
perceived relevance decreased. Or there could be an increase in some students’ perceived relevance because the skills learned from the course happened to solve their problems in other important areas. When designing relevance strategies, information about different relevance could be provided to learners so that more learners would perceive the course as relevant in different ways. For example, some learners might perceive the course relevant when they were presented with the information about how learning chemistry could help other science fields such as biology; some might perceive the course relevant from reading how chemistry knowledge could be applied as useful tips in everyday life.

If there were continuous failures in completing weekly homework, students’ confidence would decrease especially when they believed they had put enough effort into studying. The contrary could be true also. That is, if students considered themselves as not spending much time on the course but continuously getting high scores in homework, they would become much more confident even overconfident. Therefore, to keep confidence at an optimal level, learners needed to be encouraged and be provided with various challenging level problems to avoid over-confidence.

As discussed earlier, students could have high satisfaction initially, but once they found out this single course could not provide them with everything they wanted to learn or to solve every problem, they would feel disappointed and demotivated. The fact that they would not be able to keep up or to achieve their goals could be disappointing. Therefore, one thing that could be done is to constantly summarize the major topics in the course and all important content that had been covered during the entire course. In this way, learners might feel satisfied with what had been mastered. Another way was to
provide additional resources and learning opportunities for some learners to pursue if they did not think this MOOC met their needs.

**Existing Materials Analysis.**

In the first session of the course, the materials had been implemented, and the entire course was evaluated for the positive features and deficiencies in terms of the four ARCS components. Results are shown in Table 9.

From Table 9, it can be seen that the course videos included sufficient motivational strategies that an experience instructor already provided when designing her instructional videos. In addition, revising course videos would involve the instructor to redesign the videos and to reshoot these videos with the media team. The design decision made based on the material analysis was to omit redesigning the videos and to focus on other course components of which the course team and the researcher had more control, such as the course emails, assignment feedback, discussion forum threads and course pages.

**Motivational Objectives**

This section describes the objectives that are expected to happen after implementing the motivational strategies, which will be presented in later sections. Assessments were included to determine whether these motivational objectives were achieved or not. Since these were pure online courses, it was not possible to observe students’ reactions to the motivational strategies. Other measurements like surveys and interviews were conducted to assess their effectiveness. Motivational objectives and measurements are shown in Table 10.
### Table 9

**Existing Materials Analysis per the ARCS**

<table>
<thead>
<tr>
<th>Component of ARCS</th>
<th>Features</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Attention</strong></td>
<td>Positive features:</td>
</tr>
<tr>
<td></td>
<td><strong>Videos:</strong></td>
</tr>
<tr>
<td></td>
<td>• The instructor uses enthusiastic tones in the video to sustain students’ attention.</td>
</tr>
<tr>
<td></td>
<td>• The instructor uses annotation pens that can draw and write on the slides and is recorded in the video. Because most of the time, the instructor is showing in a picture-in-picture frame in the video, she can use gestures and movements while recording videos.</td>
</tr>
<tr>
<td></td>
<td>• The instructor uses large amount of examples for topics that are hard to understand and for calculations.</td>
</tr>
<tr>
<td></td>
<td>• Each video includes several in-video questions, which are normally multiple choice or simple fill in blank questions, to help learners focused.</td>
</tr>
<tr>
<td></td>
<td>• Some videos embed chemistry experiment demonstration clips, which were recorded in the chemistry lab in the development phase of the course, in order to catch students’ attention and curiosity by switching from the ordinary lecture mode to experiment mode. Long demonstration video clips are independent and marked as “demo” in video titles.</td>
</tr>
<tr>
<td></td>
<td><strong>Course pages:</strong></td>
</tr>
<tr>
<td></td>
<td>• Use buttons within pages to make course pages look differently.</td>
</tr>
<tr>
<td></td>
<td>• Use interactive tools (ZeeMaps) embedded in a course page to let students pin their locations on the map.</td>
</tr>
<tr>
<td><strong>Deficiencies</strong></td>
<td>Weekly emails have similar structure that is not appealing to students especially in later part of the course.</td>
</tr>
<tr>
<td></td>
<td>Most course pages contain texts only information. Students may lose attention reading long texts.</td>
</tr>
<tr>
<td><strong>Relevance</strong></td>
<td>Positive features</td>
</tr>
<tr>
<td></td>
<td>• In some videos, the instructor points out how the information presented in the video can be applied in everyday life or uses examples from everyday life to demonstrate.</td>
</tr>
<tr>
<td></td>
<td>• Course description page states that this course is the foundation for people who would like to study chemistry, medicine and related fields in college or graduate school.</td>
</tr>
<tr>
<td></td>
<td>• Bi-weekly problem sets contain problems that are real world questions.</td>
</tr>
<tr>
<td><strong>Deficiencies</strong></td>
<td>It is not very clear how this course or which units can be used in other fields.</td>
</tr>
</tbody>
</table>
|                   | Unlike applied science courses, this introductory chemistry course lacks application or proof of how this course can help learners find job.
Table 9 continued

<table>
<thead>
<tr>
<th>Confidence</th>
<th>Positive features</th>
</tr>
</thead>
<tbody>
<tr>
<td>Videos:</td>
<td></td>
</tr>
<tr>
<td>• The instructor speaks slowly and clearly in the videos with handwritings to make demonstration even easier to understand.</td>
<td></td>
</tr>
<tr>
<td>• Learners can easily control the videos by speeding up, slowing down, pausing or watching the video again.</td>
<td></td>
</tr>
<tr>
<td>• The instructor provides a written or oral explanation to most in-video questions after students answer them.</td>
<td></td>
</tr>
</tbody>
</table>

Assignments:
• Each homework exercise and advanced problem set allows students to make up to three submissions, and the highest score in the three attempts is recorded as the effective score of that assignment.
• The instructor provides her students’ essays as examples for the writing assignment in the course, so students would have a sense of what is expected in this assignment.

Deficiencies
• There are not many choices that students can choose from in order to obtain enough points to earn a statement of accomplishment.
• Students will know which question they answered wrong after they made one submission to homework, but there is no feedback or hints on why it is wrong.

<table>
<thead>
<tr>
<th>Satisfaction</th>
<th>Positive features</th>
</tr>
</thead>
<tbody>
<tr>
<td>• The course provides a free statement of accomplishment for students who meet the criteria provided at the beginning of the course as a certificate showing their work.</td>
<td></td>
</tr>
<tr>
<td>• How the final grade will be calculated is presented when the course launches and a course page “Grading and Logistics” contains details of grading that students can check at any time of the course.</td>
<td></td>
</tr>
</tbody>
</table>

Deficiencies
• There is no summary of what the students have learned in the course to make them feel proud at the end of the course.
• There is no email emphasizing that students’ achievements in the course are due to their hard work in the course and they should all be proud of their accomplishment.

Deficiencies
• It is not very clear how this course or which units can be used in other fields.
• Unlike applied science courses, this introductory chemistry course lacks application or proof of how this course can help learners find a job.
Table 10

Motivational Objectives and Assessments per the ARCS

<table>
<thead>
<tr>
<th>Motivational Objectives</th>
<th>Assessments</th>
</tr>
</thead>
<tbody>
<tr>
<td>The course will capture students’ attention and present clear enough information as well as structure of the course.</td>
<td>Interview asking students whether the pages and course emails captured their attention, and whether they were able to find information easily.</td>
</tr>
<tr>
<td>Students will develop a sense of perceived relevance of the course.</td>
<td>Surveys and interviews asking how they can apply what they learned from the course to life and other subject areas.</td>
</tr>
<tr>
<td>Students will set realistic learning goals based on their own experience, knowledge, and situation. Students will become confident and believe they can achieve their goals.</td>
<td>Interview asking whether they have achieved their goals. Interview asking whether confidence level changed during the course.</td>
</tr>
<tr>
<td>Students will feel they have achieved something from the course.</td>
<td>Post-course survey and interview.</td>
</tr>
</tbody>
</table>

Potential Strategies

A list of possible strategies to promote students’ motivation as determined by the ARCS model at the beginning, during and at the end of the course is provided in Table 11. These were feasible strategies that could be completed on the MOOC platform, but it was not to suggest that all of these should be designed and implemented in the course. Instead, a careful selection of strategies was conducted in the next section based on other considerations such as time and resources.

Table 11

<table>
<thead>
<tr>
<th>Potential Motivational Strategies per the ARCS</th>
</tr>
</thead>
<tbody>
<tr>
<td>ARCS</td>
</tr>
<tr>
<td>Attention</td>
</tr>
</tbody>
</table>
Table 11 continued

<table>
<thead>
<tr>
<th>Relevance</th>
<th>Confidece</th>
<th>Satisfaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shorten text information on course pages. Use tables, images, embedded videos instead. Direct students to course forums and course maps to introduce themselves.</td>
<td>Provide clear information on how this course is related to other fields of study. Examples of medical students’ experience. Interview past students on how they feel this introductory course fits into further curriculum. Ask learners to develop their own learning goals for this course.</td>
<td>Summarize the course major content to students and provide an overview of the course.</td>
</tr>
<tr>
<td></td>
<td>Ask learners to modify their learning goals constantly. Ask learners questions to help them think about how they can relate this course to other subject areas. Provide more real world examples that chemistry knowledge can apply.</td>
<td>Each week summarize what has been learned during the past week.</td>
</tr>
<tr>
<td></td>
<td>Identify what is expected at the beginning of each week. Provide hints to challenging questions in weekly exercise and problem set.</td>
<td>Positive feedback in emails emphasizing students’ accomplishment in the course. Provide a list of things that should have been mastered by learners after taking the course. Encourage learners to summarize on their own about things they have learned. State that learners should have the foundation knowledge for further study.</td>
</tr>
<tr>
<td></td>
<td>Provide information on final exam format. Provide opportunities for learners to leave comments and suggestions on how to improve the course.</td>
<td></td>
</tr>
</tbody>
</table>
**Strategy Selection**

Based on the whole list of possible motivational strategies provided in Table 11, a careful selection was conducted considering the available design time and resources, whether there were too many strategies, and whether these strategies would be annoying and distracting to students. Keller (2010) suggested to combine strategies that involved more than one component in ARCS. Course email was a major way to communicate with students off the course site because if students did not log onto the course site, they would not know what happened in the course except by reading course emails. So course emails were treated as an important element to include motivational strategies.

Discussion forum was the place students interacted with each other and obtained answers to questions. It was considered a good approach to incorporate motivational strategies in discussion forums. Furthermore, some students would check course pages, which usually contained useful information about the course, so the course pages were specially designed for motivational purposes. For students who were extrinsically motivated, earning the course certificate, which involved completing a set of assignments and an exam, was critical. Interventions were integrated in the assignments and exam to increase motivation for those who tried course exercises. The *Existing materials analysis* section revealed that course videos already contained several positive features related to enhancing motivation, and revising videos needed a large amount of both instructor and staff’s time, so videos were not included as one section that would incorporate motivational interventions. The list of selected motivational strategies from the overall strategies that were produced in the last step is presented in Table 12.
Table 12

**Final Strategies Selection per the ARCS**

<table>
<thead>
<tr>
<th>Time</th>
<th>Selected Strategies</th>
</tr>
</thead>
</table>
| Beginning| In the course launch welcome email, add some screenshot and direct links to course starting page (A, R).                                                                                                         
|          | In the course starting page, encourage students to introduce themselves on the course forum and pin their location on the course map (A).                                                                                                           
|          | On course grading page, emphasize the grading formula and that students are allowed to submit assignment within a one-week hard deadline (A, C).                                                                                                                                               
|          | On course introduction page, provide past students’ statements or stories (with permission) on how they think this course fits into other fields (R, C).                                                                                                                                               
|          | Redesign key course pages using variations of images, text blocks, bullet points and tables (A).                                                                                                                                                                                                                                           |
| During   | In the emails the instructor sends out at the beginning of each week, briefly summarize what has been presented in the last week and what will be presented in the current week (A, C).                                                                                                      
|          | In the weekly emails, use supportive tones to praise students’ good work and encourage them to keep trying (A, C, S).                                                                                                                                                                
|          | Provide feedback or hints on some challenging questions in homework and encourage students to try again (C).                                                                                                                                                                                  |
| End      | After the certificate has been granted, send out an email summarize what has been covered in the course and what will be covered in the next course of the sequence (A, R, S).                                                                                                      
|          | In the final email, congratulate students who have earned the course certificate (S).                                                                                                                                                                                                                                    |

**Course Plan**

Since these were self-directed online courses, the detailed lesson plan was modified into a weekly course plan, which provided an outline of learning objectives, potential motivational problems and selected motivational strategies for each week with comprehensive guidelines of the whole courses. Sample modified lesson plan including detailed plan of week one is shown in Table 13.
Table 13

Sample Course Plan

Course Information

Course topics: Basic chemistry

Course instructional strategy: Instructional videos, homework, and collaborative learning community.

Delivery platform: One MOOC provider

Duration: Eight weeks

Course objectives: The course covers basic concepts involved in chemical compositions, reactions, and quantitative problem solving will be emphasized with the goal of preparing students for further study in chemistry.

Motivational strategies: Students’ level of interest will decrease as time goes on. It is also harder to discover the relevance of the course to everyday life. Their satisfaction may be low if they are not aware of what they can do with the knowledge learned or they do not earn the certificate. The overall motivational strategy should sustain students’ interest, encourage them to think of the course contains basic knowledge for a lot of other subject areas, and help them feel satisfied by linking what they achieved to their personal objectives.

Pre-launch and Week 1:
Objectives: students will (a) become familiar with the course structure, schedule, assessment, and major topics; (b) understand what chemistry studies; (c) understand what matter, atom, molecule, compound, and element are; (d) distinguish observation, hypothesis, prediction, theory, and law; (e) convert numbers in scientific notation; (f) identify how many significant figures there are in a given number; (g) perform calculation and be able to keep the correct significant figures required; (h) apply Coulomb’s Law; (i) calculate molecular stoichiometry.

Motivational strategies: (a) use screen captures and direct links to key pages in course welcome emails (A, R); (b) make it clear how final grade will be calculated and it is allowed to drop the lowest assignment score (R, C); (c) on some course pages, provide quote from previous students stating how they applied knowledge from the course to other fields of study and how they succeeded in the course (R, C); (d) direct students to the course forum and map to introduce themselves and add their locations (A).

Development

For learning materials and activities that already had positive motivational factors, they were used directly or only modified partly in this step. Motivational strategies that were selected in previous steps were developed and integrated with learning materials
and activities where motivational factors were inadequate. This project did not involve multiple designers and developers’ collaboration, so it was not necessary to record steps, time and personnel who were working on certain steps. But a design journal was kept to record others’ comments and my own thoughts during the whole process.

Course videos had been determined as materials that already had sufficient motivational strategies and were well received in the last course session. Several motivational strategies used in course videos included linking knowledge to other fields (e.g. “Dalton is a common unit used in Biology”), linking previous presented content to topics that are going to cover by reviewing previous topics, step-by-step demonstrating how to do calculations (e.g. how to perform calculations and keep certain significant numbers), pre-recorded lab experiments (e.g. colorful flames), asking a question first then elaborating new topics around the question (e.g. “a lot of people are confused by the concept of the ‘mole’ when studying Chemistry, so what is the mole?”), vivid examples so they are impressive and memorable (“the amount of money a mole of pennies actually worth”), pre-recorded interviews with Chemistry professionals talking about their experience in the field, using analogies explaining complicated topics (basketball team analogy for stoichiometry).

Based on the analysis from all the previous steps, there were places where these pre-designed motivational strategies needed to be developed then incorporated in order to sustain and enhance learners’ motivation. A list of strategies and related course materials and activities that integrated these strategies is shown in Table 14. Depending on the
platform functions, the motivational strategies that were selected were incorporated into common features such as course emails, forum threads, exercises, and course pages.

Table 14

List of Motivational Design Product

<table>
<thead>
<tr>
<th>Motivation Design Strategies</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Modified course welcome email with links and screen captures</td>
</tr>
<tr>
<td>2. Modified course grading policy pages providing students opportunities to take risks</td>
</tr>
<tr>
<td>3. Forum thread asking students to introduce themselves and why they chose the course</td>
</tr>
<tr>
<td>4. Previous students’ statement on their experience in the course</td>
</tr>
<tr>
<td>5. Modified feedback with hints of how to answer and encouraging students to try again in assignments</td>
</tr>
<tr>
<td>6. Modified weekly emails with last week’s summary and current week’s topics presented in a format of concrete problems or questions</td>
</tr>
<tr>
<td>7. Modified final email summarizing the course content and topics, and encouraging learners to refer think if they have achieved their goals</td>
</tr>
<tr>
<td>8. Email after the certificate is granted congratulating those who obtain certificate</td>
</tr>
</tbody>
</table>

One example of the emails in the 2014 S & S with screen captures of the actual course site and links to outside references and to course components, such as the video list, is shown in Figure 5. The screen capture was the course map, on which a number of students pinned their locations. There was a forum link in the later bullet list when summarizing previous week’s content so students could check the forum directly from the link. A TED talk link was included as an outside reference for those students who were interested in exploring more on certain topics.
Week 2: We have a diverse group!

Greetings!

We have a very diverse group of students, from 129 different countries of the world! The class map only shows a small fraction of all of you that are enrolled in the course. Some of you hope to use this course as a refresher of knowledge after years graduated from college; some have been fascinated by chemistry for years and would like to know more about it; some are in the military so taking an online course is a perfect choice; and some are preparing to go to college or medical school! It is a great pleasure to have a diverse group of students with different backgrounds, life experiences, and goals in the course.

Summary of Previous Week

- I hope you already found out how we captured the course logo from video 1-6: colored flames. Wasn't that fun to watch?
- There are some great discussions on the forum about the particle-wave duality of light. You might be interested in checking this TED-ED demonstration out.
- About textbooks: to study this course alone, you don't necessarily need a textbook, and many of you have found online resources. For further exploration, check out Nivaldo Tro's Introductory Chemistry Essentials or any other General Chemistry textbook of your choice. Working through the problems at the back of appropriate chapters can be very helpful in solidifying your understanding and problem solving skills.

Figure 5. Screen Capture of a Course Email from the 2014 S & S.

On the key course pages, navigation was used to indicate clearly where the students were at the moment. Relevant images were placed on several pages to increase visual appealing. In addition, white spaces and colors were designed to make the pages accessible to various learners, like the screen capture in Figure 6 of the syllabus page of the 2015 R & R.
One example of an explanation for the incorrect options of a multiple-choice question in a weekly exercise in the 2015 R & R is shown below. Students who selected any of the incorrect options in this question would see a box containing the explanation next to the choice immediately after submitting the exercise:

Balance the equation on a piece of paper and find out if elements equal on the left and right. Try again! A balanced equation will have the same number of each element on both sides of the reaction arrow. Video 4–6 discusses balancing chemical equations.

**Evaluation**

Formal evaluation needs to be conducted in order to determine how well the motivational design was (Keller, 2010). The major evaluation question of this project was what learners’ perceptions of the motivational strategies applied in the course were. The
evaluation question was to explore learners’ reactions and perceptions of the motivational strategies that were incorporated into the course.

**Major changes between iterations.** During the short time period that was allowed to make revisions to the second MOOC, informal feedback that I obtained from the discussion forum and from the instructor, the other course team member, and other designers were used as the major sources to revise the motivational strategies between the two iterations. Visual changes on course pages were employed to make the course more appealing in the 2015 R & R based on the feedback from an expert in web design. More white spaces were included to make the page more readable. The navigation system of the course pages was modified with colors indicating current pages. Light grey background color was used to differentiate content with white background color when presenting weekly topics in the syllabus. Images on the course pages that were only for decoration purposes were considered unnecessary and were removed in save space and to eliminate extra information. All these changes were made in order to increase learners’ attention on these pages. Previous students’ statements about their experience in the course were included in one course page in the 2015 R & R to provide relevance of these courses and also to catch attention.

Most weekly exercise had explanations on an option-level. These explanations were written by a chemistry professional who volunteered to help. The explanation of one option in a multiple-choice question would display if it was selected as the correct answer. Explanations for the correct options were mainly praising and sometimes emphasizing the important concepts. Explanations for the incorrect options included
revealing the related concepts and pointing to the correct videos which discussed the concepts. Sometimes key equations were incorporated to remind learners. Due to platform limitations, several question types could not include proper explanations, such as multiple answer questions. These questions did not include any explanations.
Chapter 5: Data Analysis

In this chapter, I will discuss the data analysis results including quantitative results from surveys and qualitative results from interviews and design journals. The program evaluator from the university offered the Coursera courses, helped link the pre, mid and post-course surveys by respondents’ user ID and provided fake user IDs for each of the two courses so that no participants could be identified. The analysis of the survey results was performed using the software *SPSS 23 Premium* for Macs. Of the total 46 interviews with both chemistry MOOCs participants, 32 of them were transcribed by the transcription service *CastingWords*; the researcher then transcribed the remaining 14 interviews. Qualitative interview results were coded and organized with *NVivo 10.2.1* for Macs. The interviewees were numbered as SS1 to SS16 and RR1 to RR30 in the data analysis.

Demographics of Survey Participants

The pre-course survey included questions about demographic information. For the 2014 S & S course, 695 out of 3,761 learners took the pre-course survey. The approximate response rate of the pre-course survey was 18.5%. After dropping the 16 duplicates, the final sample size for the 2014 S & S pre-course survey was 679. After removing invalid data, the mean age of the 596 students in the 2014 S & S was 33.51 with a standard deviation of 15.41 and a minimum age 12 and maximum age 78, as shown in Figure 7.
For the 2015 R & R, 1,248 out of 5,824 students took the pre-course survey. The approximate response rate was 21.4%. After dropping the 33 duplicates, the final sample size for the 2015 R & R pre-course survey was 1,215. After removing missing and invalid data, the mean age of the 1,086 students in the 2015 R & R was 34.7 (SD=14.97) with a minimum of age 8 and maximum of age 87, as shown in Figure 8.
Figure 8. Age Distribution of Students in the 2015 R & R.

For gender question in the pre-course survey in the 2014 S & S course, 621 students answered it. The numbers (and percentages) of male, female and other were 292 (47.0 %), 325 (52.3 %), and 4 (0.6 %), respectively.

In the 2015 R & R, 1,134 participants responded the gender question in the pre-course survey. The numbers of male, female and other were 510 (45.0 %), 613 (54.0 %), and 11 (1.0 %), respectively.

In the 2014 S & S, of the 645 responses to the question of whether English was their first language, 361 (56.0 %) replied yes and 284 (44.0 %) replied no.
In the 2015 R & R, of the 1,149 responses to the question of whether English was their first language, 646 (56.2%) replied yes and 503 (43.8%) replied no.

**Educational Background.**

The highest education completed or degree earned question contained 11 options. In the 2014 S & S, 618 total participants who answered this question. The degrees and numbers are shown in Figure 9. Among all the respondents, the largest number of participants who answered this question obtained bachelor’s degrees (30.1%) while the least respondents had no schooling (0.3%).

*Figure 9.* Highest Education Completed or Highest Degree Earned of Students in the 2014 S & S.
In the 2015 R & R pre-course survey, the total number of responses to this question was 1,116. The number and percentage of each category of the highest education completed or degree earned question are presented in Figure 10. Among all the respondents, the largest number of participants who answered this question obtained bachelor’s degrees (27.2 %) while the least respondents had no schooling (0.4 %).

Figure 10. Highest Education Completed or Highest Degree Earned of Students in the 2015 R & R.

Another question was whether the students in the course were enrolled in an academic program. The results showed that in the 2014 S & S, of the total 617 responses, 180 were enrolled as full-time students, 53 were part-time students, and 384 were not students in any academic programs.
In the 2015 R & R pre-course survey, of the total 1,114 responses to this question, 263 were enrolled as full-time students, 129 were part-time students, and 722 were not students in any academic programs.

A further question was asking the students’ current employment status. A total of 606 students responded this question in the 2014 S & S, the most participants were employed full-time (37.8 %) while the least were homemaker, taking care of a family member or on maternity/paternity leave (5.1 %). All numbers of each employment status are shown in Figure 11.

![Employment Status of Students in the 2014 S & S](image)

*Figure 11. Employment Status of Students in the 2014 S & S.*
A total of 1,102 participants responded this question in the 2015 R & R, the most participants were employed full-time (41.6 %) while the least were retired (5.0 %). All numbers of each employment status are shown in Figure 12.

**Figure 12.** Employment Status of Students in the 2015 R & R.

**Interview Participants.**

Because the interview procedures included a survey link in one course email, the participants were paying attention to course emails and participating in the chemistry courses to some extent. The interview invitation was through a course email, students needed to: (a) read the email; (b) click the link to launch the survey; (c) fill out the whole survey; (d) leave their contact email addresses indicating they were willing to participate in the interview; and (e) respond to the interview scheduling emails sent by the
researcher. Except for the fact that the interviewees paid attention to course emails and clicked links to fill out surveys, there were other factors that separated the interview participants from the general course attendees. Most of the interviewees completed the course with a few exceptions of participants that had one or two weeks of materials unfinished. The majority participated in course activities and kept on track each week. They all had clear motivations for enrolling in MOOCs rather than traditional courses. They were somewhat self-motivated and had a high level of self-discipline. They used several study strategies to enhance their learning when taking the courses. Below is a statement by an interviewee, who discussed choosing to participate in course surveys because of reading course emails:

   Particularly if they [the course team] release a new video, or they release a new week available already, this is the thing that I try to bring [my] attention [to] when they say, OK, week three, or week four is already available, or the final is all ready, and the deadline would be this. That's the thing that I try to...Of course, most of the time they send me a survey, I will try to answer that, too. (SS5)

**RQ1: Motivation for Enrolling in the Chemistry MOOCs.**

The first research question in this study is: what are MOOC learners’ initial motivations for enrolling in a course? The pre-course survey asked students to rate the importance of eight pre-defined statements as reasons of why they selected the course ranging from *very unimportant* to *very important*. In the 2014 *S & S, I think taking this course will be fun and enjoyable* obtained the largest number of participants’ ratings of either *somewhat important* (35.3%) or *very important* (44.5%), while *I am taking this*
class because the content is not available elsewhere had the least number of participants’ ratings of either somewhat important (17.3%) or very important (11.2%). Table 15 shows the eight statements with the numbers and percentages (in parenthesis) of each agreement level from the 2014 S & S.

The 2015 R & R pre-course survey asked students to rate the importance of eight pre-defined statements as reasons of why they selected the course. I think taking this course will be fun and enjoyable obtained the largest number of participants’ ratings of either somewhat important (39.5%) or very important (42.4%), while I am taking this class because the content is not available elsewhere had the least number of participants’ ratings of either somewhat important (17.8%) or very important (9.5%). Table 16 displays the numbers and percentages (in parenthesis) of participants’ ratings of each statement in the 2015 R & R.

The course activity question asked students what activity/activities they planned to do in the course. Activities included watching videos, participating in the course forums, earning a certificate, taking the quizzes, and taking the exam. In the 2014 S & S, watching videos received the most participants’ selections while participating in forums got the least selections. The numbers of each option were shown in Table 17.

The 2015 R & R course activity question asked students what activity/activities they planned to do in the course. Watching videos received the most participants’ selections while participating in forums got the least selections. The numbers of each option were shown in Table 18.
Table 15

*Importance of Reasons for Taking the 2014 S & S*

<table>
<thead>
<tr>
<th>Statement</th>
<th>Very unimportant</th>
<th>Somewhat unimportant</th>
<th>Neither</th>
<th>Somewhat important</th>
<th>Very important</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>This subject is relevant to my academic field of study</td>
<td>131 (20.5%)</td>
<td>33 (5.2%)</td>
<td>104 (16.3%)</td>
<td>136 (21.3%)</td>
<td>236 (36.9%)</td>
<td>640 (100.0%)</td>
</tr>
<tr>
<td>This class teaches skills that will help my job/career</td>
<td>120 (19.0%)</td>
<td>50 (7.9%)</td>
<td>111 (17.6%)</td>
<td>154 (24.4%)</td>
<td>195 (31.0)</td>
<td>630 (100.0%)</td>
</tr>
<tr>
<td>I want to earn some sort of credential that I can use to enhance my CV / resume</td>
<td>183 (29.3%)</td>
<td>69 (11.0%)</td>
<td>155 (24.8%)</td>
<td>116 (18.6%)</td>
<td>102 (16.3%)</td>
<td>625 (100.0%)</td>
</tr>
<tr>
<td>Because this course is offered by a prestigious university</td>
<td>135 (21.4%)</td>
<td>67 (10.6%)</td>
<td>151 (23.9%)</td>
<td>173 (27.4%)</td>
<td>105 (16.6%)</td>
<td>631 (100.0%)</td>
</tr>
<tr>
<td>I think taking this course will be fun and enjoyable</td>
<td>29 (4.6%)</td>
<td>29 (4.6%)</td>
<td>69 (11.0%)</td>
<td>222 (35.3%)</td>
<td>280 (44.5%)</td>
<td>629 (100.0%)</td>
</tr>
<tr>
<td>I'm curious about what it's like to take an online course</td>
<td>135 (21.6%)</td>
<td>69 (11.0%)</td>
<td>166 (26.5%)</td>
<td>132 (21.1%)</td>
<td>124 (19.8%)</td>
<td>626 (100.0%)</td>
</tr>
<tr>
<td>I am taking this course in conjunction with another learning experience</td>
<td>131 (20.8%)</td>
<td>40 (6.3%)</td>
<td>163 (25.8%)</td>
<td>151 (23.9%)</td>
<td>146 (23.1%)</td>
<td>631 (100.0%)</td>
</tr>
<tr>
<td>I am taking this class because the content is not available elsewhere</td>
<td>138 (22.0%)</td>
<td>87 (13.9%)</td>
<td>223 (35.6%)</td>
<td>108 (17.3%)</td>
<td>70 (11.2%)</td>
<td>626 (100.0%)</td>
</tr>
</tbody>
</table>
Table 16

<table>
<thead>
<tr>
<th>Importance of Reasons for Taking the 2015 R &amp; R</th>
<th>Very unimportant</th>
<th>Somewhat unimportant</th>
<th>Neither</th>
<th>Somewhat important</th>
<th>Very important</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>This subject is relevant to my academic field of study</td>
<td>229 (19.7%)</td>
<td>72 (6.2%)</td>
<td>189 (16.3%)</td>
<td>282 (24.3%)</td>
<td>390 (33.6%)</td>
<td>1162 (100.0%)</td>
</tr>
<tr>
<td>This class teaches skills that will help my job/career</td>
<td>187 (16.1%)</td>
<td>97 (8.4%)</td>
<td>196 (16.9%)</td>
<td>316 (27.2%)</td>
<td>364 (31.4%)</td>
<td>1160 (100.0%)</td>
</tr>
<tr>
<td>I want to earn some sort of credential that I can use to enhance my CV/resume</td>
<td>309 (26.9%)</td>
<td>139 (12.1%)</td>
<td>276 (24.1%)</td>
<td>254 (22.1%)</td>
<td>169 (24.7%)</td>
<td>1147 (100.0%)</td>
</tr>
<tr>
<td>Because this course is offered by a prestigious university</td>
<td>210 (18.2%)</td>
<td>125 (10.9%)</td>
<td>305 (26.5%)</td>
<td>320 (27.8%)</td>
<td>191 (16.6%)</td>
<td>1151 (100.0%)</td>
</tr>
<tr>
<td>I think taking this course will be fun and enjoyable</td>
<td>37 (3.2%)</td>
<td>48 (4.1%)</td>
<td>125 (10.8%)</td>
<td>458 (39.5%)</td>
<td>491 (42.4%)</td>
<td>1159 (100.0%)</td>
</tr>
<tr>
<td>I'm curious about what it's like to take an online course</td>
<td>227 (19.6%)</td>
<td>111 (9.6%)</td>
<td>312 (26.9%)</td>
<td>280 (24.2%)</td>
<td>228 (19.7%)</td>
<td>1158 (100.0%)</td>
</tr>
<tr>
<td>I am taking this course in conjunction with another learning experience</td>
<td>195 (16.8%)</td>
<td>103 (8.9%)</td>
<td>313 (27.0%)</td>
<td>331 (28.6%)</td>
<td>216 (18.7%)</td>
<td>1158 (100.0%)</td>
</tr>
<tr>
<td>I am taking this class because the content is not available elsewhere</td>
<td>258 (22.5%)</td>
<td>167 (14.5%)</td>
<td>410 (35.7%)</td>
<td>204 (17.8%)</td>
<td>109 (9.5%)</td>
<td>1148 (100.0%)</td>
</tr>
</tbody>
</table>
Table 17

*Activity/activities Planned of Students in the 2014 S & S*

<table>
<thead>
<tr>
<th>Activity</th>
<th>Numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Watching videos</td>
<td>616</td>
</tr>
<tr>
<td>Participating in forums</td>
<td>288</td>
</tr>
<tr>
<td>Earning a certificate</td>
<td>322</td>
</tr>
<tr>
<td>Taking the quizzes</td>
<td>579</td>
</tr>
<tr>
<td>Taking the exam</td>
<td>556</td>
</tr>
</tbody>
</table>

Table 18

*Activity/activities Planned of Students in the 2015 R & R*

<table>
<thead>
<tr>
<th>Activity</th>
<th>Numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Watching videos</td>
<td>1102</td>
</tr>
<tr>
<td>Participating in forums</td>
<td>521</td>
</tr>
<tr>
<td>Earning a certificate</td>
<td>613</td>
</tr>
<tr>
<td>Taking the quizzes</td>
<td>1046</td>
</tr>
<tr>
<td>Taking the exam</td>
<td>1006</td>
</tr>
</tbody>
</table>

Students’ motivations for taking MOOCs varied. When asked the reasons they chose the chemistry MOOC, the majority of interviewees took it because of interest in or to refresh some chemistry knowledge. One interviewee stated:

I picked this one for two reasons: first is I had high school chemistry and I also had chemistry all the way up to organic in college. But I don’t think I really got it. I think I did well, especially in organic chemistry by memorizing things. But I didn’t do as well in organic because it was more theoretical. But I wanted to go back and revisit it. Plus now there is no pressure. (RR19)

There were some interviewees who took the course because they either were going to study courses that needed chemistry knowledge or chemistry was related to their jobs, like the following statement points out: “As mentioned earlier, I’ve chosen a career in Chemistry, and I’ll do and learn everything possible in that to make it a successful reality.” (RR25)

Several non-native English speakers mentioned that they took the course to improve their understanding of English in the sciences. The following quote describes
that, in taking this course, the participant wanted to improve his English as well as understand the subject area:

There are too many reasons. First of all, it was ... I wanted to know about my English listening skills. So they do not get worse. The second point was the fact [that] I didn't know anything about chemistry. And that's why. (RR7)

Interestingly, a few of the participants took the chemistry MOOC because their children were studying chemistry and they wanted to study with them and to help them, as one interviewee SS8 mentioned: “I have a couple kids who are really interested in chemistry. So I thought I should probably know something about it before I started to help them with their projects.” Several interviewees took the chemistry MOOC because they wanted to challenge themselves. One interviewee stated: “Once you are my age, you are intellectually... you are out of it. And it keeps me challenged.” (RR3).

Most interviewees took at least one other MOOC besides chemistry. Their motivations for selecting the other MOOCs were mostly based on interest or career relevance, as one interviewee stated: “I'm a math tutor and also physics. So sometimes I just do courses just to refresh some topics or just to re-visit some of these things. I've done courses on calculus. There was one on physics. I've done astronomy.” (RR21).

Although generally speaking, most MOOCs do not offer college or other credits, there were schools or organizations that accepted the completion of MOOCs for some credentials. For example, an interviewee took MOOCs to maintain her teaching certificate as current. Another interviewee’s graduate program required students to take science courses; they agreed to accept science courses from a MOOC provider, which
was the major reason this interviewee took the MOOC. One interviewee explained in detail why he selected the MOOC on data analysis as follows.

Well, for example, a number of the Coursera courses I've taken that have to do with modern techniques with data. So I took courses and learned the R language – you know, the R platform for data analysis. By taking courses like that, which first of all equipped me with tools that I can use in my job, but also just kind of sharpened me a little bit – sometimes just the little unexpected thought connections, you know, that [is] just stimulated by something you wouldn't think it's related, but mainly just the direct skills. So I've used R quite a bit in my work since learning it. And I've applied things that I've learned. It's really more of the knowledge benefits me rather than how does the credential benefit me. Or, you know, how does the fact of taking a course benefit me, the direct value that I got from the content? (RR24)

**RQ2: Motivation in Terms of the ARCS.**

The second research question in this study is: how do learners perceive the ARCS motivational strategies that are used in the courses? A sub-question is: are there differences in learners’ motivation in terms of the ARCS model through the IMMS between the two MOOC courses? The Instructional Materials Motivation Scale (IMMS) was included in the mid-course survey for both the 2014 S & S and the 2015 R & R. In the 2014 S & S, 163 out of 10,399 learners completed the mid-course survey, indicating the response rate of the mid-course survey was approximately 1.57%. In the 2015 R & R, 266 out of 10,996 learners completed the mid-course survey, displaying the response rate
of the mid-course survey was approximately 2.42%. The duplicates responses and missing values for the two mid-course surveys were removed and reported in the later descriptive section. The reversed items in the IMMS based on the scoring guide in Keller (2010) were recoded for analysis. Reliability tests were performed to the whole IMMS and the ARCS four components respectively. Table 19 shows Cronbach’s Alpha for each of the components as well as the whole IMMS in the 2014 S & S.

Table 19

<table>
<thead>
<tr>
<th>Component</th>
<th>Cronbach's Alpha</th>
<th>N of Items</th>
<th>Valid N</th>
</tr>
</thead>
<tbody>
<tr>
<td>IMMS</td>
<td>.91</td>
<td>36</td>
<td>96</td>
</tr>
<tr>
<td>Attention (A)</td>
<td>.78</td>
<td>12</td>
<td>103</td>
</tr>
<tr>
<td>Relevance (R)</td>
<td>.77</td>
<td>9</td>
<td>108</td>
</tr>
<tr>
<td>Confidence (C)</td>
<td>.78</td>
<td>9</td>
<td>108</td>
</tr>
<tr>
<td>Satisfaction (S)</td>
<td>.82</td>
<td>6</td>
<td>104</td>
</tr>
</tbody>
</table>

Table 20 shows Cronbach’s Alpha for each of the components as well as the entire IMMS in the 2015 R & R.

The mean of the whole IMMS for each participant in the 2014 S & S was calculated and descriptive statistics are shown in Table 21. The mean.X function in SPSS was used to ensure that there were no more than 20 % of missing data in the IMMS and its four components, respectively. For the whole IMMS, the X in mean.X was set as 29 since 29/32 = 80.56%. In another word, if a participant had 29 responses out of the 32 questions, his/her mean score would be calculated by the mean.29 function.
Table 20

Reliability Statistics of the IMMS in the 2015 R & R

<table>
<thead>
<tr>
<th>Component</th>
<th>Cronbach's Alpha</th>
<th>N of Items</th>
<th>Valid N</th>
</tr>
</thead>
<tbody>
<tr>
<td>IMMS</td>
<td>.92</td>
<td>36</td>
<td>175</td>
</tr>
<tr>
<td>Attention (A)</td>
<td>.85</td>
<td>12</td>
<td>178</td>
</tr>
<tr>
<td>Relevance (R)</td>
<td>.74</td>
<td>9</td>
<td>180</td>
</tr>
<tr>
<td>Confidence (C)</td>
<td>.75</td>
<td>9</td>
<td>180</td>
</tr>
<tr>
<td>Satisfaction (S)</td>
<td>.82</td>
<td>6</td>
<td>179</td>
</tr>
</tbody>
</table>

Table 21

Descriptive Statistics of the 2014 S & S IMMS

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average</td>
<td>110</td>
<td>2.75</td>
<td>4.91</td>
<td>4.15</td>
<td>.470</td>
</tr>
<tr>
<td>Valid N</td>
<td>110</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 22 shows the descriptive statistics of the IMMS in the 2015 R & R.

Table 22

Descriptive Statistics of the 2015 R & R IMMS

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average</td>
<td>184</td>
<td>2.25</td>
<td>4.89</td>
<td>4.08</td>
<td>.515</td>
</tr>
<tr>
<td>Valid N</td>
<td>184</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

To compare whether students in the 2014 S & S and the 2015 R & R had different motivation in terms of the ARCS model through the IMMS, an independent t-test and a Mann-Whitney test were both run because of the potential distribution normality violation. The two tests provided the same results, so only the independent t-test results were reported. There was not a significant difference on the scores of the average of the IMMS for students in the 2014 S & S (N = 110, M = 4.15, SD = 0.470) and the 2015 R &
The results in the M-W test were $Z = -1.00, p = 0.31$.

**Attention.** There were 12 questions regarding attention in the IMMS. To ensure that at least 80% of data was not missing, at least 10 out of the 12 responses should not be missing. The descriptive statistics of questions related to attention in the IMMS are shown in Table 23.

Table 23

*Descriptive Statistics of the Attention Questions in the 2014 S & S*

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>A_ave</td>
<td>109</td>
<td></td>
<td>3.00</td>
<td>5.00</td>
<td>4.29</td>
</tr>
<tr>
<td>Valid N</td>
<td>109</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 24 shows the descriptive statistics of the attention questions in the 2015 R & R.

Table 24

*Descriptive Statistics of the Attention Questions in the 2015 R & R*

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>A_ave</td>
<td>186</td>
<td>1.50</td>
<td>5.00</td>
<td>4.17</td>
<td>.575</td>
</tr>
<tr>
<td>Valid N</td>
<td>186</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

An independent-samples t-test was conducted to compare the mean of all the attention questions in the 2014 S & S and the 2015 R & R. There was not a significant difference in the scores of the attention questions’ mean for students in the 2014 S & S ($N = 109, M = 4.29, SD = 0.448$) and the 2015 R & R ($N = 186, M = 4.17, SD = 0.575$);
A Mann-Whitney U Test was also conducted to confirm this test had the same results ($Z = -1.35, p = 0.18$) as the independent t-test in case of normality violation.

Course email was an effective way to communicate with students. Emails could catch their attention and all the interviewees would at least skim through them for specific content. Emails should not be too long; otherwise students would not read them. One interviewee stated:

I think they are okay in terms of they [emails] are clear, they are informative. And they are not too short/not too long because sometimes you get like two lines and it tells you nothing. And sometimes this is so long, and right now I'm in the middle of something. And I have all of these other emails to read....I will look at this later. I think [that] [this, in this case, it was balanced not too short, not too long. If I remember correctly, it was like 'Welcome to Week Three.' The announcements were actually what you were putting in the emails. (RR20)

The content that the interviewees considered relevant and useful included upcoming content and reminders of due dates. Interviewees treated emails as ‘roadmaps’ that helped them see the big picture of the course. Additionally, the interviewees appreciated the encouraging tones in these emails and also thought it was a good way to connect with the instructor. One interviewee described how encouraging the emails were.

I thought they [weekly emails] were helpful. They reminded me of what I needed to do when and what was coming up. I found them helpful and sort of cheerleader-ish, and being a cheerleader is a good thing when we're all people
who are doing something else and then doing something extra. And sometimes you need a cheerleader to keep you going. (RR3)

The course pages such as syllabi and grading information also caught attention, especially at the beginning of the course. Students explored course pages to seek specific information they cared to know. Based on their purposes for taking the course, students looked for course content/introduction, course schedule, and assignments and their due dates. The following quote describes one interviewee’s exploration process: “I think--I don’t remember exactly--but I probably just clicked around…I don’t know what you call it--the website--that I clicked different links, and looked through the course requirement, and kind of explored what was there.” (RR26). Almost all interviewees did not remember the layout or specific elements like images or quotes from previous students that were purposefully designed on the course pages. A few interviewees commented on the pages and the information presented as being “clear” or “straightforward.” There were a few interviewees mentioned that they did not find some specific information on the course site but were able to find this information later. In general, when interviewees went on the course site to explore, they already had a clear idea of what information they were hoping to find so they tended to overlook other irrelevant information on these pages. For example, one interviewee pointed out in his comments that he kept track of grading and deadline information from the course pages.

I keep track of what the grading is, what is required of the course, and I was able to find that information to fill out my little grid all from the pages that are in there and that's been true for all of the due courses. So, it's not true for all of the courses
that I've taken at other schools. The way you guys have it set up I know where to look for everything. It's all very concise and it's clearly laid out, with the tabs across the top. It's clear to navigate what you're looking for. (RR2)

The design journal documented some technical problems such as the images used in course email sometimes did not show at the right position in different browsers, although the HTML codes were correct. It also recorded the suggestions made by a website designer about leaving enough white spaces on course pages to make them more visually appealing. The designer recommended making navigation system and location indicator more obvious so that learners would know immediately where to click and where they were at the time. The design journal recorded that there was a peak in lecture watching and course visiting numbers each Monday, when the course emails went out. It was noted that the first lecture in week one was viewed by the most learners, and followed by a significant decrease in numbers of watchers. Starting from week 2, only small decreases in numbers of watchers were observed each week.

**Relevance.** There were 9 questions regarding to relevance in the *IMMS*. To ensure that at least 75 % of data was not missing, at least 7 out of the 9 responses should not be missing. The descriptive statistics of questions related to relevance in the *IMMS* are shown in Table 25.

Table 25

| Descriptive Statistics of the Relevance Questions in the 2014 S & S |
|---|---|---|---|---|---|
|   | N   | Minimum | Maximum | Mean   | Std. Deviation |
| R_ave | 110 | 2.22   | 5.00    | 3.99   | .614           |
| Valid N | 110 |        |         |        |               |
Table 26 shows the descriptive statistics of the relevance questions in the 2015 R & R.

Table 26

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Std. Deviation</th>
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<tr>
<td>R_ave</td>
<td>185</td>
<td>1.67</td>
<td>5.00</td>
<td>3.95</td>
<td>.582</td>
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<tr>
<td>Valid N</td>
<td>185</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

An independent-samples t-test was conducted to compare the mean of all the relevance questions in the 2014 S & S and the 2015 R & R. There was not a significant difference on the scores of the average of the relevance questions for students between the 2014 S & S (N = 110, M = 3.99, SD = 0.614) and the 2015 R & R (N = 185, M = 3.95, SD = 0.582); t(293) = 0.550, p = 0.583. A Mann-Whitney test indicated the same nonsignificant results (Z = -0.47, p = 0.64) as the independent t-test.

Unlike taking mandatory courses, most interviewees chose to take MOOCs voluntarily for self-decided reasons (see the Motivation for taking MOOCs section). Thus, the relevance of these courses was also self-decided. For the chemistry course, a few interviewees mentioned that they were able to apply the knowledge in their everyday lives. Several interviewees felt that other subjects became clearer after they completed the chemistry course. In the following statement, an interviewee discusses how learning chemistry from the course changed his ways of thinking.
When I am doing this course [the chemistry course], I started to look at everything at different angles than I looked at it before [laughs]. Yes, of course. I can't think of any examples, but I look at everything and consider what [it] is that these atoms and molecules consisted of, their structures and how did they join in this state they are in now. What was the reaction which made them be so? I see everything a bit differently. (RR10)

Another interviewee explains that he applied the course knowledge to his everyday life.

I do [apply this knowledge], and especially after taking the class. The information stuff, it just kind of makes you more aware of what you have in everyday life. It makes you use your knowledge more. It just kind of awakens you to everything, at least to me – chemistry, I do a lot of hiking, so just natural surroundings, and it all comes together – the elements that are involved in chemistry. Then you look at the elements that are around you. (RR8)

Other interviewees found the course useful either in their future studies or their jobs. There were interviewees who used the chemistry MOOC as a foundation to apply to dental school. There were interviewees who planned to go to college or graduate school studying chemistry. There were also interviewees who worked in chemistry-related fields that found the chemistry MOOC helped their jobs. Below is a statement made by an international student who was going to college in the U.S.,

For me, the things that I learned there [in the chemistry MOOC] will be applied in my college studies. That's really important because it will make my transition to
college easier, especially because I'm an international student, so I got prepared to learn in another language. That was really important to me. (RR14)

Not all students were able to apply the knowledge learned in MOOCs to other circumstances. Interviewees mentioned that they chose the chemistry MOOC for a variety of reasons. Some of these reasons were limited, such as helping their kids learn chemistry. For these individuals, they were able to achieve the limited goals by taking this MOOC. To them, helping kids was all they had expected, so they did not consider other application or usage important, as the following statement shows. When asked if applying the chemistry knowledge in everyday life was important, one interviewee answered: “Hard to say, really. I don't think so. I don't have much application for chemistry or those things in my daily life other than helping the kids. So no, I think it was pretty much what I expected.” (SS8)

The design journal documented notable issues or questions occurred on the discussion forum. Approximately 90% of all posts were knowledge-related: learners posted questions that they had in watching videos, they asked why their solutions to certain exercise problems were incorrect, and they also provided peers with extra learning resources or more advanced topics. A few posts were about clarifications for the final exam – whether it only allowed one attempt and how long they were allowed to take the exam. Interestingly, posts’ titles included exam always had relatively higher number of views. The journal also included an example from another MOOC in which one of the community teaching assistants (who were usually students in previous sessions of the MOOC, performed well in the course, and participated frequently on the forum) recorded
a one-minute video telling how that course has changed her learning, and encouraged students not to drop the course after the first week. It might be a good idea to have peer students showing the relevance of the course and encouragement.

**Confidence.** There were 9 questions regarding confidence in the *IMMS*. To ensure 75% of data, at least 7 out of the 9 responses should not be missing. The descriptive statistics of questions related to confidence in the *IMMS* are shown in Table 27.

Table 27

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
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<td>110</td>
<td>2.00</td>
<td>5.00</td>
<td>4.05</td>
<td>0.586</td>
</tr>
<tr>
<td>Valid N</td>
<td>110</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 28 shows the descriptive statistics of the confidence questions in the *2015 R & R*.

Table 28

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>C_ave</td>
<td>184</td>
<td>1.78</td>
<td>5.00</td>
<td>4.03</td>
<td>0.566</td>
</tr>
<tr>
<td>Valid N</td>
<td>184</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

An independent-samples t-test was conducted to compare the mean of all the confidence questions in the *2014 S & S* and the *2015 R & R*. There was not a significant
difference on scores of the confidence questions’ mean for students between the 2014 S & S (N = 110, M = 4.05, SD = 0.586) and the 2015 R & R (N = 184, M = 4.03, SD = 0.566); t(292) = 0.269, p = 0.788. A Mann-Whitney test showed the same results (Z = -0.39, p = 0.70) as the independent t-test.

The majority of interviewees stated that they felt confident when taking the chemistry MOOC. When asked whether they felt confident to achieve their goals in this course, a large percentage replied positively. According to them, the instructor’s manner was very encouraging and sympathetic in her videos, which made them not feel anxious during the course. She explained difficult concepts clearly and organized her lectures very well so that the video lectures started with the easier concepts and then transitioned to more complex ones. All these positive factors the instructor included in the videos helped build the interviewees’ confidence so that they believed they were able to learn the materials, as stated in the following quote:

The way that she [the instructor] taught the class was very knowledgeable and very easy to understand. Remembering back – I know it's been a long time since I took it previously – but like I said, we didn't have the computers, we didn't have this kind of access to information. The way she taught it was really easy to remember, so I really got a good base structure for me to move on from there, a very good understanding of the basics. That made it really, really helpful. (RR8)

Other factors interviewees noted that affected their confidence included clear course information to inform students what was expected, the right amount of work in the course, and assignments that were manageable based on skills they could master. One
interviewee explained below how he increased confidence by taking the exercise multiple times and mastering them:

I thought the quizzes are actually pretty good in terms of boosting your confidence. Especially you got to try a couple times, three times I believe. They will...if you don’t get it quite right the first time, you could try it again and there was [were] different questions, but it was the same concept so you could really give yourself the full chance to do well whereas in a normal class you have one shot and that’s it, that’s your grade. You don’t have a choice to re-try again. I think that really helped in terms of you can do the quizzes until you feel like you mastered it. (RR12)

Satisfaction. There were 6 questions concerning satisfaction in the IMMS. To ensure that at least 80 % of data was not missing, at least 5 out of the 6 responses should not be missing. The descriptive statistics of questions related to satisfaction in the IMMS are shown in Table 29.

Table 29

<table>
<thead>
<tr>
<th></th>
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<th>Maximum</th>
<th>Mean</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>S_ave</td>
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<td>5.00</td>
<td>4.27</td>
<td>.669</td>
</tr>
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<td>Valid N</td>
<td>108</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 30 shows the descriptive statistics of the satisfaction questions in the 2015 R & R.
Table 30

Descriptive Statistics of the Satisfaction Questions in the 2015 R & R

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>S_ave</td>
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<td>1.17</td>
<td>5.00</td>
<td>4.14</td>
<td>.728</td>
</tr>
<tr>
<td>Valid N</td>
<td>184</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

An independent-samples t-test was conducted to compare the mean of all the satisfaction questions in the 2014 S & S and the 2015 R & R. There was not a significant difference on scores of the satisfaction questions’ mean for students in the 2014 S & S (N = 108, M = 4.27, SD = 0.669) and the 2015 R & R (N = 184, M = 4.14, SD = 0.728); t(290) = 1.520, p = 0.130. A Mann-Whitney test revealed the same results (Z = -1.70, p = 0.09) as the independent t-test.

Most interviewees felt satisfied, a sense of achievement, proud and happy after taking the chemistry MOOC. The reason that was most frequently referred to concerning where the satisfaction came from was the knowledge they had learnt in the course. At the same time, for those interviewees who tried to fill the chemistry knowledge gap or to refresh their knowledge because they either did not learn chemistry before or they took chemistry courses a long time ago. To be able to still learn things and pass the course constituted a great part of their satisfaction, as stated by the following interviewee:

I was pretty proud of myself. It’s been ten years since I took a science course. I was really happy that I got through it and I did well. I felt like I learned a lot. It was a great accomplishment of mine. It was a good mental challenge for me.

(RR12)
For many interviewees, to achieve their personal goals in the course, no matter what these goals were – they could be to gain some knowledge or to see how instructors from a different country taught – gave them great satisfaction. Several of the interviewees considered that such challenging feelings provided them with great satisfaction, as one interviewee stated: “It was for my personal challenge. I want to study hard to pass. I think it would be a deception if I did not pass...because I work hard!” (RR5). Even the simple sense of completion sometimes could add satisfaction. One interviewee expressed such a feeling after taking the course:

I went through [the course]. It's also an accomplishment. You may not have the degree that you wanted, but it's an accomplishment to just finish the course. Of course, it would be better if you had a better grade, but it's okay. We’ll survive. (RR18)

When discussing how much the statement of accomplishment (SOA) affected their satisfaction, a number of interviewees admitted that even though obtaining the SOA was not their goal for taking the course, the SOA increased their satisfaction with the course, just as the following quote points out:

My motivation isn't primarily for the certificate, but if I can accomplish my goal of what I'm trying to learn – the content I'm trying to learn – and getting a certificate at the same time, that is awfully nice! I would like that certificate…if it works. (RR2)

To the contrary, several interviewees did not care about the SOA at all, and one interviewee actually did not know if she obtained it even after the course had been over
for a while. These individual did not find the SOA of any particular use because the SOA was not their goal for taking the course, nor would they plan to use the SOA to find a new job. One interviewee stated: “Not in this case. This course is not going on my resume, for me. So the SOA, in this particular case, didn’t have any bearing on that. It was my own personal pride, I guess.” (RR12).

The design journal revealed that when prompting learners on the forum to introduce themselves, many of them participated and greeted each other. Additionally, some learners saw familiar names and greeted each other. Most of the students who posted on the forum were interested in chemistry. Several of them mentioned that chemistry was a nightmare for them in school. In both MOOCs, at the end of the course, there were a few learners who posted their appreciation for the course and the instructor. These learners expressed that they were glad to learn the content and how much they appreciated the instructor.

**RQ3: Perceptions and Experiences in the Chemistry MOOCs.**

The third research question in this study is: what is MOOC learners’ experiences in the courses? Learners’ experience in the chemistry MOOC was both investigated in the post-course survey and the interview.

In this study, learners’ experience was described in eight categories: opinions on MOOCs, course activities and components, attitudes toward course, instructors, and study strategies.

**Opinions on MOOCs.** From the questions about their opinions on MOOCs, all interviewees expressed positive attitudes and appreciation toward MOOCs and their
providers. They appreciated the fact that a large number of MOOC courses were college-level, but unlike the expensive tuition to take college courses, MOOCs were free of charge. The interviewees also considered MOOCs wonderful because they could reach to millions of learners in different places of the world. MOOCs offered a great opportunity for students who could not access high quality courses, who could not afford to go to colleges, or who dropped out of school for some reason and later wanted to continue to study. The majority of interviewees also praised the flexibility that MOOCs provided. Students were free to choose the courses they liked and drop those that did not fit their needs; students could learn at their own pace at any time or place; and students could take rigorous courses while staying at home to take care of their children. As discussed above, part of this flexibility was due to offering the courses online while part had to do with the fact that most MOOCs did not offer credit nor were they part of any official curriculum in school or college. One interviewee stated the wide variety of choices with MOOC platforms:

The one way which could be helpful is in the fact that there are so many courses, so I think a lot of people maybe are interested in the classic topics, like math or science. But there are so much variety with MOOCs that people could find what interest them the most. So it may inspire those people. (RR9)

During the interviews, the participants were asked about what influences if any MOOCs had on traditional education. Most interviewees who had opinions on this issue believed that MOOCs might complement or improve traditional education. They recognized the value of using MOOCs as supplemental materials for students at school.
They also mentioned that the popularity of MOOCs might help change the unemployment situation. For example, it was hoped that employers would not judge candidates based solely on their formal college degrees but on the fact that they were lifelong learners engaging to educate themselves by taking various MOOCs. One interviewee pointed out that some MOOC instructors revolutionized their on-campus course pedagogy after teaching MOOCs. One interesting point made by an interviewee about how MOOCs influenced to traditional education is shown below.

I think it [MOOC] democratizes the education. There are subjects I would never have even looked for, and certainly never have found, were it not for the open online courses. Subjects I can study cheaply or even for free is important. Not everybody has the money for this. You know what I get, I don't even use it, but I got the free for lifetime signature track [certificate after course completion], from Coursera. (RR28)

**Course activities and components.** The question about how much each course activity contributed to students’ learning had answers ranging from one to five – one being *not at all* and five being *a great deal*. Of the six course activities, which were applicable in the chemistry MOOC, *videos* were selected as contributed the most to learning with a mean of 4.73 and a standard deviation of .68, while *discussion forums* were considered as contributed the least to learning with a mean of 2.35 and a standard deviation of 1.23. The means and standard deviations of all the seven course activities are shown in Table 31.
Table 31

*Each Course Activity Contributed to Learning of Students in the 2014 S & S*

<table>
<thead>
<tr>
<th>Activity</th>
<th>N</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>DiscussionForum</td>
<td>43</td>
<td>1</td>
<td>5</td>
<td>2.35</td>
<td>1.23</td>
</tr>
<tr>
<td>Videos</td>
<td>62</td>
<td>2</td>
<td>5</td>
<td>4.73</td>
<td>.68</td>
</tr>
<tr>
<td>Readings</td>
<td>42</td>
<td>1</td>
<td>5</td>
<td>3.24</td>
<td>1.41</td>
</tr>
<tr>
<td>Tests</td>
<td>57</td>
<td>1</td>
<td>5</td>
<td>4.28</td>
<td>1.03</td>
</tr>
<tr>
<td>Exercises</td>
<td>61</td>
<td>1</td>
<td>5</td>
<td>4.31</td>
<td>1.06</td>
</tr>
<tr>
<td>ExtraMaterials</td>
<td>51</td>
<td>1</td>
<td>5</td>
<td>3.16</td>
<td>1.33</td>
</tr>
<tr>
<td>Valid N</td>
<td>25</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

In the 2015 R & R, of the seven course activities, which were applicable in the chemistry MOOC, *videos* were selected as contributed the most to learning with a mean of 4.71 and a standard deviation of .73, while *discussion forums* were considered as contributed the least to learning with a mean of 2.17 and a standard deviation of 1.21. The means and standard deviations of all the seven course activities are shown in Table 32.

In the interviewees, when asked about what activities they participated in during the course, almost every interviewee mentioned they watched videos and completed most of the regular weekly assignments and/or the final exam. About half interviewees pointed out that they also completed most advanced problem sets. Most interviewees read the discussion forum posts and considered this activity beneficial for their own learning, but not many posted questions or answered others’ questions on the forum. The reasons for not posting or replying on forums included that the interviewees did not have the time to post, they did not think it was necessary to post, or they did not have the social needs to participate on forums. One interviewee answered why he did not participate in forums:
“Some people are taking this course for community. I was not taking this course for community. I could have cared less. I was interested since so many people were taking it, but I had no particular desire to communicate.” (SS16).

Table 32

<table>
<thead>
<tr>
<th>Activity</th>
<th>N</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>DiscussionForum</td>
<td>71</td>
<td>1</td>
<td>5</td>
<td>2.17</td>
<td>1.21</td>
</tr>
<tr>
<td>Videos</td>
<td>104</td>
<td>2</td>
<td>5</td>
<td>4.71</td>
<td>.73</td>
</tr>
<tr>
<td>Readings</td>
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<td>1</td>
<td>5</td>
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<tr>
<td>Tests</td>
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</tr>
<tr>
<td>ExtraMaterials</td>
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<td>5</td>
<td>3.06</td>
<td>1.29</td>
</tr>
<tr>
<td>PeerAssessment</td>
<td>53</td>
<td>1</td>
<td>5</td>
<td>2.62</td>
<td>1.57</td>
</tr>
<tr>
<td>Valid N</td>
<td>25</td>
<td></td>
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</table>

Those who posted their questions on forums all felt they had obtained helpful responses from the teaching assistants and from peers. Questions related to clarifying assignments problems and seek additional help to solve the problems were the most frequently posted types on forums. Not all interviewees who used the discussion forum were seeking help from others; there were a few individuals who answered others’ questions on forums quite often. They believed that by explaining concepts or providing reasoning to others could help themselves understand the content better, as one interviewee states:

Of course, yes [I participated in forums]. It became more easily for me to express some ideas when I post answers for some of the questions in the forum, but I need
to support it. I need some practice in chemistry and English too. I hope [laughs] if there was opportunity, I can use the opportunity with another course. (RR27)

**Video lectures.** Although, during most of the interview time, interviewees were not asked directly about the video lectures, during different parts of the entire interview, they commented frequently on the video lectures for the chemistry MOOC. Participants held overall positive attitudes toward videos, as one pointed out: “I found them very structured, on a good level, but still basic. And very well presented, structured, but also visualization was very good.” (RR13). Although the instructor’s performance was commented on most frequently, there were several other factors that interviewees appreciated in the videos. One factor concerned lab experiment videos: a lab instructor showed experiments, such as chemical reactions, that could be observed easily. Interviewees enjoyed watching these experiment videos and expressed the importance of including a lab section in online science courses. One interviewee stated: “Yeah, I like the demonstration videos, where you got to actually see the sodium and [indecipherable 20:05] explosions, see what that means, the nature – it was nice to have those. Even more of those would be nice.” (RR9). Another factor is video length: most videos in the chemistry MOOC were less than twenty minutes long, which was considered a good length for attention span. The following quote shows the relationship between video length and viewers’ attention: “You have a better attention in the beginning [of a video]. Later on and at the end of the lecture, your attention is less. All of the lectures are not quite long, so you have good attention in all of them.” (RR27). The following quote also demonstrates the lengths of most videos worked great for learners:
So it was a very good pick for me. The duration of the videos was anywhere from 10 to 15 minutes long and that was perfect. It was enough to allow you to sit down with a cup of coffee and put it on. You knew that it would be about 15 minutes. (RR23)

The final factor was good visual design in the videos: interviewees felt that the colorful texts and the dynamic animations on the slides were eye-catching and could increase attention. One interviewee considered the visuals eye-catching through the statement: “…in the videos there was always like a big titles and colorful things and graphs and that's really good. That's eye catching.” (RR14).

Assessments. The assessment was another important component in the course that the interviewees discussed heavily. Two types of feedback for assessment questions were mentioned in the interviews: corrective feedback and formative feedback. The former referred to the acknowledgement of whether a question was answered correctly or incorrectly while the latter meant the explanations of why certain answers were correct or incorrect. Corrective feedback raised interviewees’ curiosity and promoted deeper thinking about the questions they did not have correct answers, as one interviewee pointed out: “During the exercises even if you don't answer it correctly, your curiosity is already raised. You wanted to [laughs] know what truly is and it was very good.” (RR10). In addition, showing the questions with correct answers engendered feelings of reward and satisfaction to several interviewees. Even though the 2014 S & S did not include formative feedback and the 2015 R & R included formative feedback written by a chemistry professional, interviewees from both courses recognized the value of formative
feedback in assessments. Most 2014 S & S interviewees would like to have detailed explanations so they could learn why the questions were answered incorrectly previously. One interviewee explained how formative feedback could help learning especially with incorrect answers:

Yeah, because when you've got something wrong, it's good to... I would sit there and stare at the problem for a while and try to figure out where I screwed up, but I think once you've gotten it wrong, to have somebody explain exactly what the correct method was is handy. (SS3)

Most 2015 R & R interviewees found the explanations helpful, and they used the information in the explanations to re-watch some videos until they understood the relevant concepts. Below is a statement made by an interviewee from the 2015 R & R course.

That [quiz explanation] is indispensable. Yeah, that is so absolutely indispensable. And there were some of them [quiz questions] that didn't have that, where I couldn't figure out what I did wrong, where to go. And so having some explanations in there or just a tip of where to go back to and re-review it was really helpful. (RR2)

Three other components interviewees considered positive regarding assessments included: the fact that three attempts were allowed when submitting assessments, an extra week granted for a hard deadline, and optional assessments (the advanced problem sets) only for the advanced track (the distinction track). All three components were related to the flexibility that MOOCs provided. Offering multiple attempts to submit assessments
provided learners with more opportunities to master the assessments, and thus reduced common test pressures for several interviewees. One interviewee stated:

I like that the exercises, for one, allowed you to have three tries to complete them. Because some of them, the first go-around I wouldn't do as well. It was more of, "Oh, OK, so that's..." I wasn't understanding this. Maybe I needed to go back.

(RR8)

Several individuals also mentioned that they used the extra week for hard deadlines when they were overwhelmed by job responsibilities, family issues, or relatively long traveling, as the following quote shows: “…having the hard deadlines was nice because I know there was some people were okay there will be circumstances where you can’t get it done…that is the flexibility I haven’t had a lot in the past.” (RR4). Not all interviewees had the time or were willing to do all the assignments in the course, especially the more advanced ones. The chemistry MOOC contained regular weekly exercises that were necessary to complete the course. It also included optional bi-weekly advanced problem sets, which required more time and more complex problem solving skills. The step-by-step thinking and problem solving in the advanced problem set questions did not appeal to several interviewees. Gaining advanced knowledge beyond very basic skills was not a goal for many of them. Thus, they appreciated the option to have the advanced problem sets only required for the distinction track. An interviewee describes how having multiple attempts to submit assessments helped build her confidence in the course:
I like the fact that I was able to resubmit. And I did do that a couple of times because when I went through it, I didn't understand everything. But then when I went through it [again], I saw I got some wrong. I learned it, and that gave me confidence. Having the ability to go back actually helped me learn it and helped me gain more confidence. Whereas if I did only have one submission, I might have been really discouraged, and it might have lead [defeated] me. (RR2)

A few interviewees valued the variation of questions when they attempted the assignments at different times. They believed that the variations added rigor to the course because students could not just memorize the answers from the previous attempt; instead, they had to apply the concept, although the same concept, to the new version of question. If they answered correctly, they would feel that they had mastered the concept.

Additionally, a considerable number of interviewees suggested more ungraded exercises in addition to the existing assignments for students to practice with before they attempted graded assignments or exams. An interviewee recommended having more practice problems in the course and also admitted that it could be time-consuming to write:

I know it would probably take a long time to write [these practice questions], but if there were more practice problems to do, I think that would be helpful. Because the more you practice it, the more the concept gets drilled in. That was something I would have liked to see. Not maybe…ones that you have to complete to finish the course, but like…just more practice problems available would have been helpful. (SS3)
**Statement of accomplishment.** Of the total 11,430 students who were included in the final survey data in the 2014 S & S, only 2.0 % (236 students) passed the course and earned the statement of accomplishment (SOA). Similarly, of the total 12,334 students in the 2015 R & R, only 1.9 % (239 students) passed the course and earned the SOA.

The statement of accomplishment (SOA) brought up complicated issues and different feelings from interviewees. As discussed in the Satisfaction section, many interviewees admitted that obtaining the SOA increased their satisfaction with the course although a few interviewees did not care about the SOA at all. Several interviewees mentioned that the SOA was a kind of proof, which demonstrated the time and effort that they had spent as well as knowledge they had learned in the course. Additional major factors that made the SOA valuable included that it was a motivator to keep the interviewees on track during learning, and it was like a reward for completing the course.

The following quote was from one interviewee who discussed the SOA:

> The statement of accomplishment really is a graduation type of thing. It's where you receive some recognition for the effort that you put in to take something.... That was very important to receive that. That's an important part of the course that you complete it. And you get something back. (RR23)

The SOA was also used for social purposes. Many interviewees had already or were planning to post the SOA on their social media or to show it to family and friends. One interviewee mentioned: “I was proud. I post on my Facebook. It was good. For the people who don't know anything about Coursera, it like getting a statement of accomplishment from some university from United States, it's like wow! It is great.”
Interestingly, several interviewees considered showing the SOA to their current or future employers just to prove they were willing and able to learn new knowledge. One interviewee commented on using the SOA as a personal development opportunity, but it also could be shown to employers:

For me, it [SOA] matters a lot because I have that possibility to do classes that I want to have that distinction in...if they are more toward where my career is or continuing education. I know a lot of people will use these courses not for actual credit – continuing education credit – but for being able to show [that] this is the amount of time I spent on the subject. And I’m doing my personal development. Having that piece of paper means something to their boss or means something to them. (RR4)

Not all interviewees used the SOA as a motivator or to prove that they were life-long learners. A few interviewees, especially those who considered themselves older and had good and stable jobs, had a very clear idea of what they were trying to achieve by taking MOOCs. Thus, they considered the SOA of not much use professionally. Instead, they considered the SOA might be useful for people who were younger or about to start their careers, as this following statement points out:

It's [the SOA is] not terribly important because I already have a pretty clear view of what I'm trying to learn and why. I think for a lot of people it seems like that would be something – for someone who's younger – I mean. I'm old [laughs]. I've already had a career. So I'm not in the same position as probably a lot of people that would be interested in this kind of a course. So for those people, it might be a
lot more important. I'm just speculating. For me, personally, I would say probably not [useful]. (RR2)

**Attitudes toward course.** Learners’ experience with and attitudes toward the chemistry MOOC was mainly asked in the post-course survey. Table 33 shows the number of participants’ selections ranging from *Strongly Disagree* to *Strongly Agree* for the six statements about their satisfaction and opinions about the course in the 2014 S & S. One respondent responded *strongly disagree* to item 1, 3, 4, and 6, respectively.

**Table 33**

<table>
<thead>
<tr>
<th>Statements</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neither</th>
<th>Agree</th>
<th>Strongly Agree</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>For the amount of time I invested in this course, I'm happy with what I learned</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>27</td>
<td>37</td>
<td>68</td>
</tr>
<tr>
<td>The course materials were presented in an engaging manner</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>24</td>
<td>41</td>
<td>68</td>
</tr>
<tr>
<td>I would like to take a more advanced course in this topic</td>
<td>1</td>
<td>3</td>
<td>7</td>
<td>23</td>
<td>32</td>
<td>66</td>
</tr>
<tr>
<td>I found this course personally fulfilling</td>
<td>1</td>
<td>1</td>
<td>5</td>
<td>26</td>
<td>35</td>
<td>68</td>
</tr>
<tr>
<td>I learned what I was hoping to learn in this course</td>
<td>0</td>
<td>2</td>
<td>6</td>
<td>30</td>
<td>30</td>
<td>68</td>
</tr>
<tr>
<td>I felt I had the background required to do well in this course</td>
<td>3</td>
<td>4</td>
<td>13</td>
<td>19</td>
<td>29</td>
<td>68</td>
</tr>
</tbody>
</table>

Table 34 shows the number of participants’ selections ranging from *Strongly Disagree* to *Strongly Agree* for the six statements about their satisfaction and opinions about the course in the 2015 R & R. Two respondents responded *strongly disagree* to
item 3 and 6, and disagree to item 5 in Table 34. One of these two also responded disagree to item 1 and 4.

Table 34

<table>
<thead>
<tr>
<th>Learners’ Experience in the 2015 R &amp; R</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neither</th>
<th>Agree</th>
<th>Strongly Agree</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>For the amount of time I invested in this course, I'm happy with what I learned</td>
<td>0</td>
<td>2</td>
<td>10</td>
<td>40</td>
<td>55</td>
<td>107</td>
</tr>
<tr>
<td>The course materials were presented in an engaging manner</td>
<td>0</td>
<td>1</td>
<td>9</td>
<td>41</td>
<td>56</td>
<td>107</td>
</tr>
<tr>
<td>I would like to take a more advanced course in this topic</td>
<td>2</td>
<td>2</td>
<td>17</td>
<td>32</td>
<td>54</td>
<td>107</td>
</tr>
<tr>
<td>I found this course personally fulfilling</td>
<td>0</td>
<td>3</td>
<td>19</td>
<td>44</td>
<td>41</td>
<td>107</td>
</tr>
<tr>
<td>I learned what I was hoping to learn in this course</td>
<td>1</td>
<td>3</td>
<td>11</td>
<td>54</td>
<td>38</td>
<td>107</td>
</tr>
<tr>
<td>I felt I had the background required to do well in this course</td>
<td>4</td>
<td>2</td>
<td>28</td>
<td>40</td>
<td>33</td>
<td>107</td>
</tr>
</tbody>
</table>

Students were also asked to rate their experience in the chemistry MOOC on a scale of one to seven – one being poor and seven being excellent. A total of 68 participants answered that question in the 2014 S & S. Approximately 75% participants rated their experience either six or seven. The numbers of each score selected are shown in Figure 12.
A total of 107 participants in the 2015 R & R rated their experience in the course. Approximately 70% of participants rated their experience either six or seven. The numbers of each score selected are shown in Figure 13.

In two consecutive questions in the post-course survey, students were asked to rate their knowledge before taking and after the chemistry MOOC on a scale of zero to ten – zero being knowing nothing and ten being an expert. The total responses of each question were 66 in the 2014 S & S. The mean and standard deviation of each question are shown in Table 35.
Figure 14. Ratings of Experience of Students in the 2015 R & R.

Table 35

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>KnowledgeBefore</td>
<td>66</td>
<td>0</td>
<td>10</td>
<td>3.94</td>
<td>2.51</td>
</tr>
<tr>
<td>KnowledgeAfter</td>
<td>66</td>
<td>2</td>
<td>10</td>
<td>6.70</td>
<td>2.10</td>
</tr>
<tr>
<td>Valid N</td>
<td>66</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

In the 2015 R & R, 106 participants answered the knowledge before question while 105 answered the knowledge after question. The mean and standard deviation of each question are shown in Table 36.
Table 36

Mean and Standard Deviation of Knowledge before and after Taking the 2015 R & R

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>KnowledgeBefore</td>
<td>106</td>
<td>0</td>
<td>10</td>
<td>3.95</td>
<td>2.30</td>
</tr>
<tr>
<td>KnowledgeAfter</td>
<td>105</td>
<td>1</td>
<td>10</td>
<td>6.83</td>
<td>2.14</td>
</tr>
<tr>
<td>Valid N</td>
<td>105</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Students were asked how the chemistry MOOC learning experience compared with other online courses they had taken in the post-course survey. Options included *much better, better, about the same, worse* and *much worse*. The most respondents considered the chemistry MOOC was *about the same* compared to the other online courses they had taken. More participants in the project considered the chemistry MOOCs *much better* or *better* than their previous online courses than *much worse* or *worse*. No respondent selected the chemistry MOOC was *much worse* than other online courses. Figure 14 shows the numbers of participants who selected the four options indicating their experience in the *2014 S & S* compared to other online courses.

The most respondents considered the chemistry MOOC was *about the same* compared to the other online courses they had taken. More participants in the project considered the chemistry MOOCs *much better* or *better* than their previous online courses than *much worse* or *worse*. Only one respondent selected the chemistry MOOC was *much worse* than other online courses. Figure 15 shows the numbers of participants who selected the four options indicating their experience in the *2015 R & R* compared to other online courses.
During the interviews, the interviewees were asked their experience in and attitudes toward the chemistry MOOC. Despite the fact that a few interviewees suggested that the assessments could be designed better and the discussion forums were not quite helpful, all interviewees held overall positive attitudes toward the course and appreciated the opportunity to learn chemistry in the course. An interviewee commented on the course rigor and quality and stated his praise, too:

I would just say I think this is an excellent course overall. I'm very impressed with it. And, like I said, I've taken several of the courses. The rigor of this and the quality of the instruction is really good. It's really, really good. Overall I'm very impressed with it. I have a very good impression. (RR2)
Figure 16. Comparing the 2015 R & R with Other Online Courses

Instructors. The post-course survey included a matrix question about students’ opinions of the course instructor. Much fewer participants selected strongly disagree or disagree to the four statements about the instructor than strongly agree or agree. The numbers of all the four statements are shown in Table 37.

Table 37

<table>
<thead>
<tr>
<th>Statements</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neither</th>
<th>Agree</th>
<th>Strongly Agree</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>The instructor explains things in very orderly ways</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>21</td>
<td>40</td>
<td>63</td>
</tr>
<tr>
<td>I would take another course from the instructor</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>22</td>
<td>40</td>
<td>64</td>
</tr>
<tr>
<td>The instructor explains difficult things clearly</td>
<td>0</td>
<td>1</td>
<td>4</td>
<td>21</td>
<td>38</td>
<td>64</td>
</tr>
<tr>
<td>The instructor communicates enthusiasm for the subject</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>15</td>
<td>45</td>
<td>64</td>
</tr>
</tbody>
</table>
The opinions of participants in the 2015 R & R are shown in Table 38.

Table 38

<table>
<thead>
<tr>
<th>Statements</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neither</th>
<th>Agree</th>
<th>Strongly Agree</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>The instructor explains things in very orderly ways</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>29</td>
<td>67</td>
<td>103</td>
</tr>
<tr>
<td>I would take another course from the instructor</td>
<td>1</td>
<td>2</td>
<td>5</td>
<td>31</td>
<td>65</td>
<td>104</td>
</tr>
<tr>
<td>The instructor explains difficult things clearly</td>
<td>1</td>
<td>1</td>
<td>5</td>
<td>36</td>
<td>60</td>
<td>103</td>
</tr>
<tr>
<td>The instructor communicates enthusiasm for the subject</td>
<td>0</td>
<td>1</td>
<td>5</td>
<td>22</td>
<td>76</td>
<td>104</td>
</tr>
</tbody>
</table>

Interviewees considered instructors and how they performed in MOOC videos very important. In the chemistry MOOC, interviewees mentioned several factors that they appreciated: how the course instructor used the course videos to enhance her teaching and her naturalness in these videos. One frequently referred to factor related to the instructor’s ways of teaching. An example was that she explained content clearly in the videos so that the students were able to understand concepts either they did not understand before or they considered were difficult. An example of her teaching style can be seen in the following statements by one interview:

I found them [the videos] very easy to follow. I thought her [the instructor’s] manner of speaking and presentation skills are very fluent, very relaxed and natural. It was very much like just being in the classroom – where someone is just talking and writing on the board. It just seemed very natural and familiar, you know. I thought it was actually very helpful that she could…actually write out
those chemicals reaction equations or whatever. She was writing the same symbols that she was talking about. It kind of helps focus attention and keeps you following attentively. (RR24)

Interviewees mentioned that the instructor’s communication skills were great and helpful. They also frequently commented on the instructor’s personality, which included being enthusiastic, engaging, encouraging and a real human with feelings. One interviewee commented on the instructor’s personality in the videos as follows:

I thought they [the videos] were great because of the instructor. She was very interactive, very engaging. I thought she has a good personality to…she kept laughing. Sometimes she makes mistakes; she’d point them out. She didn’t come across [like] she took herself too seriously, which is a good thing. That was positive. That kept me interested in watching the videos. (RR12)

The other factor that interviewees pointed out frequently in the interviews was the technology used in creating these videos. Most of the time, the instructor was either shown in full screen or in a small box in a corner of the video, which added teacher presence in the videos. The instructor used a MacBook Pro and a tablet with a stylus to write and recorded the videos. The writings and drawings could be recorded and later erased to make space for new drawings in the videos. Students reacted positively to the writings and drawings and also the engaging power of the virtual presence of the instructor in the video, as one interviewee stated:
I liked the intro with the drawings and the picture of the professor. I liked it. She's a person who really loves chemistry. That's obvious, and that motivates you. She really tries to make you enthusiastic for chemistry, and that works. (RR11)

Another technology that was used in the videos and appreciated by many interviewees was the in-video question. These interviewees considered these questions to be able to hold their attention and allowed for participation during the video to some extent. After each in-video question, the instructor would typically explain, step-by-step, how to solve the problem. Several interviewees considered this process beneficial for learning. They also valued the fact that sometimes the instructor used examples and metaphors to help demonstrate the points. However, a non-American interviewee pointed out specifically that the metaphor of a type of sport the instructor used to demonstrate certain chemistry concepts was difficulty for him to understand because the sport was not common in his country. One interviewee commented on the in-video questions and the way the instructor explained the concepts after the questions:

Sometimes the lesson is accompanied by one exercise. So you start the lesson and you see the problem, but you don’t know how to solve it. Then Prof. C starts to say how to do it. Then step-by-step, there is a stop for you to answer. If you arrive at the end and you make all the answers correct [correctly], [this] means that you were really able to solve the problems. So your knowledge is better at the end than the beginning of the video. It’s a pleasure. (RR16)

Although interviewees considered video lectures and instructors as being critical to their success in learning from or continuing with the MOOCs, lack of engaging
instructors or boring lectures were not commons reasons that these individuals dropped MOOCs. Boring video lectures was one common factor mentioned by interviewees that surely affected their learning experience, but most interviewees would not drop a course only because of boring lectures or lack of engaging instructors. Instead, not having enough time and the content not matching their expectations were the most common reasons that these interviewees dropped courses. As the following statement points out:

Well, I’m not going to give up on a professor just yet. But it all depends. Is the material difficult? Can I handle this material? Can I understand the material? If I can’t understand the professor, I will do my best to look at the texts. If I still don’t understand, I will leave. I will go to somewhere else. (RR15)

**Study strategies.** Although study strategies were not requested in the interviews, interviewees mentioned several strategies they used to help learning. Learning from mistakes in assignments and using outside references (e.g. a chemistry book, other chemistry videos) were the two most frequently mentioned strategies employed during the course. One interviewee stated:

I fortunately had a chemistry book that I could also correspond with it. It actually ran right along with it, so that really helped myself as well…Trying to get myself prepared to take the quizzes every week and staying on task. (RR8)

Learning from mistakes meant that interviewees would read explanations of the question (if any), watch video lectures again, or go to the forum to seek help when they answered a question incorrectly. The Internet was one of the most commonly used tools;
several interviewees stated that they “Googled” the concepts they did not understand, as the following quote states:

I actually spent quite a bit of time just going out and researching it on my own because...I just felt like…I don’t really get it. I don't understand how to distinguish between these. There weren't really any questions like that [hard] on the final, but [I was Googling information] to the level that I was looking for. (RR2)

In addition, note taking, planning ahead, and setting regular times to study were also common learning strategies to which the interviewees referred. Sometimes planning started when they first logged onto the course and read the course syllabus and schedule. A few interviewees would estimate the time required to take the course and plan their schedule accordingly or decide to drop the course if it did not fit their schedule, as the following quote stated:

I'm expecting to take the whole class, so as soon as it becomes available, I go through, read the syllabus, get myself ready to go, and get myself on a mental schedule of what I need to do and when. (RR8)

Several interviewees pointed out that they spent regular time dedicated to the course. For example, they would spend an hour a day during lunchtime or several hours on Sunday afternoon working on the course. Besides these strategies discussed above, most interviewees were aware of their energy and attention level while watching video lectures. If they realized that they were too tired, they would stop studying and take a break or stop and return to the course hours later. While watching video lectures, they adjusted the play speed to suit their needs and used subtitles and slides as references. The
The following statement describes exactly how this interviewee planned his time when taking the course:

That way [reading the course schedule], I knew I need to have this video watched by this time. And this one by this one [time]. I have this length of time to get these videos watched by. Because sometimes I would have to do two or three videos in a night, depending on my schedule for the week. I knew exactly where I needed to be. And this has to be done by here. And then there's this many – so I know that there's this many – videos per chapter. This is when the quiz is due. So it [all] really helped me to structure my week. (RR8)

**Chapter Summary**

The present chapter reported findings of the study related to designing ARCS motivational strategies into MOOC environments. Demographic and educational information of the participants was introduced. Then results were reported based on the first three research questions. The results indicated that experience in MOOCs included many course elements such as videos, assessments and SOAs. Although not as parts of the original research questions: instructor’s manners and study strategies were emerged as strong themes from the interviews and were introduced in this results chapter and discussed in the next chapter.
Chapter 6: Discussion

By surveying and interviewing a number of MOOC students in a design-based research (DBR) study, the present study aimed to gain a deep understanding of MOOC students’ motivation and what influences a few pre-designed motivational strategies – based on the ARCS model – had on learners’ motivation. In the two chemistry MOOCs included in this study, students participated in course activities, into which the pre-designed motivational strategies were integrated. Then part of these students voluntarily participated in a survey which examined their reactions to the MOOC course materials in terms of the ARCS model. Among these respondents, those who were willing to participate in an online interview were asked in detail about their perceptions of the motivational strategies and their experience in MOOCs. Besides the survey and interview data, the researcher’s design journal was also used as the third data source in the study.

The three research questions in this study are:

1. What are MOOC learners’ initial motivations for enrolling in a course?

2. How do learners perceive the ARCS motivational strategies that are used in the courses?

   2a. Are there differences in learners’ motivation in terms of the ARCS model through the IMMS between the two MOOC courses?

3. What are MOOC learners’ perceptions of and experiences in the courses?

The findings of the study indicated that participants enrolled in MOOCs for a variety of reasons, but the potential fun and enjoyment from taking the MOOCs was an important factor for a lot of these participants. The findings also revealed that participants
tended to focus on course information that was important to them based on their goals for the course and to ignore the other information that was irrelevant to their goals. However, participants did consider the video lecture a critical part of the whole MOOC, and how the content was presented in the videos affected their perceptions of the course as well as their motivation to continue the course. Additionally, a sense of satisfaction could result from different factors: from simply completing the course to gaining knowledge to obtaining a statement of accomplishment (SOA).

This chapter discusses the findings of the study and provides practical guidance for designing motivational strategies (based on the ARCS model) in MOOC environments. Recommendations for future studies are provided.

**Motivations Affect Participation**

Study data collected through the pre-course surveys and interviews revealed that learners enrolled in MOOCs for a variety of reasons. Kizilcec et al. (2013) stated that the variation of learners in motivation and intentions were due to the unlimited access of MOOCs. Among those reasons, interest in the subject area and the potential enjoyment from these MOOC were two important ones. This finding is consistent with previous reports (Belanger & Thornton, 2013; Breslow et al., 2013; Hew & Cheung, 2014). A large number of learners had very clear and specific goals when enrolling for a MOOC even though their motivations varied. Several learners’ goals, such as taking a course in order to help their children learn the subject, would rarely be found in traditional classrooms. Others had goals that were more similar to goals in traditional courses, such as passing all required assignments and completing the course successfully. Variations in
motivation for enrolling and specific goals learners set for themselves in the MOOCs are also consistent with several previous studies (Carbone, 2014; Rodriguez, 2012; Yuan & Powell, 2013).

Motivation can greatly affect learners’ behaviors and retention in a MOOC; thus learners’ participation levels in course activities vary widely (Halasek et al., 2014; Kizilcec, Schneider, Cohen, & McFarland, 2014). If videos serve the purpose well, learners who merely seek basic knowledge of a subject area probably will not participate in deeper discussions on the forum (Kizilcec et al., 2013). Of all the possible reasons that learners drop out of a MOOC, there should be one reason that learners who do not continue with a MOOC because it does not provide what they desire to learn. It is also possible that a large number of learners discontinue learning at certain stages of the MOOC because their goals have already been met without completing the whole course.

According to the results of the interviews conducted in this study, interviewees’ motivations during the entire, or at least the majority of the time, of the MOOCs, remained nearly the same. No interviewees seemed to lose interest in the course or be demotivated by any course components to drop the course. This result is quite possibly because the interview invitation was sent during the middle to the end of the course. At that time, perhaps only individuals who were still motivated enough to be active in the course would complete surveys and participate in interviews. Or maybe the participants/interviewees were self-regulated enough to keep themselves motivated throughout the entire course (see the Self-regulated learning strategies section below).
The varied motivations that learners have for enrolling in MOOCs can be used to design different ‘track’ in future MOOCs. A simple way to design such 'tracks' is, at the beginning of the course, to ask learners questions about what they are trying to achieve from the course. Then, based on these answers, learners will be presented with different materials and course components. For example, if a learner is looking for specific topics within a subject area, such as how to balance chemical equations, this learner can be presented with information about that topic as well as different types of problems to practice when balancing chemical equations. In this way, it is easy for the learner to assess whether she has mastered the topic she wants to learn. Learners do not necessarily have to leave the course after they have achieved their goals; instead, they can be given options to continue learning other topics if they find the course useful. The challenge of this approach is that it is more difficult to design such multiple ‘tracks’ than to design only one ‘track’ as most MOOCs currently do. Another challenge is that it is almost impossible to present every learner with an appropriate ‘personalized’ learning to fit his or her needs. To deal with these and other potential challenges, adaptive learning--with real-time and large-scale learning analytics--needs to be integrated into future MOOC environments.

When the ARCS model is used, the varied motivations and different goals bring challenges to designing the attention and relevance strategies when the learners take MOOCs. The results of this study showed that, when obtaining a course completion certificate was not their goal, learners would probably ignore messages concerning grading information in a MOOC. As an example, the chemistry MOOCs in this study
employed strategies that emphasized the importance of chemistry to several other related subject areas, like biology and quantum physics, might be considered irrelevant for learners who were required to take such courses by their academic programs or jobs. More discussions on integration of the ARCS model into MOOCs are presented in the next section.

**Motivation in Terms of the ARCS Model**

The *IMMS* measures learners’ reactions to the ARCS motivational design model-based materials. Compared to other three components in the ARCS model, the *IMMS* from both the *2014 S & S* and the *2015 R & R* indicated that, in the course materials, respondents considered attention as the best component and relevance as the worst. The same pattern was also revealed in the interviews. This is probably because many survey respondents and interviewees had a high interest in the course topic; thus, they maintained a relatively higher attention level in the course, at least at the beginning of the course. At that time, chemistry, the topic of the course in this project, was not a subject area required by many domains nor was it a subject in high demand. So participants did not consider the chemistry MOOCs high in relevance.

In terms of the ARCS components, the *2015 R & R* did not show significant differences from the *2014 S & S*. It is possible that these changes between the two iterations are too trivial to make a significant difference. Surprisingly, the *2014 S & S* had higher (but not significantly higher) scores in the whole *IMMS* as well as in all four components than measured in the *2015 R & R*. From the boxplots in Appendix L, it is obvious that there are more outliers below the lowest extreme in the *2015 R & R*. 
Possibly more survey respondents in the 2015 R & R might have negative feelings about the MOOC, which resulted in the lower scores in the IMMS. In the interviews, several interviewees in the 2015 R & R did mention that the last week of content seemed somewhat incomplete, which could be a possible explanation for the lower ratings in that MOOC.

Selectively paid attention. As noted, learners in both the 2014 S & S and the 2015 R & R had high attention scores when compared to relevance, confidence and satisfaction scores. One of the main channels to deliver motivational strategies was course email, which seemed to work well with participants in this study. Previous studies, although not in MOOC environments, have demonstrated the effectiveness of embedding ARCS strategies into online course emails (Huett, Kalinowski, et al., 2008; Huett, Moller, et al., 2008). ChanLin (2009) reported that it was effective to send frequent reminders and rewards to keep students continue learning. Although relevant images were inserted to enhance the emails and attract the readers’ attention, none of the students mentioned the use of images in the interviews. It is possible that these MOOC learners selectively paid attention to information that they cared about and ignored information that was not important to them. The instructor's supportive and encouraging tone in the emails was another way to attract attention that several interviewees noticed and appreciated.

This scanning and selecting pattern also occurred when learners browsed course pages: interviewees only scanned course pages that contained information they wanted to know. Depending on what they cared about, learners chose different pages to read and did not pay much attention to irrelevant information on these pages. Interviewees may or
may not have noticed other design components on course pages such as previous students’ statements about the course, but none of them considered these as unexpected, attention arousing, or interesting enough that they would mention them during the interviews. Instead, learners commented on course pages being “clear” and “straightforward” and that they did not have any difficulties finding information they needed.

**Self-decided relevance.** Among the four ARCS components in both the 2014 S & S and the 2015 R & R MOOCs, relevance had the lowest rating. Interviewees also expressed difficulty in drawing a sense of relevance from the course materials. It may be because chemistry is not in a high demand for jobs nor is it easily applicable to everyday life (at least not the topics introduced in these two MOOCs). Several interviewees from the chemistry MOOCs admitted that they did not perceive the course as relevant and that it was hard to draw relevance in subjects like chemistry. It is also possible that, due to the varied motivations and goals learners have in taking these MOOCs, learners perceive relevance differently. For example, the United States Department of Labor Bureau of Labor Statistics listed that the potential increase rate between 2012 and 2022 for chemist and materials scientists was 6%, which was lower than the 11% growth rate for all occupations (“Chemists and Materials Scientists,” 2014). Although Kizilcec et al. (2013) emphasized that many MOOC learners aimed for future career opportunities, the current study found that a large number of these learners were seeking intellectual challenges from the courses. Many learners are able to draw relevance from the materials in MOOCs according to their own goals for taking MOOCs. In the chemistry MOOCs, for example,
a few interviewees mentioned the course was useful because it helped them see things in life from a totally different perspective.

When designing ARCS strategies for MOOC learners, a balance between varied relevance and how to keep the course materials clear and concise needs to be taken into consideration. From this study it is evident that, to a great extent, for individuals with different motivations and goals, relevance is self-decided. For example, a percentage of learners emphasize the ways that knowledge from the MOOCs can be applied as relevant, yet, how to identify future career opportunities that use this subject area will appeal to a different percentage of learners. From the previous Attention section, it is clear that many MOOC learners selectively seek certain information from the course materials. Thus, they will lose interest if the course materials – course pages or emails – are too long with too many pre-designed relevance factors.

**High confidence.** Many MOOC learners in this study were self-confident; they believed that they could achieve their goals in the course. It is probably because the MOOCs were introductory level and required no prior chemistry knowledge. It is also possible that the learners who participated in surveys and interviews were capable persons who always believed in themselves. Several interviewees in the study mentioned the course design and their participation in activities helped increase their confidence during the MOOCs. Clear course introduction and grading information helped them create appropriate expectations for the course. Being able to master the content to pass the exercises/exams also enhanced learners’ confidence in the course. For example, an interviewee in the study mentioned that she was able to correct misconceptions or wrong
problem-solving procedures in her second or third attempt at some exercise problems; that encouraged her greatly and increased her confidence in the course. This is consistent with previous research on self-efficacy and learning goals: learners’ self-efficacy increases when there are progresses in learning, especially obvious progresses, and their goals are achieved or nearly achieved (Schunk, 1990).

Results concerning learners’ confidence showed that confidence-enhancing design strategies in course materials, especially in videos, were effective for many MOOC learners participated in this study. For particular learners who may consider the content as difficult, when the instructor shows sympathy and uses encouraging tones, it can ease learners’ emotions to some extent. As one interviewee pointed out: “The professor is a good teacher. And [even when] concepts are not simple, she encourages you and then makes you think that you can do it; and that helps.” (RR11). Existing studies have produced similar findings concerning influences that instructors could have on students’ confidence (e.g. Small & Gluck, 1994).

**Different sources of satisfaction.** In this study, satisfaction seemed to come mainly from three different aspects: knowledge learned, the statement of accomplishment gained, and the capabilities of learning and completing a course. The knowledge part is not hard to understand because a large percentage of interviewees chose the chemistry MOOC to meet an interest or to refresh knowledge. When their goals were achieved after taking the course, they would feel a sense of satisfaction even though several of them did not even finish all materials nor did well enough to pass the course. To successfully finish or pass the course was like a proof to a few interviewees that they were still able to take
courses and learn knowledge years after graduation. These individuals were proud of themselves when they followed all the deadlines and completed all work required.

The statement of accomplishment (SOA) is more complicated in terms of affecting learners’ feelings in the course. On the one hand, a number of interviewees mentioned that the SOA was not their goal for taking the chemistry MOOCs nor was it of any use for their careers. On the other hand, most of these individuals also admitted that obtaining the SOA at the end of the course generated a greater sense of satisfactory feelings about the course. Some would post their SOAs on social media to share with their family, friends, and perhaps future employers (Zheng, Rosson, Shih, & Carroll, 2015). If the MOOC provider was to remove the SOA, most interviewees would still enroll for courses that they selected, but their experience in these courses would be different. It is possible that other forms of proof, like digital badges (Gibson, Ostashewski, Flintoff, Grant, & Knight, 2013), will have the same effects on learners’ satisfaction as the SOA does. Such learners need this kind of ‘official’ confirmation from the course team to demonstrate their achievement in the course.

**Learners’ Experience in MOOCs**

**Perceived influences to education.** Most participants – both survey and interview participants – in this study appreciated the learning opportunities MOOC platforms provided. They also considered the phenomenon of MOOCs promising and a force that might change education in the future. MOOCs reach millions of learners from hundreds of countries in the world. Without MOOCs, many learners could never study certain subjects taught by world-renowned professors. For these learners, MOOCs open
the gateway to knowledge and provide more opportunities to learn and enhance their careers. In fact, several interviewees in this study mentioned that they were curious about how instructors in the U.S. taught and whether, by taking MOOCs, they would discover differences in teaching methods from instructors in their own countries. It would not be surprising if, because of the MOOCs they took, many learners decide to study certain subject areas or apply to study abroad. On an even broader scope, many learners start to think about the influences MOOCs may have on traditional education. For example, a few interviewees in this study considered that MOOCs could have positive influences, in many ways, on traditional education in the future. When MOOCs come into play, education would not be limited to a certain place at a certain time. Additionally, because of free available courses and materials, the cost of formal education may be decreased greatly. MOOCs also provide everyone with the same learning opportunities, so, in a sense, MOOCs ‘democratize education’ as the phrase one interviewee in this project used.

**Videos and instructor’s manners matter.** In MOOCs, the video lecture is one of the most important course components in that most learners plan to and actually participate in watching videos. In this study, survey results showed that the most learners planned to watch videos, and videos contributed the most with their knowledge gain. This is consistent with the results of the study by Seaton, Bergner, Chuang, Mitros, and Pritchard (2014), in which they found that compared to other course activities, MOOC learners spent the most time watching videos. This is not difficult to understand because, in MOOCs, videos are the main source for instructors to deliver knowledge. Many
learners judge the quality of a course based on video design. One interviewee in this project even dropped out of one MOOC simply because the slides in the videos, with so many animations and special effects, were too complicated. The instructor’s performance in videos is significant and influences learners' experiences as they take MOOCs. Participants in this study expressed the excellence the instructor performed in the videos. The significance of instructors is consistent with findings presented by Small and Gluck (1994), in which they reported that students constantly associated the instructor with the four components of the ARCS model. Additionally, Kay et al. (2013) expressed the need to train instructor to teach online because good face-to-face classroom instructors were not necessarily great online instructors.

In contrast, the fewest learners planned to participate in the discussion forum, and, in reality, the number of learners who actually participated in the forum was the smallest. This result is consistent with existing studies on discussion forums in MOOCs (Breslow et al., 2013; Kop et al., 2011). Several participants mentioned that they did not perceive the social needs when taking MOOCs. It is possible that most MOOC learners are full-time working professionals who have limited spare time to spend on the course, so these learners choose to participate in only the most important course components, such as watching course videos and completing homework. This may also occur because MOOCs are unlike traditional courses in schools or universities where students engage in well-formed learning communities. Many MOOC learners may not feel comfortable posting or replying on the forum with peers that they do not know or they may not feel the need to socially interact, so they choose to not participate in forums. It is also likely that the
forum is not helpful, like some participants in this study expressed that they did not find the forum helpful so they did not use it.

**Varied feelings toward the statement of accomplishment.** Statement of accomplishment (SOA) is awarded to learners who successfully pass the course requirements. A large number of participants in this project who obtained the SOA felt the sense of achievement and pride. But more importantly, these individuals treated the SOA as a learning confirmation which proved and affirmed the time and effort they spent on the course. Interestingly, several participants considered other forms of acknowledgement, like digital badges, would have the same effect as the SOA had. However, not many participants considered that if the course instructor sent out an email to emphasize all the major topics in the course and the approximate time required to complete the course, it would promote the same feelings. It is very likely that most educational systems in the world use certain forms of rewards – colorful stars in early grades or scores/rankings later – to acknowledge students’ achievement. Learners are so used to this kind of reward that they expect to have one in MOOCs. Although instructors can use other ways to confirm their efforts and achievement, it is not the same as receiving “formal” reinforcement. Again, due to the invitation process of the survey, which may cause a biased sample in the study, it makes sense that participants in this study either received the SOA or were capable of receiving one. Learners who did not participate in the study were likely to have dropped out of the course because it was too difficult and these learners did not value the certificate as much (Diver & Martinez, 2015).
Overall positive attitudes. Overall, the participants in this study showed positive attitudes toward the course. Perhaps learners who held positive attitudes were more likely to respond to course surveys, go through the whole survey and accept the interview invitation. In Tables 32 and 33 presented in Chapter 5, few respondents selected strongly disagree or disagree to certain items to indicate negative attitudes about their experience in the MOOCs. Interestingly, a large overlapping of respondents was observed that selected either strongly disagree or disagree to multiple items and also responded negatively to the learning experience rating questions shown in Figures 14 and 15. These individuals must not have had great experiences in many aspects of the MOOCs. Unfortunately, in the open-ended questions, none of these learners left any written comments to explain their experience or what they thought might be changed to improve the course. Researchers Ozkan and Koseler (2009) and Sun, Tsai, Finger, Chen, and Yeh (2008) claimed that in online environments, course quality was positively related to students’ satisfaction. The positive attitudes that participants had toward the courses were probably part of the reasons for the satisfactory feelings discussed in the Satisfaction section.

Learners appreciate the efforts instructors make to connect with them, although MOOC instructors can be thousands of miles away from their learners and they may never meet in real life. In this project, the interview participants commented specifically on the instructor’s natural manner, her humor, and real-life examples and experience she described in videos. Several interviewees pointed out that they enjoyed watching videos when the instructor made a mistake and then she corrected it and continued her teaching.
When that happened, the interviewees considered that the instructor was more like a real person who was talking to them. This is interesting because post-production normally will remove such mistakes. That is not to suggest that post-production is unnecessary. Instead, if the instructor sounds smooth and natural, it is not unacceptable in videos to leave some minor mistakes, which the instructor herself then corrects. A few interviewees in this project also appreciated the encouraging tones in the course emails and considered these emails a good way to connect with the instructor. It can be inferred that MOOC learners have a need to connect with the instructor – a real person, even though the connections are primarily virtual. As shown by the results of this study, despite the fact that MOOCs are critiqued frequently for their lack of instructor interactions and connections (Kop et al., 2011), even small efforts instructors make to connect with learners will be appreciated.

**Self-regulated learning strategies.** What strategies MOOC learners used in order to enhance their learning was not considered for investigation in the research plan for this study. However, during different parts of the interview, participants frequently referred to learning strategies that they used in the course. Learning strategies such as taking notes while watching videos, planning ahead and setting regular times to study, and researching other sources on the Internet all show a great deal of self-regulation. Self-regulated learners tend to control their own learning and be mindful of their learning process (Pintrich, 2004; Zimmerman, 1990). For example, many interviewees in this study mentioned that, if they felt tired, they would stop watching videos to take a break. They would re-watch the video after the break and, if they still felt not able to absorb content,
they would return on another day to continue learning. This is similar to the example that Pintrich (1995) provided: “…a self-regulated learner will become aware of her loss of attention and comprehension and go back and repair deficiency…” (p. 6). It is likely that, compared with students in traditional courses, MOOC learners are more self-regulated and more skillful at controlling their own learning, as shown in Q. Yang’s (2014) study. It is also possible that, as demonstrated in Pintrich and De Groot (1990), students who valued the learning tasks more intrinsically would use more self-regulated learning strategies. Researchers have already suggested that, in order to obtain more from MOOCs, learners need to be trained in self-regulation skills (Guàrdia et al., 2013; Kay et al., 2013). Due to the limitations of the survey interviewee invitation process, it is also quite possible that self-regulated learners are more likely to respond to surveys and participate in interviews. So what additional kinds of learning strategies other learners use (or perhaps they lack the abilities effectively to use learning strategies) when taking MOOCs is unclear.

**Practical and Theoretical Implications**

Knowledge that can be applied to educational practices is one important product from design-based research (The Design-Based Research Collective, 2003). In this study, motivational strategies based on the ARCS model were designed and implemented in two MOOCs. Learners’ reactions and perceptions of motivation in terms of the ARCS components were examined. This section introduces the practical and theoretical implications of this study and draws on design strategies specific for MOOC environments based on the ARCS model.
**Clear and straightforward design to catch attention.** As discussed in the previous sections, many MOOC learners selectively pay attention to information that they care about. Based on the results of this study, several suggestions for motivational strategies to catch and keep learners' attention can be integrated into MOOC ARCS motivational design and implemented into MOOCs. Clearly labelled pages or sections will help these learners navigate through the course information quickly. For example, having a course page called ‘grading information’ and a page called ‘fun facts about X (the course topic)’ should give learners enough guidance for what these pages cover and directions to check the information relevant to them. Keep the course pages and course emails clear and concise. If information is presented in texts, do not make the texts too long. Include only visual components that can help learners build mental models of certain concepts and eliminate those that are more for visually pleasant purposes (Moallem, 2001). If possible, use signaling, such as headers or dividers, to highlight or separate different parts on one page or in one email (Mayer & Moreno, 2003). Otherwise, learners will need to use their limited cognitive processing ability to process extraneous information (Mayer & Moreno, 2003; Sweller, 1994).

If time and resources permit, to catch and hold the attention of more learners, design videos to deliver important course-related information because generally, in MOOCs, more learners watch videos than participate in other course activities (Seaton et al., 2014). Based on the results of this study, to enhance learning through the attention component in the ARCS model, provide more than one channel to deliver content. A few interviewees in this study mentioned that they used video transcripts and slides to
accompany videos. Several interviewees admitted that, when the course videos were low-quality, they used only transcripts or slides for content they were interested in learning. This makes sense from a learning style and cognitive load point of view (Sweller, 1994): if learners are not auditory, or the visual-auditory dual channels in videos cause cognitive overload, alternative ways to learn the same content should be provided.

**Encourage self-designed relevance.** In this study, two important findings concerning relevance are the subject area of the MOOC and learners’ motivations for enrolling for the MOOC. The way in which relevant materials should be designed depends on what the subject of the MOOC is and whether it is high demand. For example, it is easier and more effective to design career-related strategies for subjects that are popular in jobs than those that are not. So investigating the course topics and potential course outcomes is important for designing relevance materials.

ARCS model creator Keller (2010) stated that it is important to design relevance strategies based on learners’ needs. However, as discussed in the Motivation for Enrolling in MOOCs section, MOOC learners’ backgrounds can vary widely, and these learners normally have different motivations and goals for taking courses. Plus, their motivations and perceived importance can vary according to different subject areas (Wolters & Pintrich, 1998). Thus, for learners who have uncommon goals for a MOOC, it may be more beneficial to guide them toward how to draw relevance from the course materials instead of pointing out the relevance to them. As Masters (2011) pointed out, teachers in MOOCs should let learners set their own goals or learning objectives instead of all following the same pre-designed learning objectives that may not suit these
learners’ needs. This process can be achieved by encouraging learners to write down their goals for taking the course at the beginning and revisit their goals several times during the course. After the course, learners can be guided to re-evaluate their goals and how they are/are not able to achieve them. This process can also help learners build confidence (Schunk, 1990).

**Provide encouragement and multiple ways to success.** To design MOOC materials that increase learners’ confidence, the following information should be presented at the very beginning (even as early as on the course enrollment page): what the course will cover, what prerequisite knowledge is needed and how learners are going to be assessed should be introduced clearly. According to Keller (2010), these three areas are aligned with the confidence strategy of clearly explaining expectations. This design principle may be even more important for MOOC learners because it helps them select the right courses. Flexibility in assignments should be provided because most MOOC learners are working professionals, and most also have family and job responsibilities. Even the most dedicated learners can take advantage of the flexibility within the course instead of worrying about a missed deadline. Such flexibility can be achieved by providing extra time, providing more attempts or allowing learners to drop the lowest score in all the assignments. To complete a MOOC, learners can be given multiple ways to choose how to complete assignments (Keller, 2010), such as by completing weekly assignments or by participating in several peer review assignments.

Similar to the fact that an instructor’s verbal praise could increase students’ motivation (Cameron & Pierce, 1994), that an instructor is encouraging and sympathetic
in videos is another good way to increase confidence in MOOCs. The challenge with this design principle is that it may not be in accord with every instructor’s style or it can take a long time for an instructor to prepare (Kim & Keller, 2008). If the instructor does not sincerely feel for the learner, such an approach may be counterproductive. However, the idea can be borrowed and designed into other course elements, such as course emails. The course team can send out periodic emails to encourage learners to continue working. The emails can include difficult concepts for the relevant weeks and provide hints or additional resources. In fact, the encouraging tones in the emails of this study were appreciated by a number of interviewees. Using emails to increase students’ motivation was already demonstrated as effective in non-MOOC online courses (Huett, Kalinowski, et al., 2008). Formative feedback should be provided to learners on why certain options are correct/incorrect (Shute, 2008). Key concepts/equations/reasoning can be included to stimulate thinking. Through feedback, learners can also be directed back to relevant instructional materials or external resources for more detailed and relevant information.

**Intrinsic and extrinsic rewards.** This study results showed that a course email to summarize major concepts covered in the course and challenges the learners have overcome during learning might be a good way to increase learners’ intrinsic satisfaction, as Keller (2010) pointed out. For one thing, a large percentage of MOOC learners select courses to gain knowledge. Providing a list of important topics that they have mastered from that course may promote satisfactory feelings for these learners. For another, due to the other responsibilities that most MOOC learners have, they may omit topics that are covered earlier in the course. Even if learners do remember the individual topics from
different weeks, it is beneficial to connect all the important topics so they build on each other and their relationships are shown clearly.

The overall results show that the statement of accomplishment (SOA), as an extrinsic reward, is important for increasing MOOC learners’ satisfaction. This is consistent with many studies on extrinsic rewards to students’ intrinsic motivation: rewards do not negatively affect intrinsic motivation (Cameron & Pierce, 1994; Deci, Koestner, & Ryan, 1999). However, usually the course design team does not have the choice of offering an SOA (generally the design of the MOOC platform provides them). So it is possible that, in some MOOCs, the SOA is not available for successful learners. Several interviewees in this study did mention that alternative rewards, such as digital badges, might work similarly. Designers can think creatively about alternative ways to the SOA if it is not available.

**Design-based Research**

The current study was conducted under the Design-based Research (DBR) framework. The four steps of DBR that Reeves (2000) proposed was applied in detail during the process. First, the practical problem was analyzed and relevant literature was reviewed. This procedure provided theoretical foundations for the future solution development, implementation and evaluation. Limited literature was found on how to deal with MOOC learners’ low engagement rate. The researcher proposed a motivational design method which aimed to increase students’ motivation by designing and developing motivationally-enhanced learning materials. From an instructional design and DBR point of view, it was a feasible result from the problem analysis. However, if
possible, future DBR researchers could first conduct an exploratory study to obtain a
deeper understanding of the problem and then develop a potential solution.

Second, a potential solution to the practical problem that was analyzed in the first step of the DBR was to utilize the ten-step ARCS model provided by Keller (2010). In the early stages of this design and development process, the course, audience, and material analysis were very important because they could greatly influence what strategies would be selected later. To conduct audience analysis, the previous MOOC learners' demographic information was used as the best guess for the target audience of the two MOOCs, and this proved to be a reasonable method. A challenge which resulted from the audience analysis was that MOOC learners’ attention, perceived relevance, confidence and satisfaction could vary widely. Therefore, when the strategies were designed, the current study did not emphasize any single component or components. In the analysis of all four components, it was assumed that decreases in interest would occur over time. Later designs then focused on periodic motivational messages to deal with this inclination toward decreased interest. Motivational deficiencies in learning materials were identified and addressed given the allowed time period, resources and other considerations (such as the instructor’s opinions).

Third, the strategies that were developed in the previous step of the DBR were implemented. Based on the MOOC platform’s available features, the final list of eight motivational strategies was established. The main features to integrate these strategies were emails, course pages, exercise explanations and discussion forums. The instructor and the other course team members did review and approve the revised learning materials
which incorporated these strategies. The design journal documented what happened
during the implementation and then after the course was open. Since no complicated
techniques were required to implement these strategies into emails, course pages,
exercise feedback or discussion forums, the implementation was completed without any
difficulties.

Fourth, formal evaluation was conducted. The current study used surveys and
interviews to explore learners’ reactions and perceptions concerning the motivational
strategies as well as other course components. Because of the limited time, unfortunately,
formal evaluation of the first iteration was not able to be incorporated into the design of
the second iteration. However, the design journal and the researcher’s daily involvement
in the first iteration were both used to revise the motivational strategies for the second
iteration. In Chapter 4, these major changes between iterations were discussed. Future
DBR researchers should plan for a longer time period to incorporate more formal
evaluation results from the previous iteration. The design journal did not provide as rich
information as the other data sources: surveys and interviews. It is possibly because the
design journal documented students’ posts in the discussion forum, which covered a wide
range of topics that were less related to the research topics in this study. Future DBR
researchers should explore other sources to document what happened during the course
and, as discussed above, incorporate more formal evaluation results from other data
sources.
Recommendations for Future Studies

In future studies, researchers can focus on testing the ARCS motivational strategies in an experimental study to investigate what true effects such strategies have on MOOC learner’s retention. This study solely serves as a starting point where learners’ reactions to the course materials were examined through the IMMS and their perceptions of the motivational strategies were questioned in interviews. Participants might not be aware of how such strategies influenced their motivation; to them, the strategies might not be effective. But the strategies might actually have had effects on their motivation and retention to some degree. A true experimental study should be conducted to examine this question.

Future studies can be carried out to investigate ARCS motivational strategies and their effects in other subjects. As discussed in the Relevance section, learners may perceive relevance strategies differently according to subjects. It will be interesting to find out how MOOC learners react to relevant materials in courses that are completely different in areas and in job demands.
References


Clayton, K., Blumberg, F., & Auld, D. P. (2010). The relationship between motivation, learning strategies and choice of environment whether traditional or including an


http://doi.org/10.1080/01587919.2015.1019968


http://doi.org/10.1007/s10763-004-6828-7


http://doi.org/doi:10.5210/fm.v18i5.4350


http://doi.org/10.1016/j.lindif.2007.07.005


http://chronicle.com/article/MOOCs-May-Not-Be-So-Disruptive/140965/


Kop, R. (2011). The challenges to connectivist learning on open online networks: Learning experiences during a massive open online course. *The International Review of Research in Open and Distance Learning, Special Issue-Connectivism: Design and Delivery of Social Networked Learning, 12*(3). Retrieved from


http://doi.org/10.1207/S15326985EP3702_4


http://doi.org/10.1177/0013164493053003024


Conference on Artificial Intelligence. Retrieved from

Reeves, T. C. (2000, April). Enhancing the worth of instructional technology research through “design experiments” and other development research strategies. Presented at the Annual Meeting of the American Educational Research Association, New Orleans, LA, USA.


http://doi.org/10.2307/3699927


Appendix A: Permission to Reuse the Four-step Design-based Research

Could I reuse the four-step DBR graph in my dissertation?

Thomas C Reeves <treeves@uga.edu>  
To: Kun Li <kl100309@ohio.edu>  

Tue, Dec 2, 2014 at 8:28 AM

Dear Kung Li,

I would be happy for to use the graph from my paper.

Good luck with completing your dissertation.

Here is a link to some additional resources about DBR:

http://authenticlearning.info/DesignBasedResearch/Design-based_research.html

Best wishes,

Tom

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From: Kun Li <kl100309@ohio.edu>  
Sent: Monday, December 01, 2014 11:20 PM  
To: Thomas C Reeves  
Subject: Could I reuse the four-step DBR graph in my dissertation?

[Quoted text hidden]
Appendix B: Pre-course Survey

1. Why did you enroll in this course? (Please rate on a scale of very unimportant to very important)
   - This subject is relevant to my academic field of study.
   - This class teaches skills that will help my job/career.
   - I want to earn some sort of credential that I can use to enhance my CV / resume.
   - Because this course is offered by a prestigious university.
   - I think taking this course will be fun and enjoyable.
   - I'm curious about what it's like to take an online course.
   - I am taking this course in conjunction with another learning experience.
   - I am taking this class because the content is not available elsewhere.

2. What best describes your previous experience in this course’s subject area?
   - I have a degree in this field or significant work experience
   - I have completed some coursework or have some work experience in this field
   - I like to learn about this subject on my own
   - I am mostly new to the subject

3. On a scale from 1 to 10, please rate how much you know right now about the topic of this course, where 1 means you don't know anything yet and 10 means you are an expert.

4. Which of the following course activities do you plan to complete/participate in?
   - Watch videos
   - Participate in discussion forums
   - Take the quizzes
   - Take the tests
Earn a certificate

5. What is the primary medium you plan to use to access the course/watch the videos?
   - desktop/laptop computer
   - tablet (e.g., iPad)
   - small mobile device (e.g., phone, iPod Touch)
   - Other

6. Where do you most often access the Internet?
7. How reliable is your access to the Internet and a computer or other device for accessing the course?
8. Please tell us about your past experience with online courses.
   - I have taken many online courses before
   - I have taken a few online courses before
   - This is my first online course

9. In what type of area do you live?
   - A large city
   - A suburban area
   - A small city or town
   - A rural area

10. How many hours per week will you be spending on this course?
11. Is English your first language?
12. What language subtitles would you like to see in the course videos?
13. What is your gender?
14. In which country were you born?
15. In which country do you currently reside?
16. In what year were you born (please enter 4 digits)?
17. Are you of Spanish, Hispanic or Latino origin or descent?
18. What is your race?
19. What is the highest level of school you have completed or the highest degree you have received?
20. Are you currently enrolled as a student in an educational program?
21. What is your educational background or your current field of study?
22. Which of the following best describes your employment status?
23. Do you have any additional comments that you would like to share with us?
Appendix C: Post-course Survey

1. Did you earn a Statement of Accomplishment in this class?
2. Did you sign up for Signature Track, the service where you email a photo of yourself and they verify your identity?
3. Did you enroll in a previous offering of this course?
4. To what extent did you participate in the following course activities?
   - Watch lectures/videos
   - Complete the required readings
   - Complete the optional readings or movies
   - Complete the homeworks
   - Complete the quizzes
   - Participate in discussion forums
   - Join a Google Hangout with other students
   - Actively participate in a study group
   - View the course wiki
   - Contribute to the course wiki
5. Why did you enroll in this course? (Please rate on a scale of very unimportant to very important)
   - This subject is relevant to my academic field of study
   - This class teaches skills that will help my job/career
   - I wanted to earn some sort of credential that I can use to enhance my CV / resume
   - Because this course is offered by a prestigious university
   - I thought taking this course would be fun and enjoyable
   - I was curious about what it's like to take an online course
   - I took this course in conjunction with another learning experience
   - I took this class because the content is not available elsewhere
6. How much do you agree with each of the following statements about your learning in this course?
   For the amount of time I invested in this course, I'm happy with what I learned
   The course materials were presented in an engaging manner
   I would like to take a more advanced course in this topic
   I found this course personally fulfilling
   I learned what I was hoping to learn in this course
   I felt I had the background required to do well in this course

7. In what ways have you used the material you learned in this course (check all that apply)?
   In my career
   In my hobbies or activities outside of work
   In my education
   To prepare for a test or activity in the future
   In some other way:

8. Rate your overall experience with this course.
9. How would you rate the difficulty of this course?
10. How would you rate the pacing of this course?
11. How would you rate the length of this course?
12. How would you rate the depth of content of this course?
13. On a scale from 1 to 10, please rate how much you knew before you took this class about the topic of this course, where 1 means you didn't know anything then and 10 means you were an expert
14. On a scale from 1 to 10, please rate how much you know now about the topic of this course, where 1 means you don't know anything yet and 10 means you are an expert
15. When you were taking this course, where did you most often access the Internet?
16. In what type of area do you live?
   A large city
   A suburban area
   A small city or town
A rural area

17. On a scale from 1 to 5, please indicate how much each course activity contributed to your learning in this course.

18. While this course was running, how reliable was your access to the Internet and a computer or other device for accessing the course?

19. How would you rate the quality of the videos in this course?
   - Very high-quality videos
   - Somewhat high-quality videos
   - Average looking videos
   - Somewhat low-quality videos
   - Very low-quality videos

20. How much do you agree with each of the statements about <Faculty Name>?
   - explains things in very orderly ways
   - I would take another course from
   - explains difficult things clearly
   - communicates enthusiasm for the subject

21. How much do you agree or disagree with the following statements:
   - My family supported my taking this course
   - I did not have enough time to take this course
   - My employer did not support my taking this course
   - This course was relevant to my job
   - This course met my expectations
   - I found the course difficult to navigate
   - I did not learn well online
   - I received adequate technical support

22. How much did this course contribute to your progress on the following learning
objectives?
Gaining factual knowledge

Understanding fundamental concepts and principles

Learning to apply knowledge, concepts, principles, or theories to a specific situation or problem

Learning to synthesize and integrate knowledge

Learning to conduct inquiry through the methods of the field

23. Do you plan to take this course again?

24. On average, how many hours per week did you invest in this course?

25. Please tell us about your past experience with online courses.
   I have taken many online courses before
   I have taken a few online courses before
   This was my first online course

26. How did this course compare to other online courses you have taken?

27. What best describes your previous experience in this course's subject area?
   I have a degree in this field or significant work experience
   I have completed some coursework or have some work experience in this field
   I like to learn about this subject on my own
   I am mostly new to the subject

28. Please use the space below to provide any additional comments that you would like to share.
Appendix D: Instructional Materials Motivation Scale (IMMS)

1. When I first looked at this course, I had the impression that it would be easy for me.
2. There was something interesting at the beginning of this course that got my attention.
3. This course was more difficult to understand than I would like for it to be.
4. After reading the introductory information, I felt confident that I knew what I was supposed to learn from this course.
5. Completing the exercises in this course gave me a satisfying feeling of accomplishment.
6. It is clear to me how the content of this course is related to things I already know.
7. Many of the pages had so much information that it was hard to pick out and remember the important points.
8. This course is eye-catching.
9. There were examples that showed me how this course could be important to some people.
10. Completing this course successfully was important to me.
11. The quality of the writing in the course helped to hold my attention.
12. This course is so abstract that it was hard to keep my attention on it.
13. As I worked on this course, I was confident that I could learn the content.
14. I enjoyed this course so much that I would like to know more about this topic.
15. The design of this course looks dry and unappealing.
16. The content of this course is relevant to my interests.
17. The way the information is arranged in this course helped keep my attention.
18. There are explanations or examples of how people use the knowledge in this course.
19. The exercises in this course were too difficult.
20. This course has things that stimulated my curiosity.
21. I really enjoyed studying the course.
22. The amount of repetition in the course caused me to get bored sometimes.
23. The content and style of writing in the course convey the impression that its content is worth knowing.
24. I learned some things that were surprising or unexpected.
25. After working on the course for a while, I was confident that I would be able to pass a test on Chemistry.
26. The course was not relevant to my needs because I already knew most of it.
27. The working of feedback after the exercises, or of other comments in the course, helped me feel rewarded for my effort.
28. The variety of reading passages, exercises, illustrations, etc., helped keep my attention on the tutorial.
29. The style of writing is boring.
30. I could relate the content of the course to things I have seen, done or thought about in my own life.
Appendix E: Permission to Use the IMMS

Can I have permission to reuse the IMMS please?

John Keller <jkellersan@gmail.com>  Thu, Oct 30, 2014 at 4:24 PM
To: Kun Li <kkunlli@gmail.com>

Dear Kun,

You are welcome to use the instruments. They were designed to be modified in the way that you describe, so that is not a problem.

Best wishes for success!
John K.

John M. Keller, Ph.D.
Professor Emeritus
Educational Psychology and Learning Systems
Florida State University

9705 Waters Meet Drive
Tallahassee, FL 32312-3746
Phone: 850-294-3908

Official ARCS Model Website: http://arcsmodel.com. UPDATED 18 SEP 2013
Professional Website: http://mailer.fsu.edu/~jkeller/JohnsHome/

“When facing a difficult task, act as though it is impossible to fail.

If you are going after Moby Dick, take along the tartar sauce.”

—Walter Smith

[Quoted text hidden]
## Appendix F: Interview Questions

<table>
<thead>
<tr>
<th>Interview Question</th>
<th>Rationale for the Question</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. How many MOOCs are you currently taking? What do you think about them?</td>
<td>At the beginning of the interview, warm up with the interviewee by talking with them about other MOOCs they have taken or is taking.</td>
</tr>
<tr>
<td>2. Why did you sign up for our course?</td>
<td>Find out what learners’ initial motivation is when signing up for the course: whether they take this course for learning, for fun, for exploration or for career/major advances, or others.</td>
</tr>
<tr>
<td>3. What is the most important thing that you think you can achieve from taking the course?</td>
<td>Explore learners’ goals and objectives they initially plan to obtain from the course.</td>
</tr>
<tr>
<td>3.1 (rephrase) What are you trying to get out of the course?</td>
<td>If learners did not understand question 3 or answered it unrelated, rephrase question 3 to 3.1.</td>
</tr>
<tr>
<td>3.2 Why do you think XX (what they answered the most important thing in the course in question 3) is the most important thing?</td>
<td>Find out why something is so important to learners, like why refreshing chemistry knowledge is so important, or why you value the free certificate that much.</td>
</tr>
<tr>
<td>4. Are you still keeping learning the course?</td>
<td>Find out if learners are still learning with the course.</td>
</tr>
<tr>
<td>4.1 (If no) could you tell me why you made this decision not to continue learning?</td>
<td>Seek reasons why learners decided to not continue learning; is there anything to do with the course design or other personal reasons?</td>
</tr>
<tr>
<td>4.2 (If yes) What kinds of activities do you do each week in the course?</td>
<td>Find out what activities they engaged in to continue learning.</td>
</tr>
<tr>
<td>5. After you have been in the course for some time, are there any changes in plans regarding to the things you want to obtain out of the course?</td>
<td>Question 3 asks for their initial objectives. Question 5 is to find out whether their objectives changed by time.</td>
</tr>
<tr>
<td>Question</td>
<td>Expected Response</td>
</tr>
<tr>
<td>-------------------------------------------------------------------------</td>
<td>-----------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>5.1 (If no) Tell me what you did in order to achieve your goal.</td>
<td>Find out if they actually did something in order to achieve their goals.</td>
</tr>
<tr>
<td>5.2 (If yes) What are the changes? What do you think made you change the original goals?</td>
<td>Find out why they changed their goals during the course and what the new goals are.</td>
</tr>
<tr>
<td>6. What are your overall opinions on our course site design? What about content presentation and display?</td>
<td>Starting from general opinions of the whole course may help learners remember the course design and course activities.</td>
</tr>
<tr>
<td>7. Do you usually read our course weekly email?</td>
<td>From general to more specific features of the course - course emails.</td>
</tr>
<tr>
<td>7.1 (If yes) (1) what do you think about the course email? (2) What kind of information are you looking for in weekly email? (3) Do you go to our course site directly from the weekly email? (4) Why or why not?</td>
<td>This sub-question is also from general to specific, first ask learners’ general thoughts of the course emails, then ask what information they usually look for in the emails, last find out if there are interesting things in the course emails that make them want to check out the course site for more details.</td>
</tr>
<tr>
<td>7.2 If no, (1) why not? (2) What are some information you think would be good in weekly emails but are not?</td>
<td>Find out reasons that why the weekly emails failed to catch learners’ attention and what kind of information would have been attractive to put into course emails.</td>
</tr>
<tr>
<td>8. Do you check our course pages while taking the course?</td>
<td>Also seek general opinions on course pages design.</td>
</tr>
<tr>
<td>8.1 (If yes) (1) what do you think about the pages? (2) Can you find information you are looking for on the course pages? (3) What things are you looking for that the pages have (or have not depending on the previous answer)?</td>
<td>General to specific, first ask learners’ general thoughts of the course page, then ask what information they want to include in the course pages.</td>
</tr>
<tr>
<td>8.2 (If not) (1) why not? (2) Would you go over the course pages if they have different information than our course current has? (3) What are some examples?</td>
<td>If learners don’t check course pages, find out the reasons. Is it because the pages do not contain information they find important or do they think it unnecessary to do so?</td>
</tr>
<tr>
<td>Question</td>
<td>Description</td>
</tr>
<tr>
<td>-------------------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>9. What are some of the connections you can draw from taking our course</td>
<td>Seek relevance learners have between the course and other subjects, career or everyday life.</td>
</tr>
<tr>
<td>and other courses you are taking or your job?</td>
<td></td>
</tr>
<tr>
<td>9.1 What made you draw that connection?</td>
<td>Find out whether the learners have a good sense of how the course is relevant or the course materials emphasize the connection.</td>
</tr>
<tr>
<td>9.2 Imagine a course can help you draw that connection, what do you</td>
<td>Explore learners’ reactions to the relevance features that a course can provide.</td>
</tr>
<tr>
<td>think about the course?</td>
<td></td>
</tr>
<tr>
<td>9.3 What are some examples that you think can help you draw that</td>
<td>Ask for specific examples that learners think helpful them perceive the relevance of a course.</td>
</tr>
<tr>
<td>connection?</td>
<td></td>
</tr>
<tr>
<td>10. While taking the course, do you believe you can learn what you</td>
<td>Find out learners’ general confidence when taking the course.</td>
</tr>
<tr>
<td>want to learn (or perform as you expected based on their goals stated</td>
<td></td>
</tr>
<tr>
<td>previously)?</td>
<td></td>
</tr>
<tr>
<td>10.1 (If yes) What are some potential reasons that made you think this</td>
<td>Find out whether the confidence interventions help increase learners’ confidence or other reasons do.</td>
</tr>
<tr>
<td>way?</td>
<td></td>
</tr>
<tr>
<td>10.2 (If no) Why not?</td>
<td>Ask for potential reasons why learners are not confident in the course.</td>
</tr>
<tr>
<td>11. Did you take at least one exercise in the course?</td>
<td>Examine the exercise difficulty to learners’ confidence in the course.</td>
</tr>
<tr>
<td>11.1 What do you think about the difficulty of the problems in the</td>
<td>General opinions of exercise difficulty.</td>
</tr>
<tr>
<td>exercises?</td>
<td></td>
</tr>
<tr>
<td>11.2 (If interviewees don’t find exercise problems hard) What are some</td>
<td>Find out if the exercises are designed well and if there are other components can be added to the exercise.</td>
</tr>
<tr>
<td>good things that the exercises have?</td>
<td></td>
</tr>
<tr>
<td>11.3 (If interviewees have problems finishing the exercises) What</td>
<td>Ask for learners’ opinions on how to design the exercises to make it easier to work on.</td>
</tr>
<tr>
<td>things do you think can be done when designing the course that can help</td>
<td></td>
</tr>
<tr>
<td>you with working on the exercises?</td>
<td></td>
</tr>
<tr>
<td>Question</td>
<td>Explanation</td>
</tr>
<tr>
<td>------------------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>12. What would you feel when you accomplished your goals in this course?</td>
<td>Ask for general feelings of satisfaction.</td>
</tr>
<tr>
<td>12.1 What are some other things that make you happy or satisfied in the course?</td>
<td>Find out whether there are other things during the course increasing learners’ satisfaction of the course. Certificate is mentioned in particular because it is the only external reward this course offers.</td>
</tr>
<tr>
<td>12.2 How satisfied would you be if you were able to earn the certificate?</td>
<td></td>
</tr>
<tr>
<td>12.3 How would you describe your experience in this course?</td>
<td></td>
</tr>
<tr>
<td>13. Do you want to learn more chemistry related topics in the future?</td>
<td>Find out the reasons that learners have continue motivation to learn chemistry and how they are going to learn. Also find out why learners do not want to pursue further learning in chemistry.</td>
</tr>
<tr>
<td>14. Please make free comments about any topics we discussed today.</td>
<td>Provide interviewees with an opportunity to comment on any of the ideas that have been discussed but did not dig deeper.</td>
</tr>
<tr>
<td>15. Please tell me anything that you would like to talk about our course but we didn’t have a chance to.</td>
<td>Provide interviewees with an opportunity to express other opinions and thoughts on the course.</td>
</tr>
</tbody>
</table>
Appendix G: Interview Protocol

Interview Protocol
Project: ____________  
Date: _______________  
Start Time: ___________  
End Time: ____________  
Technology: ___________  
Interviewee No.: ________

Opening statement:
This interview will be analyzed anonymously. All identity information will be removed completely before data analysis. For clarity purpose, this interview will be audio-recorded and transcribed later. All audio files will be deleted permanently after data analysis is completed.

We are going to have a conversation about students’ perceptions of taking massive open online course and what design features help learning. What you say will not affect the course score or anything related taking the course. So please feel free to tell me what you truly think.

My name is XX, I help build some of XX University’s MOOCs. I am interested in course design, both massive open online courses and the more traditional smaller-sized online courses. So I really hope I have the chance to get to know what you think about the design of our course so I can understand it better from a learner’s perspective and make improvements.

Do you have any questions? Shall we begin now?

Interview notes:

End:
Please comment on anything we talked about today.
Could you tell me anything that you would like to say but did not get a chance today?
Thank you so much for your time. I appreciate your input a lot. This is very helpful.
## Appendix H: Post-interview Summary Sheet

<table>
<thead>
<tr>
<th>Interviewee No.: ____</th>
<th>Date: __________</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length of interview: __________</td>
<td></td>
</tr>
</tbody>
</table>

Overall attitudes on course experience:

How much interesting information was there?

Interesting points that can lead to new question design.

New questions:
Appendix I: Study Consent Form

You are being asked to participate in a research study conducted by Kun Li and Dr. Dorian Canelas. The purpose of the study is to understand the students’ perceptions of Massive Open Online Course (MOOC) design and how to improve the teaching strategies in MOOCs.

Participation in the research will only require additional time to complete this mid-course survey (4 – 5 minutes). At the end of this survey, you will be asked if you are willing to participate in an online audio interview (20 – 45 minutes), also as part of this research. If you are chosen to participate in the interview, you will get a $10 Amazon gift card as compensation.

The Data Manager will link your responses to this survey to your pre and post-course survey responses as well as the forum posts that we created to ask you leave feedback about course design and how changes can be made to the design, and then your personal information will be removed completely. All data will be analyzed anonymously and reported only in aggregate form so no individual participant will be identifiable.

Your participation in this study is completely voluntary and you are free to withdraw your consent at any time. If you decide to withdraw and let us know by emailing. However, if you let us know you would like to withdraw after the data have been de-identified, we will not be able to remove your data from the data set.

Your course instructor will not know whether you participate in this research or not. The information collected will not be printed or published in any form that would identify any individual. Your responses will have no bearing on any courses you may be enrolled in, present or future.

The Data Manager will use the email address you provided to connect your responses to the pre and post-course surveys to your responses to this survey. After they connect these data, they will remove your email address and other identifying information before they give the data to us.

If you have questions about your rights as a research subject, you may contact the Institutional Review Board at. If you wish to withdraw your consent at any time, you may also contact XX at.

Please check the box below to indicate whether or not you are willing to have your
survey responses and data from your participation in this course included in this research project.

[ ] Yes, I would like to participate
[ ] No thank you – I am not interested in participating
Appendix J: Interview Consent

(The interview consent form will be sent to participants who accepted the invitation when the first PI contacts them to schedule the interview. Before the actual interview, first PI will ask if participants have read the consent form, if not, she will read the form and ask if they agree to participate.)

This study is being conducted because we are interested in understanding your perceptions of effective teaching strategies and good course design in Massive Open Online Courses (MOOC). Your opinions will help us learn how to design better MOOCs in the future.

You have been invited to an online audio interview with Kun Li, the primary researcher for the study. In the interview, which will last for about 25 to 40 minutes, you will be asked about your experience taking the course, your perceptions of the online teaching strategies in the course, and how you think we might improve the course design so that it can benefit more students. You will receive a $10 Amazon gift card as compensation for participating in the interview.

In order to protect your privacy and identity, your personal information will be deleted after the Data Manager links your interview responses to your other (pre-, mid-, and post-course) survey responses and remove your email address for data analysis purposes. For the accuracy purpose, the interview will be audio recorded. After the interview has been transcribed, the recording will be permanently deleted.

Your participation is completely voluntary and at any point, you may choose to stop the interview. Your participation will not affect your grade in the course. The instructor will not know whether or not you participated in the research.

Our results will be reported in aggregate, without any information that would allow the identification of individual participants.

If you have any questions about the research, please contact XXX@gmail.com. You may also ask any questions you have during the interview. If you have questions about your rights as a research study participant, you may contact the Chair of the Human Subjects Committee at XXX.
Appendix K: Invitation Email to Potential Interviewees

Dear student:

Thank you for responding to our course survey as well as agreeing to participate in an online audio interview. We will be using Skype or Google Hangout audio connections in the interview. Please respond to this email and let me know your Skype/Google account so I can start the connection. If you prefer other technology to do the interview, please let me know.

Please also respond to the following poll and check all your available time slots for the interview. To be convenient for scheduling, all time slots are one-hour, but the actual interview will be briefer.
[Doodle link]

Please also find attached interview consent form, which explains the purpose of the project and steps that will be taken to protect your identity.
[PDF consent form]

Again, thank you for agreeing to participate and I look forward to talking with you.
Best wishes,
Appendix L: Box Plots of the IMMS Means for Both Courses

Boxplot of IMMS Mean in the 2014 S & S:

Boxplot of IMMS Mean in the 2015 R & R:
Appendix M: IRB Approval

A determination has been made that the following research study is exempt from IRB review because it involves:

Category 1: research conducted in established or commonly accepted educational settings, involving normal educational practices

Category 2: research involving the use of educational tests, survey procedures, interview procedures or observation of public behavior

Project Title: Learners’ Motivation, Goal Orientation, and Self-Regulation in a Massive Open Online Course: A Design-Based Approach

Primary Investigator: Kun Li

Co-Investigator(s):

Advisor: David R Moore

Department: Educational Studies

Rebecca Cale, AAB, CIP
Office of Research Compliance

Date: 11/17/14

The approval remains in effect provided the study is conducted exactly as described in your application for review. Any additions or modifications to the project must be approved (as an amendment) prior to implementation.