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Motivating Students in Massive Open Online Courses (MOOCs) Using the Attention, Relevance, Confidence, Satisfaction (ARCS) Model

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Abstract
Massive Open Online Courses (MOOCs) often have low persistence rates, which may be attributed to a learners' lack of motivation. In this design-based research study, Keller's Attention, Relevance, Confidence, Satisfaction (ARCS) motivational design model was integrated into two MOOCs as an initial exploration of how to design effective motivational interventions in MOOC environment. The Instructional Motivation Materials Scale (IMMS) was used to measure learners' perceptions and reactions to the course components, in terms of the ARCS model, in both MOOCs. The whole design, implementation, and evaluation process was documented and reflected upon to provide practical guidance on designing motivational-enhanced materials in MOOC environments. The results revealed patterns of learners selectively paying attention, drawing relevance for self-determined reasons, having high confidence, and deriving satisfaction from multiple sources.

Keywords ARCS model · Design-based research · MOOCs · Motivation · Motivational design

Introduction

Massive Open Online Courses (MOOCs) constitute an evolving educational phenomenon to reduce costs and increase access compared to traditional education (Burd et al. 2015). This approach lends itself to a democratization of enrollment and reduces the influence of institutional traditions, such as strict adherence to a timetable, completion for credit, focus on grades, etc. Signing up for a MOOC generally does not require an investment in time or resources; however, successfully achieving one's goals requires, at a minimum, that the learner participates in the course and doing so, we assume, is an indicator of motivation. A drastic decrease in learners' participation occurs in most cases (Evans et al. 2016). It is plausible the design of these MOOCs lacks attention to motivational design principles, which may lead to decreased learner motivation and engagement.

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While learners' initial motivations to enroll in MOOCs have been investigated by several researchers using survey and interview methods (e.g., Shapiro et al. 2017), few studies examine learners' motivation change during the MOOC, and even fewer studies incorporate systematic instructional design into MOOCs in an attempt to increase learners' motivation. As Jordan (2014) stated, it is worth examining course design factors that influence students' engagement and completion in MOOCs. In this study, we adopted the design-based research (DBR) approach to analyze the motivational components in a series of two MOOCs and to apply Keller's Attention, Relevance, Confidence, and Satisfaction (ARCS) framework in these MOOCs. The DBR approach describes the problem, the proposed solution, the evaluation of the solution, and the implications for future practices in great detail. The present study will serve as a base for future studies of motivating students using instructional design methods in open learning environments.

Literature Review

Motivation and Motivational Design

Motivation has long been considered related to one's will and effort (Keller 2008). Small and Gluck (1994) asserted that students' motivation was as important as their learning

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abilities and learning achievements. Students' motivation and achievements, usually measured by test scores, were found to correlate positively in both traditional and distance education (Liu et al. 2012; Sankaran and Bui 2001). In many learning environments, especially voluntary learning environments, such as MOOCs, lack of motivation is directly related to learners' discontinuation of learning (Lei 2010).

In online learning environments, researchers have considered motivation as one of the major factors affecting students' commitment to studying. Hart (2012) revealed that learners' motivation was one of the most important components of persistence in online learning environments. A learner's lack of motivation can lead to lack of engagement in learning activities and poor performances (Starcher and Proffitt 2011). Song (2000) stated that "when learners do not have proper motivation to persist, they will drop the course or they will procrastinate" (p. 227).

Keller (2006) defined motivational design as "the process of arranging resources and procedures to bring about changes in motivation" (p. 3). Motivational design, based on motivational theories, includes principles and rules to guide a longer systematic process (Keller 2006). While motivational design theories or models usually involve comprehensive guidelines to handle different aspects of motivation, they all emphasize the importance of adapting to specific situations when applying these theories or models (Keller 2010).

The ARCS Model

The ARCS model was first created by John Keller in the 1970s and validated by other researchers (Keller and Suzuki 2004; Small and Gluck 1994). It is based on expectancy-theory, which "assumes that people are motivated to engage in an activity if it is perceived to be linked to the satisfaction of personal needs (the value aspect), and if there is a positive expectancy for success (the expectancy aspect)" (Keller 1987a, pp. 2–3). The model uses a systematic design process from analyzing target audiences' motivations, designing motivational strategies based on the motivational analysis and other constraints, implementing the strategies and evaluating the effects. Attention means that designers need to draw and hold learners' focus during instruction. Relevance means that learners should be informed how the content relates to their needs. Confidence is the degree learners believe they can succeed. Satisfaction is the degree learners feel they are satisfied with their learning results (Keller 1987a). More recently, Keller (2008) expanded the original ARCS model by adding the fifth component: volition. In this study, we used the original model because it has been applied in different contexts, and there are validated instruments measuring motivation in terms of the four components.

The ARCS model has been widely applied in online or blended learning environments to improve students' motivation, attitude, retention rate, performance, and other psychological traits (Li and Keller 2018). For example, ChanLin (2009) found positive student attitudes toward the ARCS-enhanced learning materials in a web-based media service class. Hodges and Kim (2013) reported better attitudes toward the course topics in the experimental group which used ARCS-enhanced materials than the control group, which did not use these enhanced materials in a blended algebra course. Ocak and Akçayır (2013) reported better motivation, higher learning gains, and better final performances in the experimental group in a blended computer application class. L. Visser et al. (2002) found that students' retention rates improved after implementing ARCS messages and students held positive attitudes toward those messages.

Massive Open Online Course

MOOC refers to the teaching method with instructors deliver course components via an online management system for thousands of students at no costs (Masters 2011). MOOCs include cMOOCs and xMOOCs, where the former utilizes a connectivism approach to connect students and the latter extends the behaviorism approach and is more structured (O'Toole 2013). A detailed definition between xMOOCs and cMOOCs is beyond the scope of this paper. We refer to xMOOCs in this paper. 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). Glance et al. (2013) and Butler (2012) stated that most MOOCs include short lecture videos, auto-graded quizzes, peer or self-assessments, and an online discussion forum; some had virtual office hours with instructors using web conferencing tools.

The large number of registered students contributes to the uniqueness of MOOCs. Students' backgrounds are diverse, including their age, highest degree earned, participation in class, experience with subject area, and reasons for selecting the course (Belanger and Thornton 2013). Learners have various initial motivations to enroll in specific MOOCs, such as for personal interest, career advancement/transition, and others (Shapiro et al. 2017; Zheng et al. 2015). Possibly because of the varied intentions, high dropout rates are always noted and reported in MOOCs, especially during the beginning of the courses (Hone and El Said 2016).

Researchers have examined ways to engage MOOC learners and improve MOOC retention rates. After identifying major reasons why students drop out of MOOCs, Nawrot and Doucet (2014) argued that MOOC providers should aim at increasing engagement by specifically designing the MOOC platform. Guo et al. (2014) provided a set of video design guidelines for improving students' engagement in watching videos.

This exploratory study aims to design and incorporate ARCS strategies into MOOCs and explore leaners' perceptions of the ARCS-enhanced learning materials. Two research questions were raised in the study:

1. How do learners perceive the ARCS motivational strategies that are used in the courses?
2. What are some practical implications for future MOOC designers in terms of promoting learners' motivation using ARCS motivational strategies?

Method

Study Design

Designed-based research (DBR) is 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" (Wang and Hannafin 2005, pp. 6–7). DBR is iterative and adaptable to the results of every implementation and to changes from circumstances, such as audience input and researcher's reflections (Kelly 2004; Reeves 2000). 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).

Our goal in this study was to identify ways to improve an established educational approach (MOOCs) be implementing and tailoring a strategy (ARCS) that has demonstrated utility in other contexts. This study used a DBR approach, in which (1) a practical educational problem was identified; (2) a potential solution was designed based on relevant literature; (3) the solution was implemented and evaluated in a real educational setting; (4) the whole design process was documented and reflected on in order to draw implications for future researchers and practitioners (Reeves 2000).

Research Setting

The research setting in this study was two sequential courses offered on Coursera: a large international MOOC provider, delivered in Fall 2014 and Spring 2015. These two courses ("course 1" and "course 2" respectively) covered introductory-level chemistry topics with about 1.5 to 3 h of video lectures per week, weekly quizzes with approximately ten questions each, optional bi-weekly advanced problem sets, and a mid-term and a final exam. Content was released on a weekly basis with an opening announcement email. At the end of the courses, learners who successfully met the passing requirements would obtain a Statement of Accomplishment (SOA) with Coursera's logo and the instructor's signature stating that they passed the course. The two courses were designed following the analysis, design, development, implementation, and evaluation (ADDIE) process in 2013 and had been launched for two sessions before our study.

Data Collection and Analysis

In course 1, we implemented ARCS motivational strategies and collected feedback from the students and the practitioners. Based on the feedback, we made changes to our original strategies and applied them to course 2. We also collected feedback during this iteration to check the effects of the revised strategies.

Three types of instruments were used in each course to collect data: the *Instructional Materials Motivation Survey* (*IMMS*) designed by (Keller 1987b), semi-structured interviews, and the researchers' design journal. The *IMMS*, containing 36 items using five-point Likert scales, measures the four constructs of the ARCS model. In our research, we modified the *IMMS*' language to be more specific to the course and the subject matter (e.g., "After working on this lesson for a while, I was confident that I would be able to pass a test on 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"). We asked participants to leave their email addresses if they were willing to participate in an online interview at the end of the *IMMS*.

Semi-structured interviews were used to probe for deeper thoughts that could not be revealed in the *IMMS*. We developed the interview questions based on our experience with the MOOC platform and a review of the literature (see appendix A for interview questions). During the whole design process, we kept a design journal in which we documented issues, important decisions, ideas, and thoughts.

The data collection process was the same for both courses. In week 6, we delivered the *IMMS* through the course email tool. Week 6 was selected to allow a more comprehensive sense of the course experience for learners. Students who indicated willingness to participate in the interview were contacted and audio interviewed via Skype or Google Hangout. Interviews were audio recorded and transcribed for systematic analysis. In course 1 and 2, 163 and 266 responses to the *IMMS* were collected and analyzed respectively. Sixteen and thirty interviews were conducted in the two courses respectively. Interview transcripts were coded and analyzed for themes related to attention, relevance, confidence, and satisfaction, as well as course design features and suggestions. Qualitative analysis software *Nvivo* was used for coding.

Strategies to Ensure Research Rigor

Because data analysis is qualitative in nature and all data sources came from the learners, we used "triangulation of sources" (Patton 2002, p. 556) in our data collection and analysis to ensure credibility. We recorded details in our design journal to capture important issues from the whole design process. For example, our interview data revealed that some participants took the course to gain knowledge, while some hoped taking this course could help with their future education. This corresponds to an excerpt of a design journal entry:

From the discussion forum that asked students why they took the course, about two thirds of them said it is for learning new knowledge or for refreshing their old knowledge. About one third of them responded that the subject is related to their future potential fields of study, life or their career.

Design Process and Results

Our decision-making was based on Keller's ARCS model, our experience working in MOOC environment, and reality constraints, such as time and resources. This section describes these decision-making in design and development of the practical solution, which is step 2 in the four-step DBR process. Keller's (2010) ten-step ARCS design procedure was used to guide the design.

Course Information

As discussed in the Research Setting section, the research environment was two introductory chemistry courses. The basic structure of the courses was the same. Both courses lasted for 9 weeks with a 1-week break in the middle and 2 weeks at the end for completing the final exam.

Audience Information

According to Keller (2010), audience information is the basis for performing audience analysis, which is critical in motivational design. The pre-course survey result from the course session prior to course 1 was used as a best guess to analyze the audience.

Demographics There were 3306 students who completed the age question in the pre-course survey, with more learners (27.13%) between 26 and 34 and fewer above 65 (3.02%). 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 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.

Prior Experience and Education 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 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, approximately 7.13%.

Planned Course Participation When asked about their planned time and effort into the course, a majority of participants planned to spend four to 6 h per week, consisted of 45.85% of the total number, while only 3.04% planned to spend more than 12 h per week.

Motivations for Enrolling Of the total 3299 responses, 65.33% considered *the course is relevant to my academic field of study* important (the scales are moderately important, quite important, and very important). There were 64.89% out of the 3289 responses who thought *the course teaches skills that will help my job/career* important. Approximately 90.01% participants out of the 3294 responses considered *taking this course will be fun and enjoyable* important. Of the total 3259 responses, 51.37% selected *curious about what it is like to take an online course* important.

Existing Materials

We evaluated the positive features and deficiencies for the entire course in terms of the four ARCS components. Results are shown in Table 1. The course videos were determined to already include many of the ARCS strategies. We decided to omit redesigning the videos and to focus on other course components, which a designer would be in a position to control and manipulate, such as the course emails, discussion forum threads, and course pages.

Motivational Objectives

Assessments were included to determine whether these motivational objectives were achieved. Since these were online courses, it was impossible to observe students' reactions to the motivational strategies. Other measurements like surveys and interviews were used as evaluation methods. Motivational objectives and measurements are shown in Table 2.

Potential ARCS Strategies

We produced a list of ARCS strategies target for the beginning, during, and the end of the course. This list was not limited by other constraints such as time and resources.

Table 1 Existing materials aqnalysis per the ARCS

Component of ARCS	Features
Attention	Positive features: • The instructor uses enthusiastic tones in the video to sustain students' attention. • The instructor uses annotation pens that can draw and write on the slides and is recorded in the video. The instructor is showing in a picture-in-picture frame in the video to use gestures and movements. • The instructor uses large amount of examples for topics that are hard to understand and for calculations. • Each video includes several in-video questions, which are normally multiple choice or simple fill in blank questions, to help learners focused. • 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. Course pages: • Use buttons within pages to make course pages look differently. • Use interactive tools (ZeeMaps) embedded in a course page to let students pin their locations on the map. Deficiencies • Weekly emails have similar structure that is not appealing to students especially in later part of the course. • Most course pages contain texts only information. Students may lose attention reading long texts.
Relevance	Positive features • 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. • 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. • Bi-weekly problem sets contain problems that are real-world questions. 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 job.
Confidence	Positive features • Handwritings make demonstration even easier to understand. • Learners can easily control the videos by speeding up, slowing down, pausing or watching the video again. • The instructor provides a written or oral explanation to most in-video questions after students answer them. 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.
Satisfaction	Positive features • The course provides a free statement of accomplishment for students who meet the criteria as a certificate showing their work. • 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. 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. • It is not very clear how this course or which units can be used in other fields.

Strategy Selection

The strategies were selected based on the available design time and resources, number of strategies, and whether these strategies would distract students. Keller (2010) suggested to combine strategies that involved more than one component in ARCS. The list of selected motivational strategies is presented in Table 3.

Strategy Integration

Since these were self-directed online courses, the detailed lesson plan was modified into a weekly course plan, providing an outline of learning objectives, potential motivational problems, and selected motivational strategies. A sample lesson plan including detailed week one content and activities is shown in Table 4.

Table 2 Motivational objectives and assessments per the ARCS

Motivational objectives	Assessments
The course will capture students' attention and present clear enough information as well as structure of the course.	Interview asking students whether the pages and course emails captured their attention, and whether they were able to find information easily.
Students will develop a sense of perceived relevance of the course.	Surveys and interviews asking how they can apply what they learned from the course to life and other subject areas.
Students will become confident and believe they can achieve their goals.	Interview asking whether confidence level changed during the course.
Students will feel they have achieved something from the course.	Interview asking whether they have developed a sense of achievement.

Materials Development

Table 5 contains a list of strategies and related course materials and activities that integrated these strategies.

Motivational Strategy Evaluation

During the time to prepare course 2, we obtained informal feedback from the discussion forum of course 1, the instructor, and other course team members. Additionally, we used a preliminary data analysis of the *IMMS* in course 1 to revise the motivational strategies for course 2.

Study Results

The Survey Results

Motivation in Terms of the ARCS In course one, 163 out of 10,399 learners completed the *IMMS*. The response rate was approximately 1.57%, which is typical for surveys in MOOC environment. In course two, 266 out of 10,996 learners completed the *IMMS*. The response rate was approximately 2.42%. Duplicate responses and missing values were removed. Cronbach's alpha of the *IMMS* and each of the four constructs were between 0.74 to 0.92. Tables 6 and 7 present descriptive statistics of the *IMMS* in course 1 and 2 respectively.

Major Changes Between Iterations Descriptive statistics of the course 1 *IMMS* showed that attention and satisfaction had high mean scores. Relevance received the lowest mean score among the four components. Thus, a major change in course 2 was to improve participants' perceived relevance of the content. We included previous students' statements about their experience in the chemistry MOOC in course 2 to enhance relevance. To improve confidence strategies, praise for good work and encouragement were added in quiz feedback. Explanations for the incorrect selections were included with related concepts and videos, as well as key equations.

Although attention strategies in course 1 were relatively effective, we employed visual changes to make course 2 more appealing according to the feedback from a web design expert. We included more white space to improve readability and modified the navigation system of the course pages to indicate

Table 3 Strategy selection per the ARCS

Time	Selected strategies
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).

Table 4 Sample course plan

Course information
Course topics: basic chemistry
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.
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).

current pages. We used a light gray background color to differentiate content with white background color when presenting weekly topics in the syllabus. Additionally, we removed decorative images to minimize distraction.

The Interview and Design Journal Results

Attention Course emails caught learners' attention. The content that the interviewees paid attention to included upcoming topics and reminders of due dates (71.7% of interviewees). Interviewees treated emails as "roadmaps" that helped them see the big picture of the course (13.0%). Additionally, the interviewees considered the encouraging tones in these emails an effective way to connect with the

Table 5 List of motivational design product

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

Table 6 Descriptive statistics of the IMMS in course 1

	N	Minimum	Maximum	Mean	Std. deviation
Average	110	2.75	4.91	4.15	.470
A_ave	109	3.00	5.00	4.29	.448
R_ave	110	2.22	5.00	3.99	.614
C_ave	110	2.00	5.00	4.05	.586
S_ave	108	2.33	5.00	4.27	.669

instructor (26.1%). 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.

The course pages such as syllabi and grading information also caught attention (63.0%), especially at the beginning of the course. Students looked for course content/introduction, course schedule, and/or assignments and their due dates. One interviewee stated: "I read them for the general idea and to see what the timing is, 'When do I need to do this?' That's what I do."

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 course pages as being "clear" or "straightforward" (17.4%). For example, one interviewee

Table 7 Descriptive statistics of the IMMS in course 2

	N	Minimum	Maximum	Mean	Std. deviation
Average	184	2.25	4.89	4.08	.515
A_ave	186	1.50	5.00	4.17	.575
R_ave	185	1.67	5.00	3.95	.582
C_ave	184	1.78	5.00	4.03	.566
S_ave	184	1.17	5.00	4.14	.728

pointed out 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 … 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.

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, 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 Unlike taking mandatory courses, most interviewees chose to take MOOCs voluntarily for self-determined reasons. Thus, the relevance of these courses was also self-determined. Several interviewees felt that other subjects became clearer after they completed the chemistry course (17.4%). In the following statement, an interviewee discussed how learning chemistry from the course changed his ways of thinking:

> When I am doing this course, I started to look at everything at different angles than I looked at it before [laughs]. 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 different[ly].

Another interviewee explained 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.

Other interviewees found the course useful either in their future studies or jobs (21.7%). Some planned to go to college, graduate school, or professional school to further studying. Some working in chemistry-related fields found the chemistry MOOC helped their jobs. Below is a statement made by non-U.S. student who was going to college in the USA:

> 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.

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 (21.7%), such as helping their kids learn chemistry, so they did not consider other application or usage important. 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."

The design journal documented the content types in the discussion forum. Approximately 90% of all posts were knowledge-related: learners posted questions that they had, they asked why their solutions to certain exercise problems were incorrect, and they also posted extra learning resources or more advanced topics. A few posts were about clarifications for the final exam such as how long the exam lasted. Interestingly, posts' titles included the word "exam" always had relatively higher number of views.

Confidence 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. The instructor explained difficult concepts clearly and organized her lectures well starting with easier concepts and then transitioning to more complex ones. All these positive factors in the videos helped build the interviewees' confidence and made them believed they were able to learn the materials (26.1%), as stated in the following quote:

> The way that she [the instructor] taught the class was very knowledgeable and very easy to understand ... 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.

Other factors interviewees noted that affected their confidence included clear course information about what was expected and the estimated amount of work in the course, as well as manageable assignments (21.7%). 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.

Satisfaction Most interviewees felt satisfied, a sense of achievement, pride, and happy after taking the chemistry MOOCs (93.5%). The knowledge they learned in the courses gave them the satisfied feeling (50.0%). For some, being 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.

For many interviewees, to achieve their personal goals in the course, no matter what these goals were—to gain some knowledge or to see how instructors from a different country taught—gave them great satisfaction (34.8%). Several interviewees considered that the feelings of challenge provided them with great satisfaction (21.7%), 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!" Even the simple sense of completion sometimes could add satisfaction (26.1%). 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.

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 (45.7%). One interviewee pointed out: "It [the SOA] is a proof that I studied these materials, and reached a certain level of mastery of it. It's cool. It's interesting."

To the contrary, several interviewees did not care about the SOA at all (13.0%). One interviewee even did not know if she obtained it after the course had been over for a while. These individuals did not find the SOA of any particular satisfaction 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: "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."

The design journal revealed that 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 enjoyed the course.

Discussions

This study served as a starting point to examine motivational issues and to motivate learners in the MOOC environment. We discuss the results with the uniqueness of MOOCs and also provide implications of motivational design in MOOCs.

Perceptions of the ARCS by the IMMS

The *IMMS* measures learners' reactions to the learning materials which incorporated the ARCS strategies. The *IMMS* from both courses indicated that respondents considered attention the best component and relevance the worst even after we revised relevance strategies in the second course. The same pattern was also revealed in the interviews. The reason that the four components as well as the overall survey means were lower in course 2 than course 1 is that course 2 had more outliers on the extreme low side, meaning that more learners perceived the ARCS materials not so effective in course 2. However, we did not find the same pattern from the interviews possibly because the interview sample was small.

Selectively Paid Attention

Interviewees showed patterns of scanning and selectively paying attention when browsing course emails and course pages: depending on what they wanted, learners chose different information to read. Interviewees might or might not have noticed other design components such as previous students' statements about the course, but none of them were impressed enough to mention during the interviews. Instead, learners appreciated the clean design and did not have any difficulties finding the information they needed.

Implications for Instructional Design Email proved an effective method to catch learners' attention in this study. Emails should be concise and contain information about course content and/or assignment deadline reminders. Previous studies, although not in MOOC environments, have demonstrated the effectiveness of embedding ARCS strategies into online course emails (Huett et al. 2008b). ChanLin (2009) reported that it was effective to send frequent reminders and rewards to keep students continue learning. The instructor's supportive and encouraging tone in the emails was another way to attract attention that several interviewees noticed and appreciated. This is consistent with previous studies that online students' attitudes are affected by the teacher's social presence (Richardson and Swan 2003; Swan and Shih 2005).

When designing course pages, eliminate irrelevant and unnecessary information. Use white spaces and section headers to help learners locate relevant information quickly and avoid information overload (Gerson 2000).

Self-Determined Relevance

Among the four ARCS components, 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 high demand from employers, nor is it easily applicable to everyday life (at least not the topics introduced in these two MOOCs). It is also possible that, due to the varied goals learners have in taking these MOOCs, they perceive relevance differently. Although Kizilcec et al. (2013) emphasized that many MOOC learners aimed for future career opportunities, the current study found that a large number of learners were seeking knowledge and/or enjoyment from the courses. The MOOCs might be relevant to their own interest but certainly did not have a direct relevance to their life or career.

Implications for Instructional Design 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-determined. From the Selectively Paid 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 are too long with too many relevance factors. Multiple assignment types can be used for learners to choose the most relevant based on her own goals and backgrounds (Koper and Olivier 2004).

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 only introductory level. It is also possible that the learners who participated in surveys and interviews were capable persons who always believed in themselves.

Implications for Instructional Design Various course activities with an appropriate level of difficulty should be included in MOOCs. Being able to master the content to pass the exercises/exams also enhanced learners' confidence in the course. This is consistent with previous research on self-efficacy and learning goals: learners' self-efficacy increases when there is progress in learning and they achieve their goals (Schunk 1990). Thus, learners can be provided with multiple opportunities to complete assignments. Clear course introduction and grading information helped them create appropriate expectations for the course.

For learners who might consider the content difficult, the instructor could show sympathy and use encouraging tones in videos, because it would 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." Existing studies have produced similar findings concerning influences that instructors could have on students' confidence (Small and Gluck 1994).

Different Sources of Satisfaction

In this study, satisfaction seemed to come from three different aspects: knowledge learned, learners' capabilities of learning and completing a course, and the statement of accomplishment. The knowledge part is not hard to understand because a large percentage of interviewees chose the chemistry MOOC to pursue an interest or to refresh knowledge. Being able to keep up with the course made a few interviewees proud of themselves when they were able to keep up with the course pace.

The statement of accomplishment (SOA) is more complicated in terms of affecting learners' feelings in the course. Though many interviewees mentioned that the SOA was not their goal for taking the chemistry MOOCs, nor was it of any use for their careers, many admitted that obtaining the SOA at the end of the course generated a great 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, which is similar to the result reported by Zheng et al. (2015).

Implications for Instructional Design 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. If future designers want to increase learners' satisfaction in this way, but an SOA is not available, other proofs like digital badges may be used as alternatives to the SOA (Gibson et al. 2015).

Limitations

The study was not able to evaluate the effectiveness of the ARCS strategies on learners' motivations in these two MOOCs using an experimental design. This was because when the study was planned and conducted, A/B testing was not widely available to partners in Coursera. Another limitation of the study was that the main data sources, surveys and interviews, were self-reported, and thus might be biased. The fact that a proportion of learners in course 2 had taken course 1 was the third limitation. There might be a training effect for the course 2 participants carried over from course 1. Future studies should use independent courses to eliminate the training effect.

Future Directions

Future studies can examine whether the strategies affect learners' motivation and retention by an experimental design study. Relevance was shown as the weakest component in this study. More relevance strategies, from existing studies on the ARCS model in other learning environments (e.g., Chang and Lehman 2002; Means et al. 1997), should be designed when conducting the experimental design study. More objective data from the platform, such as page views or time spent on task together with self-reported measures will provide a more comprehensive perspective on learners' motivation (Touré-Tillery and Fishbach 2014).

Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflict of interest.

Appendix

1. How many MOOCs are you currently taking? What do you think about them?
2. Why did you sign up for our course?
3. Are you still keeping learning the course?
4. What are your overall opinions on our course site design? What about content presentation and display?
5. What do you think about our course emails (if they answered yes to whether they read the emails)?
6. What do you think about our course pages (if they answered yes to whether they check the course pages)?
7. What are some of the connections you can draw from taking our course and other courses you are taking or your job?
8. While taking the course, do you believe you can learn what you want to learn (or perform as you expected based on their goals stated previously)?
9. What would you feel when you accomplished your goals in this course?
10. Do you want to learn more chemistry-related topics in the future?
11. Please make free comments about any topics we discussed today.

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